WATER & IRRIGATION

Development and Financing of Farm and Ranch Irrigation Systems

AGRICULTURAL COMMITTEE
THE AMERICAN BANKERS ASSOCIATION

The American Bankers Association

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The American Bankers Association's Agricultural Committee gratefully acknowledges the contributions made by Guy O. Woodward, Engineering Experiment Station, Utah State University, and Wayne D. Criddle, State Engineer of Utah, in the preparation of this manual. The unselfish work of these men will enable banking to better serve rural families in their application of water management to farm and ranch operations.

CONTENTS

SUMMARY

Water has always been an extremely important natural resource, but never before has the proper management and control of it been so essential. Agriculture's use of water for irrigation has doubled during the past three decades, and it now appears that an even greater increase will occur in the future.

This manual is designed to guide bankers in their decisions to assist farm and ranch families with the development and financing of irrigation systems.

The total supply of water is presently sufficient to serve the needs of all users; however since it is not properly distributed so as to be available where and when needed, the management of water resources is becoming extremely important. Much attention is being given to the development of "new" supplies. This, in reality, is merely a desire to change what is happening to existing supplies.

As a result of experience and accumulated knowledge, many changes are now under way which will increase man's ability to utilize the water supply more efficiently. Better methods of conveyance, distribution, land preparation, and reuse of water have added tremendously to the effective use of our water resources. In addition, the supply of usable water is being expanded since important gains are being made in the areas of desalinization, weather modification, decreasing noneconomic uses, controlling evaporation, and mosquito control.

In the past, agriculture and industry have been the two important users of water . . . industry in the East, and agriculture in the West. However, the pattern is changing in the West where industrial and municipal users are rapidly overtaking the use by agriculture as a result of the expanding population and industrial development in many areas.

Public agencies at the federal, state, and even local levels now offer assistance with water development costs. Now, more than ever before, attention is given to multiple purposes of water development projects with proper consideration to indirect as well as direct benefits to the communities involved.

Many legal problems have arisen as to the rights to water use. It is believed that water usage must be somewhat flexible, and that water must be used for the best public interest. In many areas, much needs to be done to clarify laws concerning water use. A summary, by states, of laws and agencies responsible for their administration can be found in Appendix A.

The planning of a farm or ranch irrigation system requires careful attention to the water development cost, system design, and the annual operating cost. It is important that the banker properly evaluate all such costs and clearly determine the adequacy of the system before credit is extended for this purpose.

The importance of irrigation to agriculture varies for different

crops and for various parts of the country. However, past experience shows that it is rapidly becoming an important factor in profitable farming in many areas and certainly is having a tremendous impact on the agricultural economy through production of higher yielding and better quality crops, thus providing greater returns and a more dependable income.

More and more farmers are making the decision to develop an irrigation system for their farm operation. Such large capital investments generally require some financing. Banks throughout the country are developing programs to handle these loan requests. Two general approaches are used – the direct and the indirect. The direct loan offers an opportunity to provide a more flexible credit program and to develop a good bank-customer relationship. The indirect program is necessarily more rigid in nature, but does offer an opportunity to create a satisfactory volume of business in a relatively short period of time.

In the financing of irrigation installations, particular attention must be given to the man, his business, and the adequacy of the system being financed. The continued interest the bank demonstrates through a complete and sincere service of the loan account is as important as the original loan.

Part I

INTRODUCTION

Importance of Water

Water, now, is universally discussed as never before. "Dwindling" water supplies, the population explosion, and industrial development are being "spotlighted" by the public, and rightly so. Lack of adequate water of suitable quality as needed, and/or its best use, development, and reuse may well determine the future progress and development of our nation and the entire world.

Use of water for irrigation in the United States has doubled in the last 30 years. Recent forecasts indicate that it will again double in the next two decades. A scientific and properly controlled program of development is needed if such demands are to be met. Many legal, economic, agricultural, engineering, and social problems must be studied and solved so that future ventures will be in the best interest of the individual, community, state, and nation.

With these thoughts in mind, the Agricultural Committee of The American Bankers Association decided to prepare this manual. It covers many aspects of irrigation. Competing needs for this precious resource, its uses, development programs, legal problems, economics, government participation, types of irrigation systems, and financing are all discussed.

Guide for Bankers

This manual is intended primarily to serve as a guide for banks beginning to extend credit in the field of irrigated agriculture. However, banks already engaged in this field may find some of the material of benefit. Although many interrelated factors are involved, sound, sensible approaches must always be considered in extending agricultural credit. In fact, such loans often may form the basis by which the economy of an entire area becomes stabilized and effective. Dealers, distributors, manufacturers, and all businessmen will benefit, thus strengthening the community, state, and nation.

For the reader with limited time to study this report, the important points to consider in irrigation design layout are tabulated on the following page (Table 1). The reader will find more detail and explanation on subsequent pages. However, it must always be kept in mind that any water development must be in accordance with the laws of the state. See Appendix A for a summary of the laws for each of the 50 states.

THROUGHOUT THIS PUBLICATION THE TERM "FARM" WILL BE USED TO INCLUDE BOTH "FARM" AND "RANCH."

TABLE 1

Items to Consider for Overhead Sprinkler and Surface Irrigation Methods*

Item	*Overhead Sprinklers*	*Surface Methods*
A. COSTS		
1. Interest	(a) All original costs of obtaining and developing water (b) Total investment on sprinkler system (c) Land in ditches not available for cropping	(a) Same as sprinklers (a) (b) Investment in land leveling, distribution system, and structures (c) Same as sprinklers (c) (d) Special farm equipment needed for irrigation purposes
2. Depreciation	(a) On all equipment, both portable (15 years) and stationary (15-30 years)	(a) On all structures, (wood 5-10 years, concrete 30 years) (b) On special irrigation equipment
3. Power	(a) Power for obtaining water (1½¢/foot of lift/acre-foot) and for operating sprinkler system (approximately $1.50/acre-foot)	(a) Power for pumping if source of supply is not at highest point on farm (b) Power for land preparation equipment
4. Water Cost	(a) Annual cost of water from source including operation and maintenance on water supply	(a) Annual cost of water from source
5. Labor	(a) Moving of sprinkler laterals (¼-1 hour/acre), pump and screen cleaning, and valve regulation† (per application) (b) Storage of equipment for winter, moving to harvest crops, etc. (c) Service on power units	(a) Furrowing out crop, making borders, etc. (b) Adjusting and controlling water, including installation of siphons, spiles, gated pipe, headgates, (⅓-1 hours/acre/application) (c) Same as sprinklers (c)
6. Maintenance	(a) Maintenance on sprinkler systems (usually amounts to about 20 per cent of the labor cost)	(a) Maintenance of conveyance and control structures, land floating, irrigation ditch and equipment (4-5 hours/acre/season)
7. Drainage	(a) Drainage system to remove excess rainfall and irrigation water	(a) Drainage system required to remove excess rainfall and deep-percolation from irrigation
B. RETURNS	(a) Gross returns from crops (b) Any fire control benefits (c) Other benefits	(a) Gross returns from crops (b) Other benefits

*Subirrigation is so limited in usage that it is not itemized here.
†Larger mechanical moves may be much less.
Source: Compiled by Messrs. Woodward and Criddle.

