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January
1940

Nebraska
COOPERATIVE EXTENSION WORK
IN AGRICULTURE AND HOME ECONOMICS
U. of N. Agr. College & U. S. Dept. of Agr. Cooperating
W. H. Brokaw, Director, Lincoln

Extension
Circular
769

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By
Ivan D. Wood, Extension Engineer
R. O. Pierce, Assistant Extension Engineer

IRRIGATION OF THE FARM GARDEN

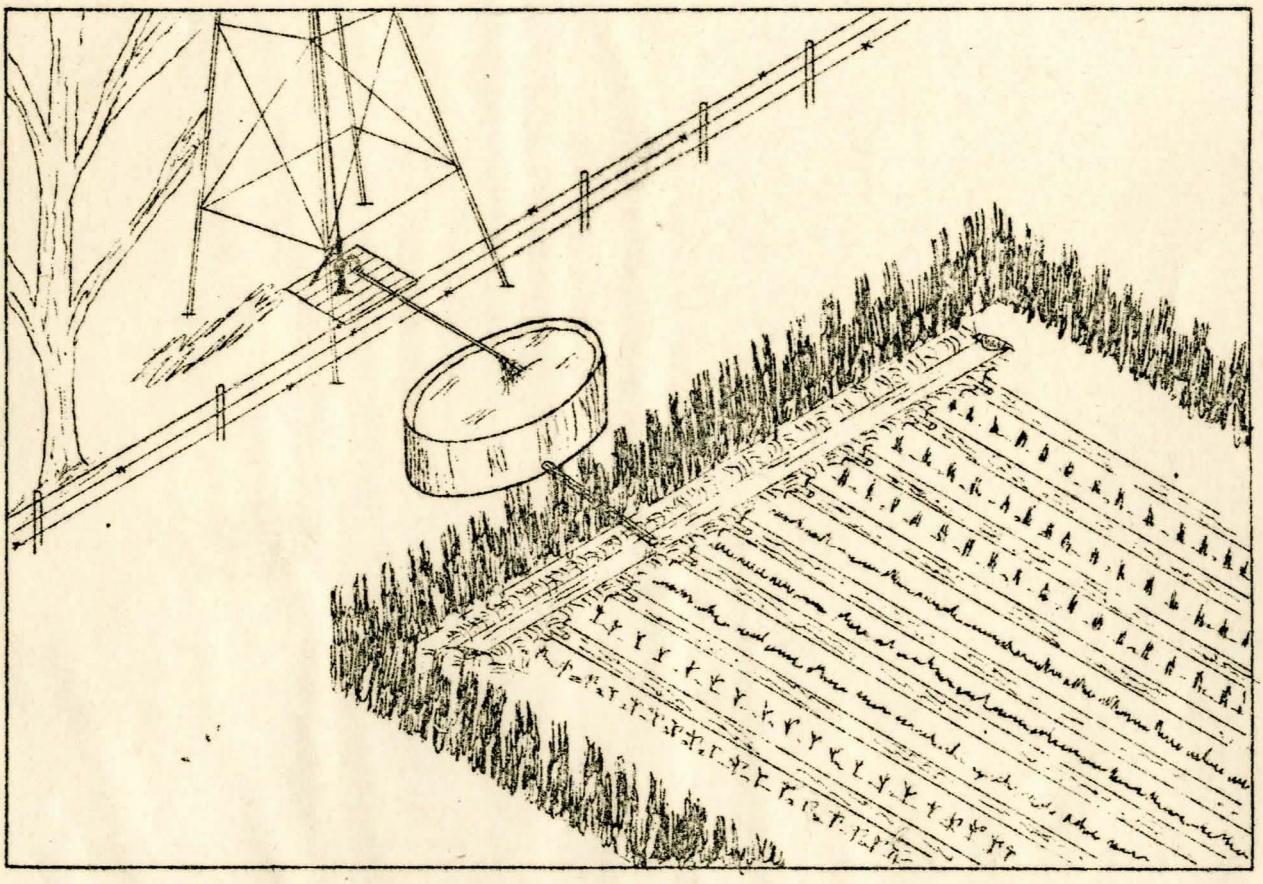

Figure No. 1.
Distribution of Water from the Farm Well to the Garden Plot using a Horse Tank for Storage. A head ditch or furrow laid on the contour distributes the water to lath boxes or pipes from which it runs down the furrows between the rows.

SUMMARY AND ILLUSTRATIONS.

Vegetables contain a high percent of water and to produce a crop of high quality and high yields sufficient moisture must be supplied to mature the crop at an optimum rate.

I. LOCATION OF THE GARDEN

A. In locating the garden the following points should be taken into consideration. Lighter soils do not bake and get out of condition as easily as do heavier ones. Lighter soils warm up sooner in the spring but may be more difficult to irrigate if too much sand is present. Lighter soils make better use of the rain that falls since runoff is not so great and evaporation from the surface is less.

B. In seeking a location for ease of irrigation place the rows up and down the slope and seek slopes of 2 to 3 inches per 100 feet if possible. Slopes of from 18 inches to 2 feet per 100 feet will be found difficult to irrigate.

C. In seeking good locations for gardens advantage should be taken of windbreaks in the form of hedges or trees, which will give protection against hot winds and encourage the drifting of snow.

D. If irrigation is contemplated the availability of the water supply must be considered in locating the garden plot.

II. CONSERVATION OF MOISTURE

Nebraska silt loam soils will hold as much as 2 inches of water per foot which is available to crops. Sandy soils will hold from 1 1/2 to 1 3/4 inches of water per foot. From 4 to 6 inches of water stored in the soil during the fall and winter months may be a big factor in producing a good garden the following year.

A. Listing or lister damming the garden soil in the late summer or fall may prove beneficial in conserving moisture by retarding runoff and preventing the snow from drifting. There may be a decided advantage in the use of mulches of straw for long-season crops such as tomatoes and potatoes but it is not recommended for the short season crops as radishes, lettuce, etc.

B. Snow Traps and Snow Ridging - Snow often blows from the garden and drifts elsewhere and to prevent this ordinary slat fencing may be used around the north and west or bundles of corn or sorghum may be placed along the fence line and held in place with a strand of wire. The planting of a strip of tall growing sorghum around the garden area will often give protection from hot winds in summer and cause snow drifting in winter. Snow may be encouraged to drift by building snow ridges with an "A" drag. Snow may be dumped on the garden plot by the use of a buck scraper, Fresno or similar implement.

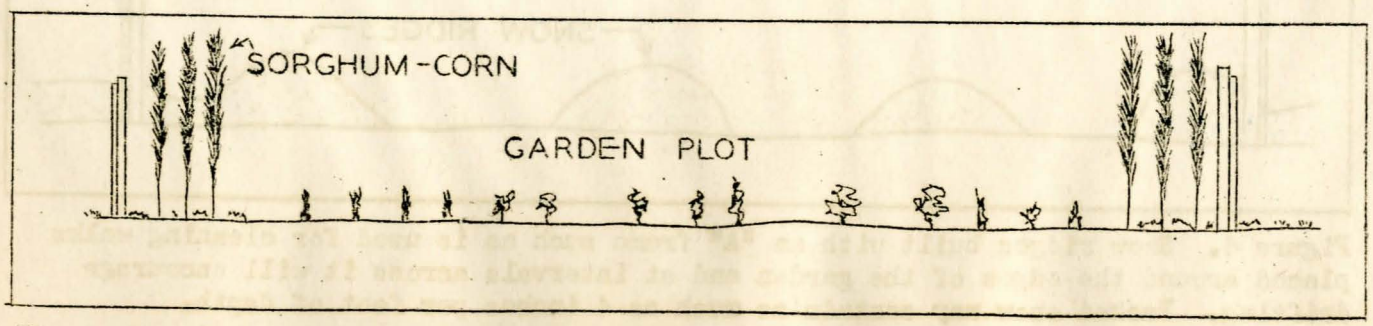

Figure 2. Sorghums of the tall variety or other similar crops planted around the edges of the garden may provide some measure of protection from hot winds and encourage the drifting of snow in winter.

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Snow as it falls contains slightly more than an inch of moisture per foot but wet, packed snow may contain 4 inches per foot of depth.

C. Protection from hot winds is very important and may be accomplished in the manners described above.

D. In parts of the state where summer fallow is successful for grain crops, it is logical to believe the same practice will be successful for gardens. The surface of the fallow must be kept clean of weeds and rough to retard evaporation.

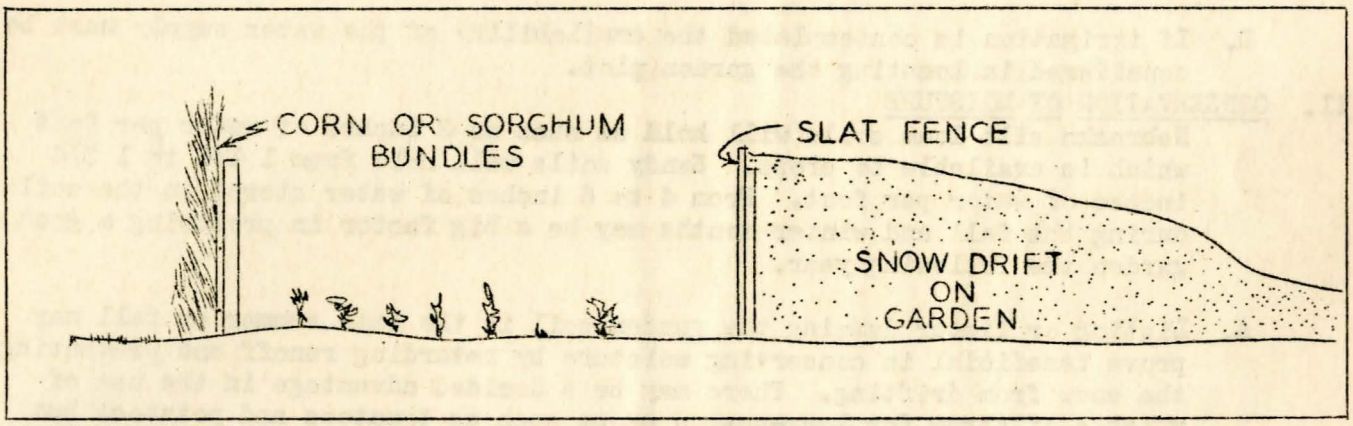

Figure 5. Corner sorghum bundles laid against the garden fence and held in place with wires provides some measure of protection and if spaced slightly will encourage snow drifting. Slat fencing will also produce deep snow drifts under certain conditions.

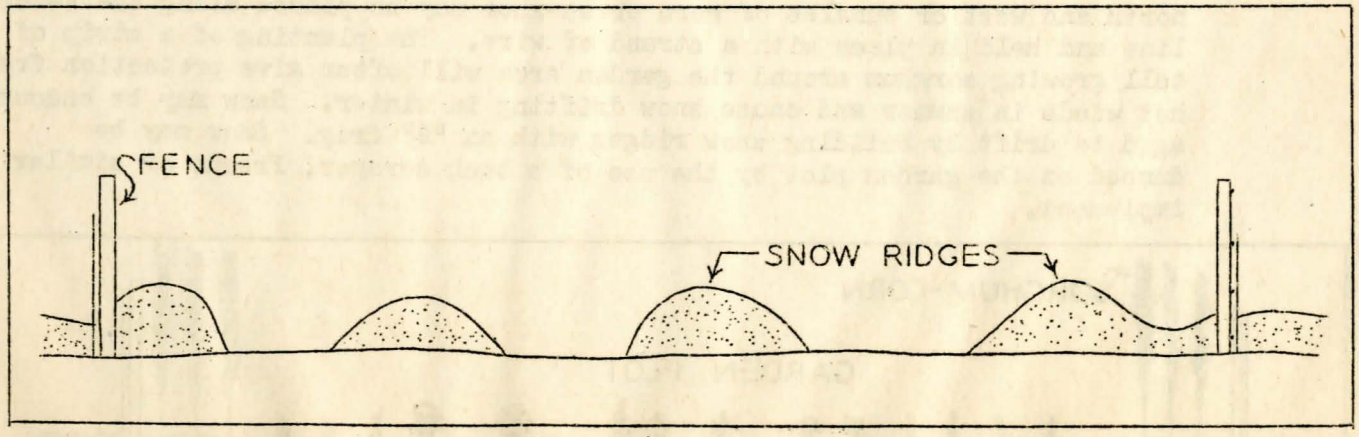

Figure 4. Snow ridges built with an "A" frame such as is used for cleaning walks placed around the edges of the garden and at intervals across it will encourage drifting. Packed snow may contain as much as 4 inches per foot of depth.

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III. IRRIGATION OF THE GARDEN

A. It has been shown that large yields of high quality vegetables can be grown by the proper application of irrigation water to the garden. Time is required to irrigate with limited supplies and a crop may be ruined if irrigation is delayed too long.

B. Farm wells and windmills will supply from 2 to 3 gallons per minute. In addition to supplying the domestic water supply the farm well can often supply from 3000 to 5000 gallons per week for irrigation purposes. This would supply irrigation to from 1/9 to 1/5 acre per week with a 1 inch application. See Figure 1 on the front cover of the circular.

By running the windmill in the late summer and fall months a subsoil supply may be built up.

C. Piping often presents a problem. Used black pipe of 1 inch diameter is sufficient for most purposes and can often be obtained for from 4 to 5 cents per foot. A trough built of 1 x 4 inch material painted can be made for about $4.00 per 100 feet and will be found convenient for conducting water from the windmill to the garden or point of storage.

D. Better results may be had when irrigating with a limited flow if some form of storage like an old horse tank can be used. A greater rate of flow can be secured in this way and a more even distribution may result. See Figure 1 on the front cover of this circular.

E. There is opportunity to use small irrigation wells in the river valleys where the water table is 10 feet or less below the surface. Small pipe casings are used and the pumping is done with $1\frac{1}{2}$, 2, or $2\frac{1}{2}$ inch horizontal centrifugal pumps. Small farm engines or old automobile engines may be used for power.