WATER SUPPLIES

Available Water

If we talk about the entire world, there is a great amount of water. But it is not usually distributed as needed for man's use. According to Nace,[1] "The total surface area of the earth is 197,000,000 square miles. About 140,000,000 square miles (71%) is covered by the world ocean, about 6,651,000 (3.4%) by polar ice caps and glaciers, about 300,000 (0.15%) by natural fresh-water lakes, and about 200,000 (0.1%) by natural saline lakes. About 50,500,000 square miles[2] (about 25%) is continental dry land. Somewhat more than 18,000,000 square miles (about 38%) of the land area is arid to semiarid."

Mr. Nace has also estimated the distribution of the world supply of water in Table 2.

TABLE 2

Distribution of World Supply of Water

Location	Volume of water (billions of acre-feet)		Percentage of total
World ocean		1,060,000	97.39
Water on the continents*			
Glaciers and polar ice caps	19,927		1.83
Fresh-water lakes	101		.0093
Saline lakes and inland seas	68		.0063
Average in stream channels	.253		.00002
Root zone of the soil	10.2		.00094
Ground water, above 2,500 ft.	3,700		.339
Ground water, 2,500 to 12,500 ft.	4,600		.424
Subtotal on land		28,406.5	
Atmosphere		11.5	.0011
Rounded total		1,088,418	100

*The total land area, including that under ice caps is about 51,970,000 square miles.

The average precipitation on the continental United States is about 30 inches, of which 21 inches is consumed where it falls. This leaves nine inches of manageable water. Presently only about three inches is withdrawn from the underground and from streams, and about one inch is consumed. If precipitation were uniformly distributed over the country, and if it were distributed throughout the

[1]R. L. Nace, "Water Management, Agriculture, and Ground-Water Supplies," United States Geological Survey, Washington, D. C., November, 1958, pp. 1 and 5.

[2]Nace further points out that the land area of the United States contains only 5.3 per cent of the total world land area. Consequently, if the ground-water supply above 2,500 feet were equally proportioned, our share would amount to 196-billion acre-feet. In contrast, the large lakes on the North American continent contain *one-fourth* of all the fresh water on the globe.

year as needed for agriculture, industry, municipalities, and other users, our water problems would be much simpler. There is a great dry "fan" extending generally from the Columbia River, which runs westerly into the Pacific Ocean, and the Mississippi which flows southerly into the Gulf of Mexico. Both of these rivers discharge tremendous quantities of unused fresh water to the ocean each year. If part of the Columbia River flow could be shifted southward and part of the Mississippi westward, great areas deficient in water supply could be firmed up. True, the cost is great, but needs and benefits may someday warrant such costs. But with all the water that falls on our more humid eastern area, more and more irrigation will be required to meet the needs of many quality foods – particularly vegetables.

With all our trouble in getting adequate usable water to meet our needs, we still have a tremendous ground water reserve in the United States. Assuming Nace's estimate to be correct that the annual recharge to the ground water is 1.2 billion acre-feet within the upper 2,500 feet of the earth's surface, tremendous droughts extending for long periods of time can be weathered if the country is properly prepared. The big problem right now is that drafts on local "branch banks" are not uniform. Some of the locals are being heavily overdrawn. Others are receiving no drafts. Thus, water management must enter into the picture to assure more uniformity.

WATER NEEDS

Water is basic to all our needs. Even in the midst of perennially water-short areas, few users know what this need really is. True, many irrigators may know how much they like to divert to keep labor and structure needs to a minimum. However, few realize that in many areas, for every four acre-feet diverted from the source, only one reaches the plant roots for actual use by the plants. Only recently have irrigators begun to understand that a wheat crop in producing 60 bushels per acre needs only about 15 inches of water for consumptive purposes, and that part of this may come from rainfall on the field itself. Likewise, many cities go on year after year without metering water to their consumers, never finding out how much water is really needed, nor how much is being wasted.

Developing New Supplies

Talk about developing new supplies of water is, in reality, merely hope of changing what is happening to existing supplies. Actually, new supplies cannot be developed. They are simply "new" to the new use to which they are put. Development simply stops some natural use from occurring or prevents water from wasting to the ocean.

Natural uses resulting in little or no economic returns to the country are tremendous. Such uses continue even while we talk about water shortages. Evaporation from water surfaces and moist land

areas, and the amount used by so-called "phreatophytes" continues at a phenomenal rate.

Water supply development is controlled and limited by many factors. The unavailability of water may offer a physical limitation that simply cannot be overcome.

Closely associated with physical availability is the economics of the development. Before extending credit for an irrigation project, costs and physical feasibility of water development must be known. In fact, all factors affecting costs and the benefits must be known to determine the soundness of the venture. A number of these factors will be discussed under a later heading, "Water Development Costs."

It is possible that water development for irrigation may be sound both physically and economically, but still should not be pursued. Some of the reasons for hesitating could well be state or area policies, or other uses with a higher priority such as industrial needs or municipal expansion.

Legal aspects *must* be carefully investigated. The right to use water can be denied even after construction has taken place if water laws are not followed. Appendix A gives a brief summary of the laws of each state as they affect water use. This also shows the agency responsible for water rights administration. Water laws should be well understood for the state in which a person is interested. Some states, for example, require and grant limited time permits to use water for irrigation. Others require no permits. Still others grant rights to use water on a priority basis which means first in time is first in right. Lack of sufficient basic information on state water laws has proved detrimental to water supply developments of all kinds. The projects have failed because all of the basic information was not gathered and used. Still other potentially successful projects have been refused because of being judged on only a portion of the facts.