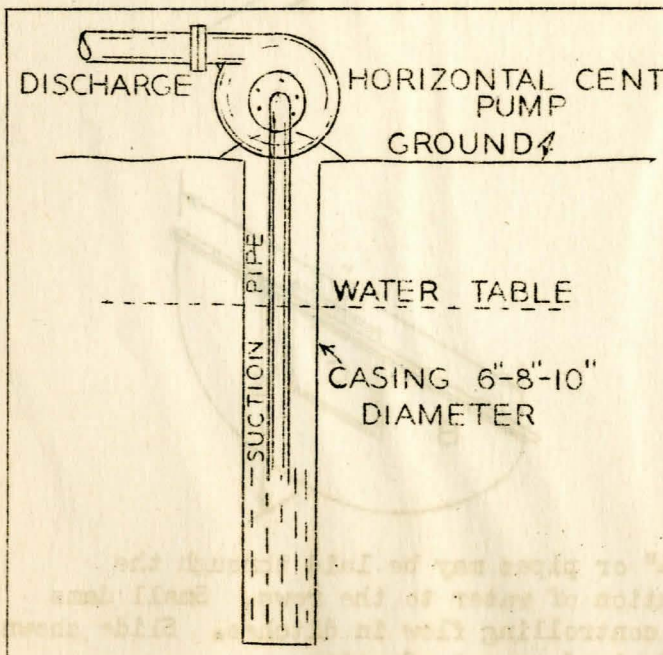

Figure 5.
There is often an opportunity in river valleys to sink a small casing into the water bearing gravel and to install on the surface a cheap horizontal centrifugal pump of $1\frac{1}{2}$ or 2 inch diameter for irrigating a large garden.

F. The type of pump, shown in Figure 5, is also adapted for pumping from streams and lakes. The pump should be set within 10 feet of the water surface. The suction lines and discharge pipes should be at least 1 inch larger in diameter than the diameter of the pump discharge.

G. It is often possible to put a dam across a ravine to produce a farm pond which will supply enough water for garden irrigation. The ground below the dam may sub-irrigate sufficiently in some locations. In other cases a pipe thru the dam will conduct a supply to the garden plot when needed.

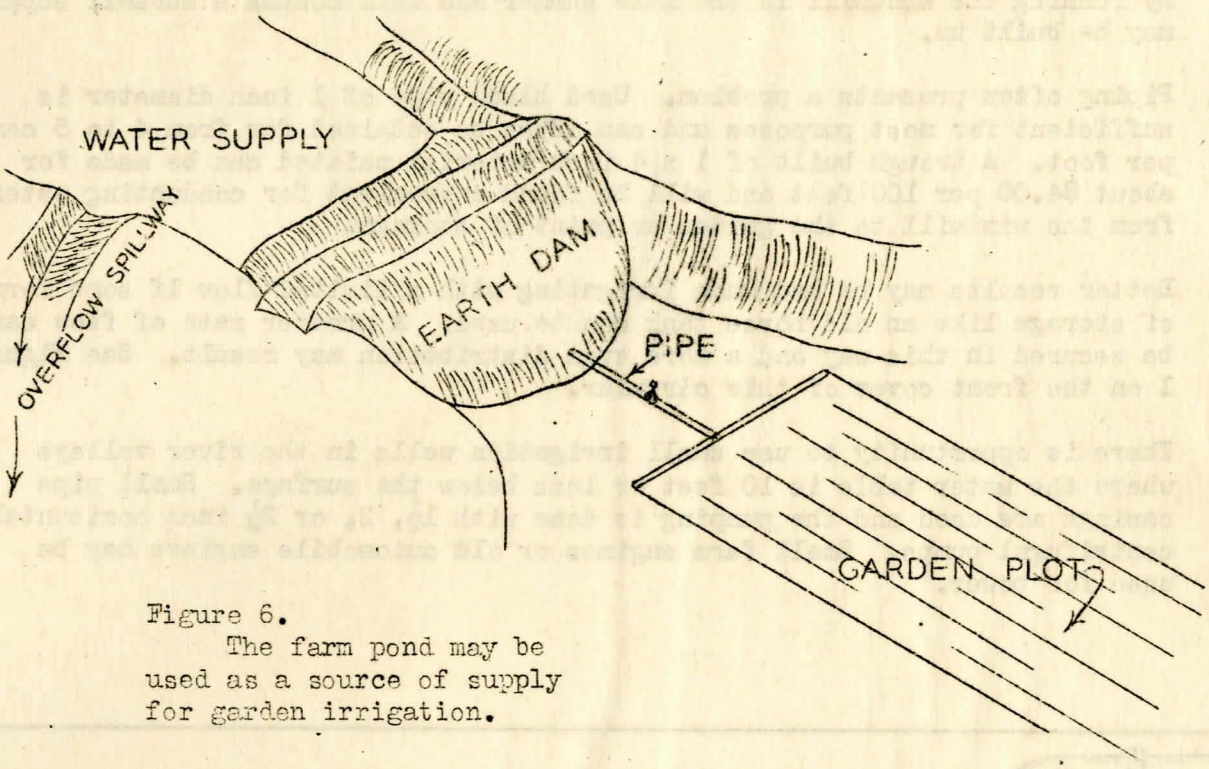

Figure 6.
The farm pond may be used as a source of supply for garden irrigation.

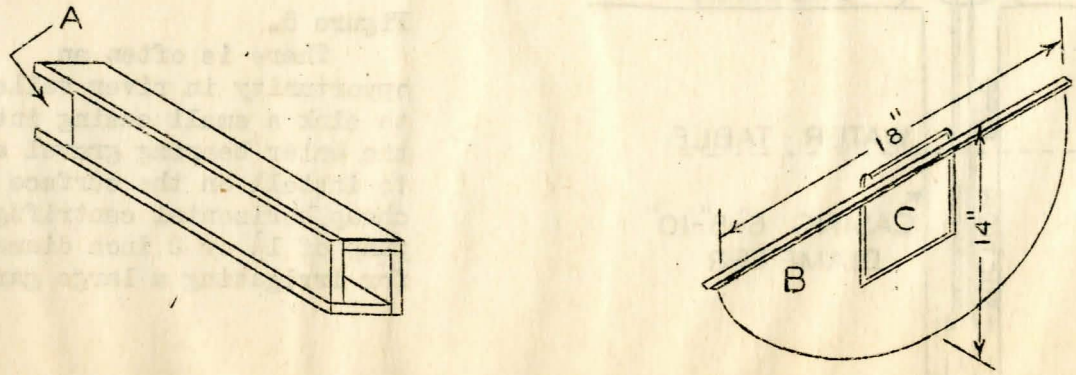

Figure 6. (Lower part) The lath box at "A" or pipes may be laid through the ditch embankment to insure uniform distribution of water to the rows. Small dams "B" made of 20 gauge metal may be used for controlling flow in ditches. Slide shown at "C" permits the operator to bypass any desired amount of water.

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H. Runoff water from the farm yards or from nearby pasture lands may be diverted by means of a furrow to a small reservoir at the upper side of the garden. This reservoir is made by throwing up an embankment of earth with a plow. Thru the embankment small pipes or lath boxes allow the water to run directly to the rows of vegetables. Often an application of several systems of moisture conservation and irrigation can be applied to one garden with success.

I. Water should be applied to the soil so that a uniform distribution is obtained if possible. In sandy soils and on flat slopes more water may be turned into each furrow than on hard soils and steep slopes.