CHANGES UNDER WAY

What is often considered as the total usable water supply may be far from correct. As knowledge and understanding of this great resource and its uses increase, man's ability to use it more beneficially will increase. Consequently, as in all fields of endeavor, more basic data is needed.

A complete inventory of all water falling on each drainage and its disposal must be known eventually. This is especially important in the arid West where surface run-off now represents less than 5 per cent of the precipitation falling on the watershed above. Small changes in the amounts retained on the watershed may cause a great effect on the flow in the valley below. And, although the quantity of water coming off the watershed is important, the way in which it comes is equally important. An infrequent high peak flow without storage will not serve man's need. And, often, natural storage caused by improving the watershed may be cheaper than building complete artificial storage.

CONVEYANCE

It has been estimated that up to 25 per cent of the water diverted from streams for irrigation purposes is lost from the canals and ditches en route to the fields. This offers a real source of water saving and salvage. The increased use of lined canals or pipelines is eliminating many of these losses that have existed over the years. Also, the use of plastics, chemicals, and highly dispersed sediments to seal leaky canals is becoming increasingly popular. With present techniques and materials, these conveyance losses should be held to a minimum.

DISTRIBUTION

Distribution of water among users and application to the land become extremely important for efficient use of irrigation water supplies. For surface irrigation, land improperly leveled and lacking a good irrigation system layout will result in wasted water regardless of how much personal attention is given by the irrigator. Likewise, irrigation requires some attention even with the best prepared land surface and best irrigation system. Without proper attention, low efficiency in the use of water will occur.

Thus, both suitable irrigation equipment and good technical guidance for the layout of the farm irrigation system and establishment of proper irrigation practices should be sought. Irrigators should be encouraged to utilize this help which is generally available through the United States Department of Agriculture, various state colleges, or private specialists in the field.

DRAINAGE AND REUSE OF WATER

Large areas of our country are presently unsuitable for agriculture because of lack of drainage. Even in the arid West, natural or man-made wet areas are wasting great quantities of water back to the atmosphere and keeping land out of productivity. The man-made wet areas are usually the result of canal seepage or overirrigation.

Man now understands the problems of drainage much better than ever before. Wet lands can and should be drained and the water put to beneficial use. Oftentimes the more saline drainage waters cannot be used directly for irrigation; however, dilution with fresh water is an accepted practice.

PHYSICAL LIMITATIONS

Since World War II there have been tremendous changes in machinery and equipment. Conversion of land which a few years ago could not be considered as suitable for leveling and irrigation is now

entirely feasible. Now farms are constructed to meet the desire and need of the owners. If topsoil is shallow, it is simply stock-piled to one side until the subsoil is leveled to the desired grade. The good topsoil is then uniformly spread over the field. Also, canals can now be constructed and lined in record-breaking time. Continuous underground concrete pipelines can be poured in place at considerably less cost than if constructed from precast sections.

It is now quite possible to move mountains and construct earth-fill dams – projects far from practicable a few years ago. Owners of irrigated farm land are now "thinking big." And so they must, if they are to keep pace with the changing civilization and its moon rockets. Our top farmers have been one of the leading groups in enlisting mechanical know-how and applying new developments. But the gap between the *good* farmers and the subsistence farmers is tremendous and must someday be closed.

Thus, when we see the Mississippi and Columbia Rivers discharge great quantities of water into the ocean every year, we must start thinking about 1,500-mile moves of this water. Such "pipe dreams" could not even be imagined a few years ago because of the physical limitations (nor could most of us believe a flight to the moon possible in our lifetime). A mountain in the way doesn't bother us now. We can either go around it or through it. And we will do just that when our population demands more food and fiber.

SPECIAL MANAGEMENT CONSIDERATIONS

We must keep in mind that water can be used over and over until it is literally worn out. As an example of this thinking, we might go through the cycle of uses that often occur from the time precipitation falls on the watershed until some residual part of it eventually reaches the sea.

Snowfall on high mountains forms the basis for much winter recreation. Skiers are taking to the hills in ever greater numbers. They are able to use the "water" before it melts and starts its trip downward.

After the snow melts, part is retained to grow timber and range plants. Some goes into stream channels furnishing fishing streams and watering wild life. It may then go through a power plant to generate electricity on the way down to centers of population.

By this time, the water has already been used at least three times. Now, part of it heads for agriculture, part for industry, and part for municipal uses. But water diverted for agriculture may be diverted and then rediverted several times. Only part of that originally diverted reaches the plant roots and is transpired back to the atmosphere. A major part percolates into the ground and either returns naturally to the stream or is drained or pumped out of the ground and reused.

Industry generally uses water for cooling, washing, or transporting. As a result, most of that originally diverted is available for reuse. The same is true of that diverted for municipal uses. A relatively small part is actually consumed. Under some of these uses the quality may be greatly impaired; however, we know how to clean up effluent from agricultural drains and from industrial and municipal uses. Such reclamation costs money; but water, as long as it is wet, will probably justify the cost of reclaiming as time goes on.

Now, after once serving the needs of these primary users, (agriculture, industry, and municipalities) the remaining water may be reused by any one of the other users although normally it is not desirable to have municipal and industrial effluents reused for municipal purposes. But both agricultural and industrial interests are becoming anxious to use treated sewer effluents.

And toward the low point on the "totem pole" of water users are wild life refuges. Ducks and other game birds on the refuges which receive the final effluent oftentimes thrive.

DESALINIZATION OF WATER

There seems to be little difficulty in desalting sea water or making brackish water potable. The problem is to find processes by which the ends can be achieved at economical cost. To date, the costs have been from about $1,000 down to about $300 per acre-foot. The most optimistic figures to date suggest that costs in the neighborhood of $125 to $150 per acre-foot might be reached. Such costs, while practical for certain industrial and domestic uses, are far out of line with respect to what agriculture can pay.

WEATHER MODIFICATION

Rainmaking, by one means or another, has been attempted from time to time for many decades – or even centuries. In fact, man's interest in weather modification can be traced back through records and artifacts to the Stone Age.

Although results to date have not been too encouraging, increased studies by high-altitude observatories and more basic information on the effect of the sun upon our weather and water supplies may offer some interesting ways of modifying our weather and rainfall conditions.

DECREASE NONECONOMIC USES

Perhaps the most practical and economical means to get some immediate relief to some water supply problems, particularly in the West, is by taking water away from plants and other water users that are of little or no economic value. Undoubtedly as time goes on, water use will be evaluated in terms of the returns expected per unit of

water used and the need for the use to which the water is put. Certain heavy-water-using crops and processes may be restricted in areas of extreme water shortages.

CONTROLLING EVAPORATION

According to a report to the Committee on Interior and Insular Affairs, United States Senate, 85th Congress, 2nd Session, dated April 14, 1958, a great amount of water is lost directly by evaporation. In the Western States, such losses due to evaporation from water surfaces average 11.5 million acre-feet per year. Evaporation from Lake Mead alone exceeds 700,000 acre-feet annually.

MOSQUITO CONTROL

Mosquito control problems have been created by improper irrigation and drainage practices and should be considered both as a farm and community problem in irrigation system design. A good system should be designed so that no mosquito problems are created nor allowed to exist.

In many irrigated areas of the West, mosquitoes are a menace to the health of human beings and cause economic losses because of their affect on animals. Those areas bothered most severely seem to have several conditions in common. Usually the soils are tight, the slopes flat, and generally poor irrigation and drainage practices are used.

Contrary to popular belief, permanent streams and sloughs do not produce all of the mosquitoes. In fact, because of the minnows and many other natural enemies of the mosquitoes that develop in these waterways, few of the mosquito larvae ever reach the adult stage.

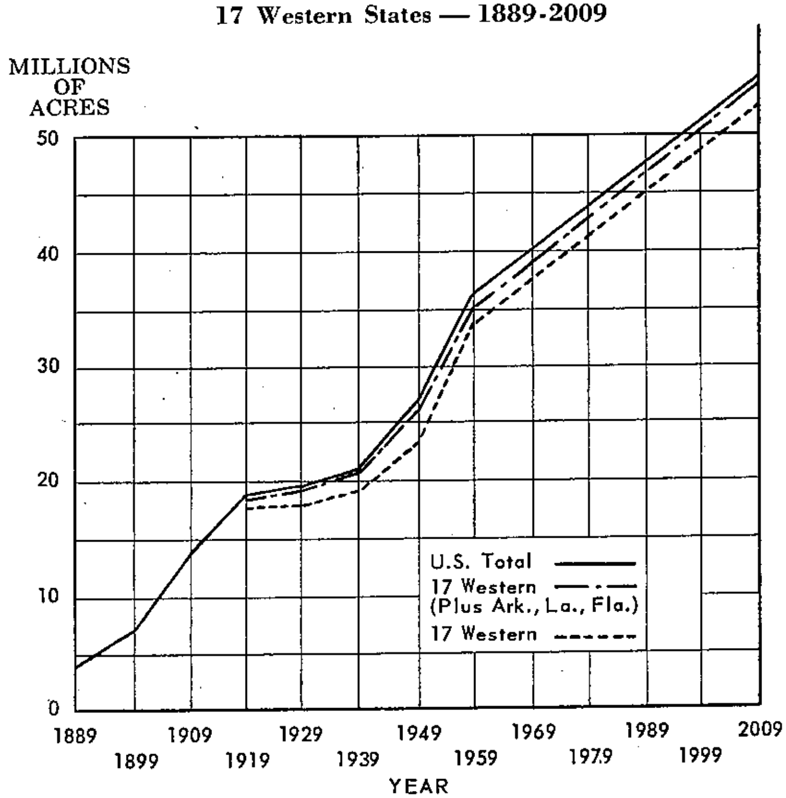
The greatest production of mosquitoes, however, is in those areas flooded intermittently and where water stands for one to three weeks. According to the entomologists, the adults of certain kinds of mosquitoes lay millions of eggs in the soft mud as the water recedes. These eggs lie dormant as long as a year, if need be. Just as soon as water hits them again, and if the temperature is right, they hatch out and, within about a week develop into adult mosquitoes that are hungry and ready to go to work on people and animals. If the free water disappears in less time than it takes to develop the mosquitoes, we have no problems.

Thus, mosquito control plays right into the field of conservation irrigation. During the heat of the summer, alfalfa and many of our better legumes and grasses will be killed in less than 24 hours by ponding water. Only water-loving plants can withstand extended periods of ponding. Therefore, if a farmer raises good alfalfa on his field, he cannot raise mosquitoes. On the other hand, if he allows ponds to develop which will raise mosquitoes, he cannot produce alfalfa.

Water Uses

Expansion of irrigation in the United States (see Figure 1) has been greatest since 1939. In 1939 about 21½ million acres of land were reported as irrigated in the United States. This figure rose to 27 million in 1949, and to over 36 million in 1959, or almost a 70 per cent increase during the 20-year period. In the past, agriculture has been the greatest single user of fresh water in the United States. From three to four million acre-feet are used daily during peak periods. Nearly half of the total fresh water used annually is for irrigation purposes. Well over 90 per cent of this total use for irrigation has been in the 17 Western States.

FIGURE 1
Trends in Irrigated Acreage in United States, 17 Western States Plus Ark.-La.-Fla., & 17 Western States — 1889-2009



Source: Prepared by Messrs. Woodward and Criddle. Data from Irrigation Census and various projections by others were used in preparation of this chart.

Industry has been the next largest consumer of water. It also requires nearly half of the water used in the United States. Major uses for industry have been in the eastern half of the country.

Public and rural supply constitutes only a small percentage of the total water use — some 6 per cent.

However, the pattern of water use is changing rapidly in the West. Because of the expanding population and industrial development, municipal and industrial use of water is rapidly overtaking the use by agriculture. These new uses produce more income per unit of water and allow for greater utilization of man power than does agriculture. As an example, California made tremendous changes from 1950 to 1955 according to McGauhey and Erlich.[3] In 1950 agricultural uses were reported as being 68 times as much as industrial uses. By 1955, the ratio had decreased to 3.8:1. This was not the result of any decrease in irrigation. Reported irrigation use actually increased 12.6 per cent in the five-year period. But industrial uses increased over 2,000 per cent. And eventually, agricultural uses may be reduced because economics will allow industrial users to purchase water rights from agricultural users.

From an agricultural loan standpoint, this trend should not be considered serious. The change will occur only if industry can properly reimburse agriculture, and this should fully safeguard the security of the loan.