J. For the irrigation of most garden crops the use of small furrows between the rows will be found effective. For short season crops such as lettuce or radishes one furrow may be used to several rows since the rows are often placed as close as 8 to 10 inches apart.

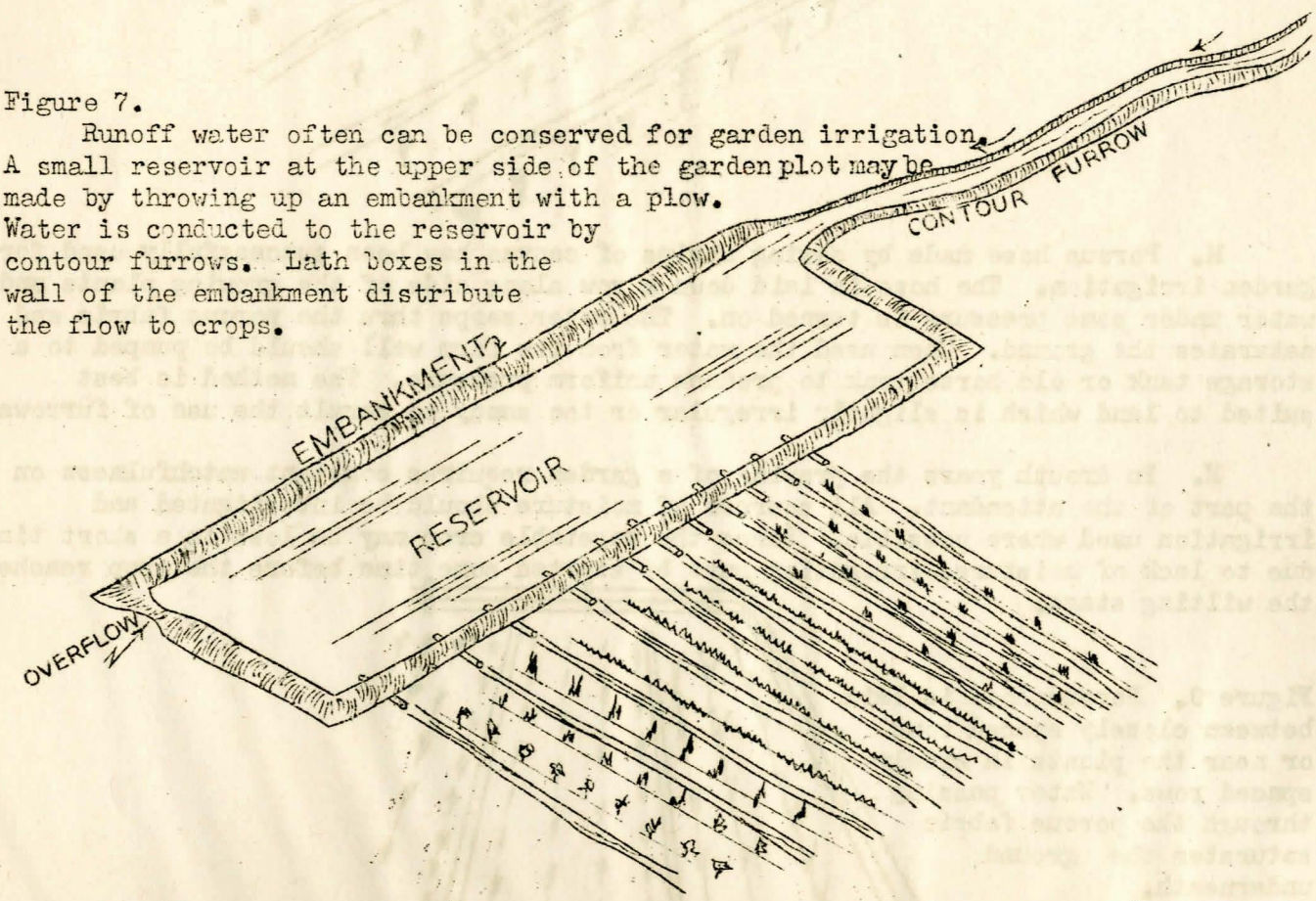
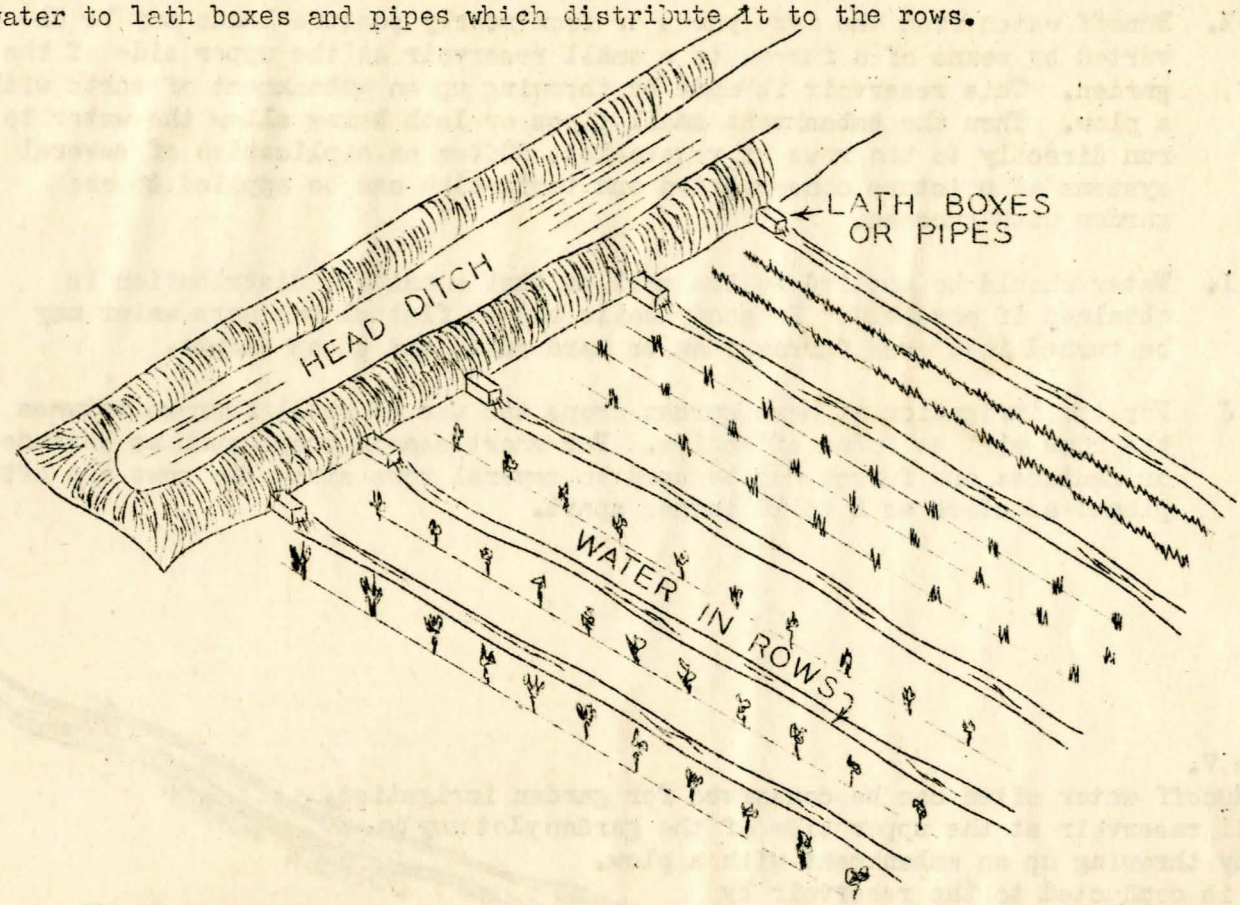


Figure 7.
Runoff water often can be conserved for garden irrigation. A small reservoir at the upper side of the garden plot may be made by throwing up an embankment with a plow. Water is conducted to the reservoir by contour furrows. Lath boxes in the wall of the embankment distribute the flow to crops.

L. A head ditch consisting of a lister furrow from which the dirt has been cleaned with a shovel will serve to carry the head of water to the individual rows. Water may be removed from the head ditch to each individual rows by means of small wooden boxes made of lath, pieces of 1/2 or 3/4 inch pipe, or short pieces of old garden hose. These are laid thru the bank of the ditch and may be plugged with corn cobs to control the flow.

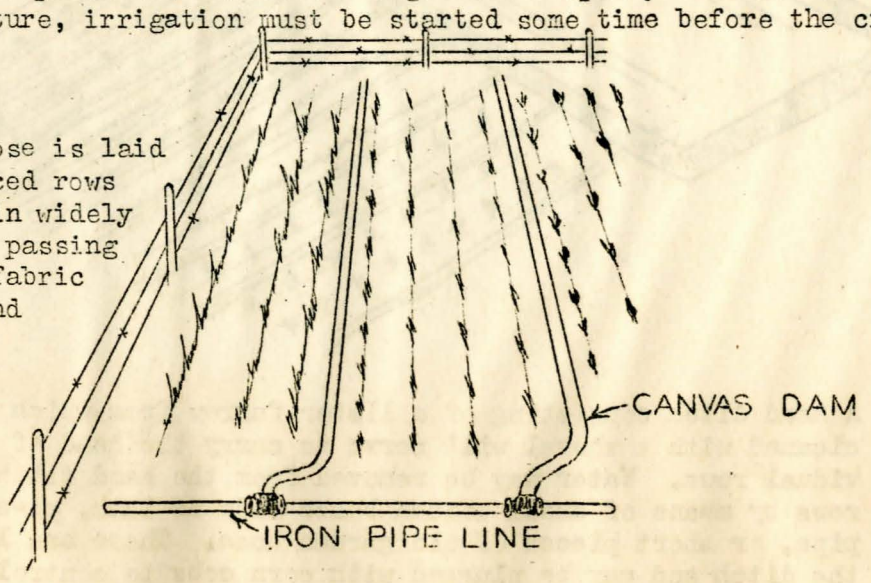
Figure 8. The head ditches consisting of a furrow may be used to conduct irrigation water to lath boxes and pipes which distribute it to the rows.



M. Porous hose made by sewing strips of canvas has been successfully used for garden irrigation. The hose is laid down a row along side of the growing plants and water under some pressure is turned on. The water seeps thru the porous fabric and saturates the ground. When used the water from the farm well should be pumped to a storage tank or old horse tank to produce uniform pressure. The method is best suited to land which is slightly irregular or too sandy to permit the use of furrows.

N. In drouth years the growing of a garden requires constant watchfulness on the part of the attendant. All sources of moisture should be investigated and irrigation used where possible. Since the vegetable crop may be lost in a short time due to lack of moisture, irrigation must be started some time before the crop reaches the wilting stage.

Figure 9. Porous hose is laid between closely spaced rows or near the plants in widely spaced rows. Water passing through the porous fabric saturates the ground underneath.



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IRRIGATION OF THE FARM GARDEN

I. INTRODUCTION.

Recent drouth years have demonstrated the difficulty of growing a vegetable garden without the use of supplemental moisture. Practically all vegetables contain from 85 to 90 percent of water and good yields as well as high quality are dependent upon a supply of moisture which will mature the crop at the optimum rate. Some vegetables may survive prolonged drouth periods but they are liable to do so at the expense of quality and yield.

Even before the recent drouth years, dry periods of 10 days or more duration during which the effective rainfall was less than ½ inch, have occurred 171 times during 43 years, since 1888 at Lincoln, Nebraska. In other words, about one-third of the days between May 1 and September 30 were drouth days for vegetable production.

The following paragraph from Bulletin 278 of the Nebraska Experiment Station states the water requirements of vegetable crops as follows:

"One inch of water in one rain or from irrigation, should maintain vigorous growth for five to seven days during very hot weather and ten days to two weeks in cooler weather. With smaller applications much more frequent irrigations and a greater total amount of water are necessary to maintain the same growth, and the final results are very likely to be less satisfactory. Heavy applications of two inches or more are also less desirable because the soil may be poorly aerated for a time and the loss from rotting, blight, etc. will be increased."

13,576 gallons of water are required to apply a one inch depth to an area as small as one-half acre. To pump this amount of water with a windmill which delivers 3 gallons per minute would require 76 hours, or nearly 8 days of 10 hours each.

II. LOCATION OF THE GARDEN.

Some of the things which should be taken into consideration in locating a garden plot are soils, slopes, protection from hot winds and availability of water supply.

Often there is not much choice as to soils but the lighter more sandy types are to be preferred since they do not bake and get out of condition as easily as heavier soils. Lighter soils make better use of the water which falls in the form of rain since there is less runoff and probably less evaporation from the surface layers.

The rows are laid out up and down the slope for best success in garden irrigation. Rows running across the slope are not satisfactory since the stream is liable to break from one row to another unless the slope is slight, less than 6 inches per 100 feet. Slopes of 2 to 3 inches per 100 feet in the rows or from 3/8 to 1/2 inch per rod will be found very satisfactory. Slopes of 18 inches to 2 feet per 100 feet or from 3 to 4 inches per rod may be found difficult to handle unless very small streams are used in each row.

Protection from hot winds is very important and advantage should be taken of windbreaks which will protect from the south and southwest. Hedges or trees which will encourage the drifting of snow are very advantageous and should be considered in connection with garden location.

When the garden plot is to be irrigated the availability of the water supply, whether from the well, stream or from diversion of runoff must be given careful consideration.

III. CONSERVATION OF MOISTURE.

It is possible to store large quantities of water in the upper 3 feet of most Nebraska soils in the fall and winter months for use of vegetables the following growing season. Silt loams soils will hold as much as 2 inches of water per foot which is available to plants, and sandy soils as much as 1½ inches. Six inches of water stored in the soil, in addition to that which falls in the form of precipitation or which may be added as supplemental irrigation, may be a great factor in the production of a good vegetable crop.

A. Surface Treatment for Moisture Conservation.

After the last crop has been removed in the late summer or fall months, the garden plot may be given one or more of the following treatments which help conserve moisture. Lister furrows, dammed with a shovel or damming attachment at intervals of 10 feet, may prove beneficial in conserving fall rains and in holding snow where it falls. The dams should be omitted if fall irrigation is planned.