Public and Private Assistance on Reclamation Projects

There are a number of agencies that can assist on irrigation projects and help individual farmers. These include both federal and state agencies, and occasionally there is assistance at the county level.

WHAT ABOUT RECLAMATION?

Irrigation water development projects benefit not only the irrigation farmers but all activities within the area. Indirect benefits often greatly exceed direct benefits. Thus, more attention is being given to multiple-purpose projects and to community benefits that result from these developments. Also, in many areas, development for agricultural uses is merely "banking" water or temporarily using it until a higher economic use develops. Through due process of law, water then can be taken over by other users. Agricultural users will get along on less water per acre of ground or retire some land from irrigation.

Regardless of the development, its location, and the use to which

[3]P. A. McGauhey and Harry Erlich, "Economic Evaluation of Water," *Proceedings of American Society of Civil Engineers*, Vol. 85, No. IR-2, Paper 2059, Ann Arbor, Michigan, June, 1959, p. 13.

it is to be put, all factors affected should be given proper credit for any benefits to each. New irrigation projects can no longer be justified economically with only part of the factors included. Indirect and public benefits are just as real in many cases as are the direct benefits to the farmers. The public must be made aware of these benefits and must accept the responsibility of paying for them.

PUBLIC AGENCIES

United States Bureau of Reclamation – The Bureau was established over 50 years ago to construct projects beyond the physical capability of the local people. Originally the Bureau constructed purely irrigation projects, all construction costs to be repaid by the water users. Over the years has come a gradual change in the policy of the Bureau until today most projects are multipurpose in scope. Oftentimes nonreimbursable flood control and fish and wild life interests constitute a major part of the cost. And power development which must be repaid with interest is forming a mighty work horse on which other interests must lean in order to make the project feasible. We now have the "Basin Account" concept under which projects that are predominantly for power production are constructed and their net revenues used to assist other water development projects in the basin. Under the policy of the Bureau, only the large projects would be constructed, including the storage and diversion works and the canals and main laterals on the project lands. More recently, project drainage and smaller laterals have been considered as proper work, also. Salvage of water from phreatophytes is likewise now considered as a proper function of the Bureau.

In 1956, Public Law 984 was passed by the 84th Congress, 2nd Session, allowing the Bureau of Reclamation to assist on small reclamation projects where the total costs did not exceed $5-million. Such projects actually tend to get into land developments as well as project development. Under this law, the Bureau can assist in the construction of the complete distribution system to deliver water to each individual field.

United States Army Engineers – Civil projects of the Army Engineers are largely in the field of Harbors and Flood Control. However, recently some municipal water storage and water salvage has been built into their projects. Although flood control projects are considered nonreimbursable, any water conservation must be paid for by the beneficiaries.

United States Department of Agriculture – Under programs of the U. S. Department of Agriculture, both technical and financial aid is given water conservation projects.

The Soil Conservation Service program, with its districts established under state law, supplies most of the technical assistance for

all soil and water conservation work within the Department. Assistance on individual farms and to small groups has been the major effort of this agency. S.C.S. also operates the small watershed program under Public Law 566, passed by the 83rd Congress, 2nd Session. This program provides for working with state and local officials in establishing complete conservation programs on watersheds of 250,000 acres or less. It also allows for making studies on larger watersheds in cooperation with state and other federal agencies, to develop a framework plan under which the various agencies can work in a coordinated effort.

The Agricultural Conservation Program assists individual farmers and groups financially in getting permanent conservation practices on the farms. The technical aspects of this program are handled by the Soil Conservation Service technicians.

The Farmers Home Administration makes available loans at a low interest rate to worthy farmers to assist in the farm operation. Frequently, such loans are made to assist in the construction of water conservation structures or practices.

State agencies – Most states give assistance in the development and construction of water conservation projects. Usually such help is given in the form of interest-free loans and technical help.

Also, in cooperation with the Extension Service of the U. S. Department of Agriculture, a rather complete educational program is offered in the field of water conservation. Educational assistance is available through the County Agent and Extension Service Specialist programs. Most of the Western States have an irrigation engineer on their extension staffs, and his services are made available to the individual farmer and to farmer cooperatives.

Private assistance – Farmers wishing technical help may often get considerable asistance from the equipment dealers and operators in the area. However, the tendency of such technicians to push their particular equipment, and the possibility of the farmer not hearing all sides is to be expected. Nevertheless, a well-informed person can get a great deal of help without making improper requests of the company representative.

Private capital is also available for many agricultural developments. But generally the long-term loan does not appear to be too attractive. The sale of revenue bonds has been suggested as a reasonable approach for some of the larger projects.

Legal Problems

Water law in the eastern United States has been based on the theory of riparian rights; i.e., the rights of the owner of waterfront property. With respect to streams, riparian rights include the right to have flow of water continue past his property undiminished in quantity and unpolluted in quality. Obviously this, taken literally, will not allow any development for consumptive purposes. Most uses cause some stream depletion, and quality is also usually affected to some degree by any usage.

In the West, the law of prior appropriation and beneficial use generally governs. Agriculture (largely irrigation) was the first major user. And it seems to be only human nature for any appropriator to attempt to tie up more of the usable water than actually is needed. But assuming the first appropriators do use the water beneficially, later users must purchase water from older users to assure its availability for their needs. This may be entirely proper since industries and other users often return many times what agriculture does per unit of water; and because of its greater value to them, it is worth their while to purchase it.

Thus, in the public good, it is believed that water usage must be somewhat flexible; i.e., that water must be used in the best public interest. It is not suggested that a man doing a good job of irrigation farming should be deprived of his right to the use of water except under due process of law. If the water is needed for a higher use, the new user must pay a proper amount for the right. But the vehicle for accomplishing the changes necessary for public good must be available, and the public made aware that such is possible.

IRRIGATION SYSTEMS

Irrigation systems discussed here will be limited to the privately owned family farm. In order properly to evaluate such systems for extension of credit, it is first necessary to determine the adequacy of the irrigation system.

Water Development Costs

In extending credit, consideration should be given to all of the costs involved in developing the water and transporting it to its place of use.

All items of importance affecting the cost of irrigation water supplies should be known, and added to that of the overall irrigation system.

WELLS

The cost of constructing and developing a well should be amortized over its expected life. For example, a receding water table may limit the life of a well. Geologists, well drillers, or others having such knowledge for the area in question should be called on.