Working the surface with a cultivator and leaving trash or a mulch of straw to prevent evaporation and to assist in preventing runoff, may prove beneficial. There is a decided advantage in using a straw mulch during the time vegetables are being grown. The benefits are greatest with long-season crops such as tomatoes and potatoes but mulching is not recommended for short season varieties as radishes, leaf lettuce, peas, cauliflower and early cabbage. Mulches should not be applied until the crops are well established with the exception of potatoes which may be covered just before the plants come through the soil.

B. Snow Traps and Snow Ridging.

A ten inch snow fall will equal about one inch of rainfall ordinarily but due to high winds snow is often of little benefit to the garden since it drifts to places where the moisture is of little use. The garden plot can often be placed where high drifts are known to occur due to the effect of trees or hedges. In the case of a permanent location for the garden plot, such protection should be planted.

Ordinary slat fencing around the north and west side of a garden area will often cause drifts 4 feet deep to form. In some observations made by the North Dakota Agricultural College it was shown that as much as 4 inches of moisture per foot of packed snow could be obtained from drifts. In some instances, as much as 16 inches of moisture or a season's rainfall was stored in the soil from snow drifts. Some farmers in this state have set old cane or corn bundles along the garden fence to provide protection from hot winds in summer and to produce snow drifts in winter.

Snow can be prevented from blowing away by the use of snow ridges built by the use of an "A", such as is used around many farms to clean off pathways and sidewalks. Ridges of snow are built entirely around the garden and cross ridges are placed about one rod apart. When these ridges have drifted full to the top the "A" can be used again and higher ones constructed. Wet, thawing snow often can be dumped onto the garden space by use of a buck scraper, a Fresno, a hay sweep or even a plank set on edge with a chain attached to the ends to provide a hitch. This wet snow may contain as much as 4 to 5 inches of water per foot in depth.

C. Protection from Hot Winds.

Numerous examples can be pointed out where trees or other forms of windbreak have provided protection from hot winds so that crops have been produced which otherwise would have been ruined. The planting of tall growing sorghums entirely around the garden might well provide protection from hot winds and produce a snow trap in winter as described above.

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D. Summer Fallow Methods.

In those portions of the state where summer fallow is practiced for field crops there is reason to believe the same practice will be successful in garden culture. The surface must be kept rough to retard evaporation and must be kept clean of weeds which are great users of moisture. The fallowed surface may also be mulched with straw to retard evaporation and assist in preventing runoff.

IV. IRRIGATION OF THE GARDEN.

It has been shown by experiment that splendid yields of high quality vegetables can be produced by the proper application of irrigation water to the garden. It must be borne in mind, however, that the application of water in sufficient quantities to be effective takes considerable time with the limited supplies usually available on the farm. The crop may be lost or seriously injured if water is applied too late. The sub-soil moisture supply should be carefully watched and the application made in time to prevent wilting.

A. Sources of Supply.

The Farm Well.

In some parts of the state the farm well will scarcely supply enough water for the livestock but over most of the state a plentiful supply of water exists and the windmill will pump enough to provide some supplemental irrigation for the garden.

The amount of water which the farm well will supply per minute depends upon the wind velocity, the size of the cylinder and the length of the stroke. From 2 to 3 gallons per minute is a usual flow. It is probable that the farm well will supply from 3000 to 5000 gallons per week for irrigation and this amount would irrigate from 1/9 to 1/5 of one acre with a 1 inch application of water per week.

1/5 acre is a strip of ground 87 feet wide by 100 feet long.
1/9 acre is a strip of ground 48 feet wide by 100 feet long.

The well can be used through the fall and late summer months to build up a moisture supply in the sub-soil to a depth of 3 feet in the garden plot for use the following season. This reserve supply may greatly lessen the amount of water required during the growing season.

One problem always encountered in the use of the farm well for irrigation is the pipe necessary to convey water to the garden. It is often possible to buy old black pipe of 1 inch diameter for 5 to 6 cents per foot. An economical trough can be made of 1" x 4" material and painted for around $4.00 per 100 feet.

Better results usually will be had with the use of the farm well if some sort of storage can be provided so that a supply of water can be pumped and used in a shorter period than is possible with direct flow. An old horse tank 10 feet in diameter and 2 feet deep will hold nearly 1200 gallons. A group of old oil barrels connected with pipe nipples will serve fairly well. Earth reservoirs are not to be recommended because of losses due to seepage.

Small Irrigation Well.

In many places along the river valleys where the water table is within 10 feet or less of the ground surface, small irrigation wells can be profitably installed for garden irrigation. A 6 or 8 inch casing made of standard pipe with slots cut in it with a welding torch can be sunk into the water bearing gravels with a small sand bucket. Some have used old range boilers with the ends cut out and welded together to make a casing. It is slotted as in the case of the pipe just described.

A small 2 or 3" horizontal centrifugal pump set on the ground surface with the suction pipe placed down inside the casing into the water will provide a flow of from 50 to 150 gallons per minute. A small farm gasoline engine will usually provide plenty of power.

Streams, Lakes, Ponds.

The same type of horizontal centrifugal pump as described above can be placed on the bank of a stream or pond and used to force water to a garden plot some distance away. The pump should set within 10 feet of the water surface, if possible, and the pipe used for the suction and discharge should be at least 1 inch larger than the size of the pump. That is, a 3 inch pipe for a 2 inch pump, etc. In some instances old threshing machine water wagon pumps have been ingenuously rigged up to pump for irrigation and operated with an engine rather than by hand.

In clear streams which are relatively free from floods and in large springs which occur in some portions of the state, the hydraulic ram is sometimes used for garden irrigation purposes. This device is operated from the flow of water in a drive pipe and forces a small quantity to a higher level. It has the advantage of operating all the time day and night and may be depended upon for long and reliable use.

Diversion and Seepage from Farm Ponds.

The farm pond made by placing a dam across a ravine often may furnish a water supply for the farm garden. In some locations, notably in the Republican River watershed, the soil conditions are such that portions of the ravine below the pond may become sub-irrigated and thus form a good place for the production of many kinds of vegetables.

At the time the dam is built it may be possible to place a 2 inch pipe through the embankment which will permit the use of water from the pond on a garden plot when irrigation is necessary.

Diversion of Runoff Water.

In most seasons enough water runs off from the farm yards to produce many crops of vegetables if it could be diverted to the garden. Often in a very dry year there will occur heavy showers of from $\frac{1}{4}$ to $\frac{1}{2}$ inch, most of which escapes by runoff and evaporation. If this runoff from yards higher than the garden plot could be diverted to it, the results often would be beneficial.

One of the best methods of using this runoff water in the garden may be described as follows: At the upper end of the garden a reservoir is made by plowing several furrows together to form a levee or embankment. The dirt may be packed by tramping and if some water is available to wet it while it is being packed, so much the better. It is necessary, of course, to have the bottom of this reservoir as level as possible so it will fill equally full of water and not break over the embankment at any point. To this reservoir one or more furrows may be run to conduct runoff water. Often a diversion ditch is available which carries water away from the buildings. A furrow running out across a piece of pasture land would be an ideal arrangement. At one end of the dirt reservoir a place for overflow may be left lower than the remainder of the embankment.