The type of water-bearing formation, quality of water, casing material, or some such factor may also limit the expected life of the well. Such information is needed before extending credit for irrigation.

Water-use permits or rights in some areas may be given for only a specific time. Construction and development estimates should always be obtained from the contractor in advance of drilling.

DAMS

Unless a sedimentation problem exists, dams need not be depreciated. With proper maintenance, dams should be as good in 100 years as when constructed. Proper annual maintenance charges will be needed as will interest on the investment.

Where sedimentation or silting occurs, an estimate of the life of the reservoir should be made from the silting rate. If dredging or cleaning is feasible, maintenance could be prorated on an annual basis.

Costs of dam construction, including the necessary spillways to protect the dams, can be estimated rather accurately. In some cases, spillway costs exceed the cost of the dam itself.

STREAM-FLOW DEVELOPMENT

Costs of developing water supplies from streams can also be quite accurately estimated. Diversion works and conveyance facilities must not be overlooked. Bridges, culverts, rights-of-way, and maintenance costs should be carefully checked.

DEVELOPMENT OF SPRINGS AND SEEPS

The same general considerations should apply in this category as with the surface streams. All costs should be considered.

OTHER DEVELOPMENT COSTS

Where electric power is to be used, the possible cost of extending the power lines should be considered. This is an important, but often overlooked, item which the local power company may not install without cost to the new user.

The original cost of a farm irrigation system is important, but does not indicate operation, maintenance, and replacement costs. The greatest item in the original cost of developing land for surface irrigation is leveling. With good maintenance, depreciation is negligible. Without maintenance, depreciation should be charged against land leveling at a rate which is consistent with experience in the area.

Other costs of land preparation may include brush clearing, terracing, and surface and subsurface drainage. Costs of conveyance systems, either open channel, closed conduit, or a combination of the two must be considered. Regardless of the type of system, annual maintenance is necessary and should be budgeted.

Irrigation structures such as drops, checks, turnouts, division boxes, spiles, siphons, and gated-pipe, and farm machinery such as floats, ditchers, border-drags, furrowers, and/or other equipment are always involved.

If a well and pumping plant is a part of the system, interest and depreciation must be considered as well as the annual operation and maintenance costs.

As in most undertakings, labor is a most important item in costs. It must not be overlooked.

Sprinkler irrigation costs should be measured by the same economic "yardstick" as surface irrigation; i.e., the total annual costs and benefits per acre. Although water development costs may not vary directly with the type of irrigation system used, generally surface irrigation requires large streams for efficient application, while sprinkler irrigation can utilize either small or large streams with equal efficiency.

Costs of a distribution system for sprinkler irrigation can be broken down into three main headings: mainline, lateral, and system control equipment.

Although mainline equipment could have been considered under water "Conveyance," it is generally considered to be a part of the farm distribution system. Pipe sizes should be chosen to give maximum economy. To accomplish this, the annual cost of the pipe added to the annual fuel cost should be studied for each size of pipe that will do the job. Only then can the most economical size pipe be determined.

Annual costs of sprinkler laterals should also be considered on a per-acre basis, and the pipe size should be determined to prevent wide pressure fluctuations from one end to the other. Pressure variation along the lateral line should not exceed 20 per cent.

Control equipment, such as T-valves, should be included. The additional cost for these items is usually readily offset by the saving in labor.

Subsurface irrigation development costs may be quite similar to surface irrigation costs. With this method of irrigation, the distribution system consists of feeder ditches with regulating devices to maintain the water at a specified depth in the ditches. Subirrigation as a method of artificially applying water is limited to special site conditions not generally found throughout the country. Labor costs are usually low.

System Design

Detailed information in the form of "irrigation guides" is available for the various areas in each state. These guides, available from the Extension Service or Soil Conservation Service, show the flow rates and volume of water needed for each irrigated acre. The total farm requirement in gallons per minute and/or the acre-feet per year can be computed using the acreage under consideration to determine if the system design is ample.

Recommended frequency of application for each crop is shown in the "irrigation guides" for various soil types, depths, water-holding capacities, and so on. An irrigation system design should show this information. Some conditions may justify a variation from these recommended standards, but the justification should be stated.

A sprinkler irrigation system design will show the number of sprinklers and the spacing of sprinklers on the lateral line as well as the spacing of laterals on the main line. Appendix B was prepared for use in determining the depth of water that will be applied on the field in any given time. Application rates are important and should be consistent with those shown in the irrigation guides. A rate higher than maximum can cause soil compaction and run-off. A rate that is too low will allow for excessive evaporation and wind drift.

For surface application, recommended lengths of run and stream sizes are available for each site condition. A design for surface application should be consistent with the irrigation guides in this respect, also.

Pipe size determination has been discussed elsewhere, and if the economics of the mainline or supply lines has been considered, there should be no further concern on this phase. Lateral sizes have also been discussed, but perhaps should be rechecked for pressure variations along the line.

The horsepower needed for various pumping loads can be computed or determined from tables. An electric motor will deliver the horsepower stamped on the specification plate. But combustion engine usable horsepower varies with elevation and temperature and must be so adjusted. Also the horsepower rating of engines is made for a bare engine without fan, generator, or other equipment and, hence, must be adjusted for these accessories as well. A further reduction in usable horsepower to only 50 per cent of the rated horsepower may result from noncontinuous operation.

Labor requirements in irrigation vary with method of irrigation, experience, type of equipment, and many other site conditions. A few checks of potential labor costs may be in order, however.

In sprinkler irrigation, labor for hand-move systems varies from 0.5 man hour per acre per move to over 1 man hour per acre per move. An experienced man under good conditions should be able to approach or beat the half-hour time. As crops grow taller, more time is required. Mechanized laterals and wheel lines can be moved in just a few minutes, greatly reducing the time and drudgery of the job. Consideration should be given to labor-saving devices and automation.

A good surface irrigation system will compare favorably with sprinkler irrigation in the labor requirement. Consideration should also be given here to automation and labor-saving equipment.

Fuel types will be mentioned under "Annual Operating Cost." The suggested tables are sufficiently accurate to be used in estimating costs. If actual fuel consumption greatly exceeds that shown in the tables, the pumping plant and piping system should be checked by a qualified person.