Through the embankment on the side next to the garden, pieces of 1 inch pipe or lath boxes are placed corresponding to the rows to be irrigated. A heavy shower of short duration will often fill the reservoir to overflowing and all the water may be used on the garden as it seeps out through the pipes or lath boxes. It is a self-operating device and may prove of considerable value.

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In many cases it is possible to divert part of the runoff from a ravine to a potato patch or garden plot. There are examples where farmers have located a garden on ground high enough so that it did not flood and then diverted water from a ravine to a small reservoir, as has been described, from which it was allowed to irrigate the garden. The arrangement can often be profitably used to store water in the subsoil during the late summer, fall and spring months.

Combination of Several Sources.

Probably the most successful gardens grown during these dry years will be those in which several sources are used to secure or obtain the necessary moisture. For instance, a farmer might find it convenient to use fences or hedges to collect large snow drifts during the winter which build up a good subsoil reserve. During the hot months he might use diverted runoff to a small reservoir, as has been described, when possible and at other times use the windmill if a deficiency of moisture still exists. The successful system will be the one which is best adapted to the farm on which it is installed.

B. Application of Irrigation Water.

Water should be applied to the soil so that a uniform distribution is obtained. The rate at which water may be applied will depend on the type of soil and the slope as well as the head of water available. In sandy soils considerable water must be turned into each furrow since the rate of absorption is high. If a small stream were used it would go but a short way down the slope and only the upper part of the plot would be benefitted.

In heavy soils a smaller stream can be used and with steep slopes a small stream must be used to prevent erosion as well as to get uniform distribution.

Fall Irrigation.

There is much to be gained by irrigating the garden plot in the fall of the year when time is available for the slow discharge of the farm well to saturate the subsoil and there is little loss from evaporation. For fall or late summer irrigation lister furrows may be placed up and down the slope and the water from the farm well turned into each furrow in turn until the desired penetration of moisture is obtained.

If a greater head of water is available, the lath box system described elsewhere may be used. In fall irrigation, it is possible to cover the lister furrows over with coarse hay as a mulch. The coarse slough grass will not block the flow of irrigation water but will retard evaporation.

Smaller Furrows for Gardens.

For the irrigation of most garden crops small furrows made between the rows with garden tools will be found effective. The main ditch from which the water is taken for each row is located as nearly on the level or contour as possible across the high side of the garden. This ditch may be an ordinary plow or lister furrow from which the loose dirt has been cleaned with a shovel.

To get an even distribution of water to each row, a lath box, a piece of 3/4 inch pipe or a short piece of old garden hose is placed in the ditch bank opposite the rows to be irrigated. Each piece of pipe or box can be plugged with a piece of corn cob if it is desired to shut the water from any particular row or rows.

If it is desired to raise the level of the water in the lister furrow or head ditch a small metal, canvas or wooden dam may be used. After the water has

been started frequent examination of the subsoil should be made to determine how deep the moisture is percolating. It may be desirable to use more or less water per row.

Use of Porous Canvas Hose. (Extract from Extension Circular No. 746, Nebraska Agricultural College)

The porous hose method of irrigation has, heretofore, not been used in Nebraska. The method has been tried out with great success in the state of Michigan, where it was first introduced. The system consists of a pump to lift the water and force it into a length of canvas hose placed between the crop rows. Usually an iron pipe is used to connect the hose and the pump or storage tank. One end of the hose is fastened to the supply line while the other end is closed.

When the water is pumped into the hose, it seeps through the pores of the fabric and soaks into the ground for a foot or more on each side. The hose is left long enough to supply the needed water and is then moved to the next crop row with the aid of a convenient roller device.

TABLE 1 - Number of Minutes Hose Should Remain in Different Length Rows to Apply 1-inch of Water.*

Gallons Pumped per Minute	Length of Row in Feet 20	50	75	100	200	250	300	400	500	600
1	40	100	150	200						
2	20	50	70	100						
5	8	19	28	40						
10	4	10	14	19						
15	3	6	9	13						
20	2	5	7	10	20					
25		4	6	8	16	20				
40		2	3	5	8	10	15	20		
50			3	4	8	9	11	15		
60				3	6	8	9	13	16	19
75				2	5	6	7	10	12	15
100				2	4	5	6	8	9	11
125					3	4	5	6	8	9
150						3	4	5	6	7

*Table based on a 3 ft. row spacing. Fractional parts of a minute have been omitted.

Canvas hose can be made from 8, 10, or 12 ounce duck by cutting it into narrow strips and sewing the edges together with a flat fell seam. Such a seam is easy to make and will prevent raveling. Most duck is 36 inches wide which gives four strips each 9 inches wide. Strips this size result in hose between 3 and 3½ inches wide. Smaller hose may be desired for short lengths but when using more than 12 or 15 feet, this larger size is better. This is particularly true when the water is not under pressure. For larger pump installations, it is well to have the hose as large as, or larger than, the discharge of the pump.

It is sometimes necessary to connect two or more lengths of the hose. The end of the next length of hose to be attached can be placed over the end of the hose already connected and the two will be held together by the outward pressure of the water flowing inside the hose. If such a connection does not prove satisfactory,

a makeshift connection can be made from a piece of galvanized tubing about 8 inches long. One end of the tubing is inserted in the end of one hose while the end of the other hose is placed over it and the whole thing bound with flexible wire.

When long lines of canvas are used, it may be necessary to use different weights of canvas along the line. More even distribution of water will result if a heavy weight of canvas is used near the supply, especially where the water has to be forced up-grade. When going down a rather steep grade, the order may have to be reversed and the heavier canvas put at the lower end.

The length of life of the hose depends upon the care it receives. If left lying on the ground between irrigation, the hose will not last more than one year; if taken up and properly dried, it should last from four to five years. Treatment with the following mixture has prolonged the life of hose considerably;

Asphalt paint	1 gallon
Gasoline	1 pint
Kerosene	1 pint

The mixture must be stirred thoroughly. The hose is soaked in the mixture and wrung out dry with an old clothes wringer or other suitable method.

The method of porous hose irrigation is especially suitable on slightly irregular land and where the soil is either too sandy or too heavy for satisfactory furrow irrigation.

Spray Irrigation.

Irrigation of the garden with a spray system because of the expense involved will not be adopted on many Nebraska farms. The most common type consists of parallel lines of pipe from 40 to 50 feet apart supported on posts 6½ feet high. Each line is equipped with nozzles to produce the spray. The system has the further disadvantage to the farmer of requiring water under considerable pressure.

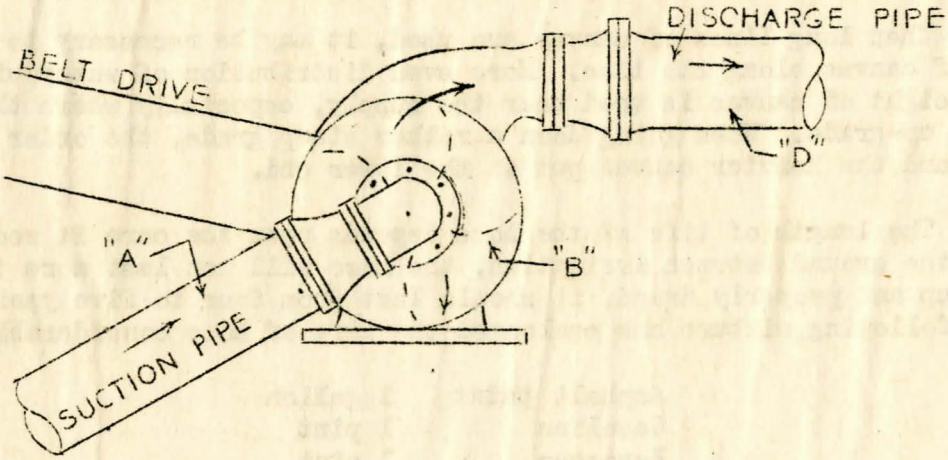
C. Pumping Equipment.