Irrigation system management is the key to success in this venture. Water should be applied when and in such quantities as needed. A "feel" chart, Appendix C, was developed to indicate, by the feel of the soil, how much moisture is available for crop use. Study and practice in the use of this chart will give the operator greater effectiveness in irrigation and can well result in increased crop production.

All irrigation structures should be given proper care. Siphons, spiles, and plastic and canvas dams should be cleaned and stored when not in use. Irrigation pipe should be piled on racks above the ground for overwinter storage. Rubber gaskets should be stored in water over winter. Pumps and engines should be kept dry and properly serviced according to the manufacturer's recommendations. During freezing weather they should be drained and covered for proper protection.

Irrigation systems may have some "off season" uses of value to the owner. Fire protection is an important consideration. Emergency water supplies may be another. Settling dust in roads and in yards is easily accomplished, as are a number of other jobs that require a supply of water.

Here, again, it should be emphasized that a competent engineer can be most helpful to one not fully familiar with irrigation practices and system requirements and can often save him a great deal of money. Only an engineer thoroughly familiar with irrigation

system design and one who has had experience along this line of work should be consulted.

Annual Operating Cost

Land preparation for irrigation is a continuing cost. Good surface irrigation of annual crops requires "floating" – dragging the surface to remove small irregularities – preferably in two directions.

Operation and maintenance of the system is a "must." Costs for repairs, operation, and maintenance of the irrigation structures, and costs for the pumping plant, must be listed. All labor, such as that needed for pipe moving, surface irrigation, ditch cleaning, and weed control on ditch banks, must be considered.

Fuel costs for pumping can be quite closely estimated (see Appendix D) by knowing the hours per season of expected pumpage. In the case of electricity, standby charges or other fixed costs should be added to the total calculated fuel consumption costs. Oil and grease may be considered with the operation and maintenance costs.

A cost item often overlooked in irrigation is the value of land lost to production because of ditches, roads, and the like. This land out of production will reduce the overall returns and should be given appropriate weight in any cost-and-return analysis.

IMPACT OF WATER USE ON AGRICULTURE

Proper irrigation requires the uniform and efficient application of water to soils as needed to keep plants rapidly growing. Since growing crops require plant food, water, and air in their root zone, too much or too little of any of these will slow down or stop growth. The purpose of irrigation, whether in arid or humid areas, is the same; i.e., to make water a nonlimiting factor in crop production. In most areas of the United States drought periods occur. In the Southwest, long periods of drought are expected. In the more humid regions, drought periods may be of only a few days' or a few weeks' duration. But droughts *do* and *will* occur, and plants that get too dry just once each summer may not produce any more than if the entire summer were dry.

WATER REQUIREMENTS OF CROPS

The quantity of water required for consumptive use of each crop is rather uniform throughout areas of similar climatic conditions. This consumptive requirement can be met by rainfall, moisture stored in the soil from winter precipitation, moisture from a high water table, and/or water from irrigation. If sufficient water is available from any one or a combination of the natural sources, then irrigation is not needed. Soils play an important part in the amount of water that is made available for crop use from these natural sources, and only the deficit needs to be supplied by irrigation. Also, the efficiency with which the irrigation water can be applied is affected by the soil characteristics; and soils must therefore be taken into consideration in designing the irrigation system.

Investigators of irrigation have found that most precipitation falling during the summer or growing season in irrigated regions is available for consumptive use by the crops. However, in those areas where rainfall is heavy and where considerable spring run-off occurs, corrections must be made for the noneffective precipitation. After the effective precipitation has been determined and after the moisture contributions from other natural sources have been evaluated, it is then possible to estimate the net consumptive water requirement that must be supplied by irrigation.

The daily use of water by grain sorghum in the High Plains area of Texas is shown in Appendix E. It will be noted from the figure that at the time of planting about .05 of an inch of water is lost daily by evaporation from the land surface. By the time the sorghum has reached the "boot stage" (some 50 days after planting), daily water use has reached a maximum of over .30 of an inch per day. This higher rate includes both evaporation from the land surface and transpiration through the plants. After the "boot stage," the use of water decreases until harvest time when the only loss is evaporation from the land surface. The total seasonal consumptive use is about 24 inches, of which precipitation supplies about 11 inches in this area.

The consumptive water requirement for some major crops at selected points throughout the western United States is shown in Appendix F. In using this table, it must be remembered that the effective precipitation should be subtracted from the depths shown and this deficiency should then be supplied to the crop for optimum production. Also it must be remembered that more water will be needed at the farm than this net amount, since some excess is always needed in applying the water and storing it in the soil for use by the plants. The efficiency of application should be in the neighborhood of 60-80 per cent, depending on the method of application, the soil, and the climatic conditions under which the water is applied.

APPLICATION OF IRRIGATION WATER

Irrigation water may be applied to the land by surface, sprinkler, or – under rare conditions – subsurface methods. If a sprinkler system is properly designed and used, control and high efficiency in the use of irrigation water presents no real problem. However, if the water is to be applied by surface methods, land preparation and system design become extremely important for good, efficient irrigation.

Criteria for land leveling for each of the various surface methods of applying water are presented in Appendix G. Furthermore, even after the land is properly leveled, there are certain relationships between the influencing factors that must be observed if proper irrigation is to be accomplished. These influencing factors are:

1. Size of irrigation stream
2. Texture and intake rate of soil
3. Slope of land
4. Depth of water to be stored each irrigation
5. Unit area of land to be irrigated with a given stream

The irrigation relationships for furrows and borders are given in Appendices H and I.

Moisture control through irrigation has resulted in benefits extending far beyond the farm. Some of these indirect benefits will be discussed later. However, the direct benefits to the farmer vary widely for several reasons:

1. The amount of irrigation water needed and its cost vary widely from one area to another.
2. Different crops have widely varying returns.
3. Uniformity and efficiency of water application vary widely.
4. The cost of applying water is widely variable.

Needless to say, irrigation pays greatest dividends on high-valued crops in areas where the frequency and duration of droughts during the growing season make it hazardous or impossible to grow such crops without addition of water. However, in the United States, hay and pasture are the most widely grown of irrigated crops; and yield-returns, because of irrigation, are as varied as the climate over the United States.

The average 1958 crop value per irrigated acre on the Bureau of Reclamation Belle Fourche Project in South Dakota was $36,[4] on the Strawberry Project in Utah, $67 per acre, and $433 per acre on the Yuma Auxiliary in Arizona. The average per acre crop value on all Reclamation projects is over $146.