On most farms it is probable that garden irrigation will be accomplished with the farm water supply. If it becomes necessary to pump from a stream, shallow well or pond then the horizontal centrifugal pump is probably the most effective and the cheapest in first cost. It consists of a scroll case or volute in which revolves an impeller supported on a shaft and driven by a motor or engine.

The revolution of the impeller at "B" drives the water to the outside of the case at high velocity which sets up pressure and causes the water to discharge through the discharge pipe at "D". The water which has been discharged is replaced by that drawn up through the suction line at "A" which enters the case near the center of the impeller at "B" to be discharged through the discharge line "D".

Pumps of this type should be set within 15 feet of the water surface and better yet at 10 feet or less. The suction line should be of heavy pipe since the lighter grades would collapse. For low lifts of 10 to 15 feet, light grades of galvanized iron pipe may be used for the discharge line.

Pumps of the type just described must be primed and for this purpose a foot valve may be used on the end of the suction line which holds the pump and the pipe lines full of water. Should the prime be lost the pump may be filled from a tank of bailing water from the stream and pouring it into the opening on top of the pump.



Some farmers run their irrigation pumps with a light car motor or a small gasoline engine. In Table No. 5, will be found some costs for pumping with gasoline engines.

Horizontal centrifugal pumps are rated by the size of the discharge pipe. Information regarding small sized centrifugal pumps is given below:

Size Discharge	Discharge in Gallons per minute	Speed in Revolutions per minute
1 inch	10 to 60	1090 to 1640
$1\frac{1}{2}$ inch	20 to 125	585 to 780
2 inch	30 to 200	520 to 1035

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TABLE 2 - Rate of Flow Required for Applying one Inch of Irrigation Water on Various Areas.

Size of Area in Acres	Rate of Application - Hours									
	1	2	3	4	5	6	7	8	9	10
	Gallons per Minute									
0.1	50	25	16.6	12.5	10	8.3	7.1	6.2	5.5	5
0.2	100	50	33.3	25.	20	16.6	14.2	12.5	11.	10
0.3	150	75	50.	37.5	30	25.	21.4	18.7	16.6	15
0.4	200	100	66.6	50.	40	33.3	28.5	25.	22.	20
0.5	250	125	83.3	62.5	50	41.6	35.7	31.	27.7	25
0.6	300	150	100.	75.	60	50.	42.8	37.5	33.3	30
0.7	350	175	116.6	87.5	70	58.3	50.	43.7	38.8	35
0.8	400	200	133.3	100.0	80	66.6	57.	50.	44.4	40
0.9	450	225	150.	112.5	90	75.	64.	56.	50.	45
1	500	250	166.	125.	100	83.	71.	62.	55.	50
2	1000	500	333.	250.	200	166.	142.	125.	110.	100
3	1500	750	500.	375.	300	250.	214.	187.	166.	150
4	2000	1000	666.	500.	400	333.	285.	250.	220.	200
5	2500	1250	833.	625.	500	416.	357.	310.	277.	250
6	3000	1500	1000.	750.	600	500.	428.	375.	333.	300
7	3500	1750	1166.	875.	700	583.	500.	437.	388.	350
8	4000	2000	1333.	1000.	800	666.	570.	500.	444.	400
9	4500	2250	1500.	1125.	900	750.	640.	560.	500.	450
10	5000	2500	1660.	1250.	1000	830.	710.	620.	550.	500

TABLE 4 - Horsepower Required for Pumping Water at 50% Pump Efficiency

Gals. per Minute	Total Head in Feet									
	10	20	30	40	50	60	75	100	125	150
10	.05	.10	.15	.20	.25	.30	.37	.50	.62	.75
15	.08	.15	.22	.30	.37	.44	.56	.75	.94	1.12
20	.10	.20	.30	.40	.50	.60	.75	1.00	1.25	1.50
25	.13	.25	.37	.50	.62	.74	.94	1.25	1.56	1.87
30	.15	.30	.45	.60	.75	.90	1.12	1.50	1.87	2.25
35	.18	.35	.52	.70	.87	1.04	1.31	1.75	2.19	2.62
40	.20	.40	.60	.80	1.00	1.20	1.50	2.00	2.50	3.00
45	.23	.45	.67	.90	1.12	1.34	1.69	2.25	2.81	3.37
50	.25	.50	.75	1.00	1.25	1.50	1.87	2.50	3.12	3.75
60	.30	.60	.90	1.20	1.50	1.80	2.25	3.00	3.75	4.50
75	.38	.75	1.12	1.50	1.87	2.24	2.81	3.75	4.69	5.62
90	.45	.90	1.35	1.80	2.25	2.70	3.37	4.50	5.62	6.75
100	.50	1.00	1.50	2.00	2.50	3.00	3.75	5.00	6.25	7.50
125	.63	1.25	1.87	2.50	3.12	3.74	4.69	6.25	7.81	9.37
150	.75	1.50	2.25	3.00	3.75	4.50	5.62	7.50	9.37	11.25
175	.88	1.75	2.62	3.50	4.37	5.24	6.56	8.75	10.94	13.12
200	1.00	2.00	3.00	4.00	5.00	6.00	7.50	10.00	12.50	15.00
250	1.25	2.50	3.75	5.00	6.25	7.50	9.37	12.50	15.72	18.75

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TABLE 5 - Cost of Pumping an Acre Inch of Water Against Various Heads with a Gasoline Engine or Electric Motor.

Head in Feet	Gas Engine				Electric Motor		
	Gasoline Price per Gallon Cents				Electricity Price per K. W. H. Cents		
	10	12	14	16	2	3	5
20	$0.09	$0.10	$0.12	$0.14	$0.09	$0.14	$0.23
30	.13	.15	.19	.21	.12	.17	.29
40	.19	.22	.25	.30	.18	.27	.45
50	.23	.26	.30	.34	.23	.34	.57
60	.27	.32	.36	.42	.27	.40	.63
70	.31	.38	.43	.50	.32	.48	.79
80	.35	.42	.48	.56	.36	.54	.91
90	.39	.48	.54	.63	.41	.61	1.02
100	.45	.54	.63	.71	.45	.68	1.13
125	.54	.65	.76	.88	.57	.85	1.42
150	.66	.79	.93	1.08	.68	1.02	1.69
175	.77	.92	1.09	1.24	.80	1.20	2.00
200	.88	1.08	1.22	1.42	.90	1.35	2.26

The tables apply only to small installations. Tables, as well as other information, applying to larger installations can be obtained through the County Agricultural Agent or the Agricultural Extension Service, College of Agriculture, Lincoln, Nebr.

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