CROP RESPONSE TO IRRIGATION

It is impossible in a manual of this kind to discuss the response of all crops to irrigation in every area of the United States. However, the results of irrigation studies on a few crops in various areas of the country will be discussed.

In Illinois [5] irrigated pasture produced 1¼ tons per acre per year more dry matter than the nonirrigated field. The animal-carrying capacity was 71 per cent higher on the irrigated field with an average increase of 111 animal-unit days per acre. Rotational grazing and good management practice showed better returns than continuous grazing. (Irrigation scheduling fits in well with rotational grazing.)

Irrigation was effective and necessary in maintaining legumes in pastures. All legumes died on the nonirrigated field. To meet the water requirements of the pasture, about 14 inches of water was applied per season.

A report on pasture response in Mississippi [6] noted that "irrigated Dallis, Johnson, and Coastal Bermuda grass pastures produced over 300 pounds of beef cattle per acre in the period from July 26 to November of 1954."

A report from Georgia [7] states: "If a pasture is to be irrigated, an adapted grass such as Coastal Bermuda and Star Millet that will respond to water and fertilizer should be planted on a well-drained soil that has a good moisture holding capacity. It is better to irrigate a small acreage and do a good job than to try to water your entire pasture land. Three to four cows per acre can be carried where a good job of irrigation is done on a high-yielding forage."

[4] *1958 Crop Report and Related Data, Federal Reclamation Projects,* Division of Irrigation, Bureau of Reclamation, Department of the Interior, Washington, D. C., August, 1959, pp. 20-27.

[5] G. E. McKibben, L. E. Gard, R. J. Webb, H. A. Cate, and B. A. Jones, Jr., *Experimental Irrigation of Ladino Clover-Grass Pasture,* Bulletin No. 640, Agricultural Experiment Station, University of Illinois, Urbana, Illinois, March, 1959, p. 27.

[6] Perrin Grissom, W. A. Raney, and Peter Hogg, *Crop Response to Irrigation in the Yazoo-Mississippi Delta,* Bulletin No. 531, Agricultural Experiment Station, Mississippi State University, State College, Mississippi, May, 1955, p. 23.

[7] Willis E. Huston, *Irrigating Georgia Crops,* Bulletin No. 597, Agricultural Extension Service, University of Georgia, Athens, Georgia, January, 1957, p. 17.

Results of irrigation work at the Dairy Experiment Station, Lewisburg, Tennessee,[8] show the following:

TABLE 3
Income per Acre During Pasture Season 1951-1954

Items		1951	1952	1953	1954	Average
Income*	Unirrigated	$327	$279	$262	$195	$266
	Irrigated	448	389	324	297	364
Profit from Irrigation**		$121	$110	$ 62	$102	$ 99

*Income from sale of milk above value of feed consumed at barn and cost of irrigation.
**Difference in gross income from irrigated and unirrigated pasture after subtracting cost of supplemental feed and irrigation.

Another report [9] states: "It is possible to produce 1,000 pounds of beef gain or milk equivalent per acre on well-managed irrigated pastures in South Texas. Irrigated pastures offer good profits in milk or beef production and the best known method of soil improvement."

Most of the pasture irrigation investigational work in the Western States has been done on water supplies, water requirements, irrigation methods, pasture varieties, fertilization rates, and other agronomic and management practices. The benefits from irrigation have long been recognized. In most areas of the West, without irrigation, there is no production. Thus the economics is simply tied up with the cost of irrigation and the returns that are possible.

The acreage of irrigated cotton in the Southeast has increased rapidly during the last 10 years. Even in the wetter years, cotton is now being irrigated.

South Carolina [10] shows cotton irrigation returns as follows:

TABLE 4
Average Increases in Yields and Returns from Irrigation of Five-Acre Cotton Contest Demonstrations — 1956

Fields	Average Yield Per Acre	Lint Increase Per Acre	Seed Increase Per Acre	Cost Per Acre, Two Irrigations	Increase Per Acre Over Irrigation Cost (Lint and Seed)
	Lbs.	*Lbs.*	*Lbs.*		
Nonirrigated	593				
Irrigated	861	268	490	$30.00	$70.50

[8] A. G. Van Horn, W. M. Whitaker, R. H. Lush, and John R. Carreker, *Irrigation of Pastures for Dairy Cows,* Bulletin No. 248, Agricultural Experiment Station, University of Tennessee, Knoxville 16, Tennessee, June, 1956, p. 11.

[9] E. M. Trew and Carl S. Hoveland, *Irrigated Pastures for South Texas,* Bulletin B-819, Agricultural Experiment Station, Texas A. and M. College, College Station, Texas, p. 3.

[10] Clemson Extension Cotton Committee, *Cotton Irrigation in South Carolina,* Information Leaflet, Extension Service, Clemson Agricultural College, Clemson, South Carolina, May, 1957, p. 4.

Increases in yield at the Sandhill, South Carolina Branch Station for 1954-55 were 733 and 450 pounds respectively in favor of irrigation.

Carreker [11] shows the results of irrigating cotton at Watkinsville, Georgia, and Auburn, Alabama, in the following table:

TABLE 5

Seed Cotton Yields With and Without Irrigation

Treatment	Pounds Per Acre				
Georgia	*1949*	*1950*	*1951*	*1952*	*1953*
Without Irrigation	1155	1087	2165	742	934
With Irrigation	1286	1430	2538	2534	1731
Alabama					
Without Irrigation		1328		1449	2200
With Irrigation		1953		2538	2200

Grissom, et al.,[12] report on cotton irrigation as follows: "On sandy loam soils, during the 1952-54 periods, irrigation increased the yield of cotton an average of approximately 750 pounds of seed cotton per acre . . ."

Work of Phillips, Curtis, and Lytle [13] is summarized below:

TABLE 6

Plants Per Hill*	Lbs. Seed Cotton Per Acre: 1957 Available Moisture**			1958 Available Moisture**		
	0%	*25%*	*50%*	*0%*	*25%*	*50%*
1	1137	1870	1849	1240	2164	2238
3	1088	1937	1821	1013	2119	2136
6	1120	1950	1631	1040	1882	1897

*Plant spacings 12 inches apart in drill
1 plant per hill = 13,068 plants per acre
3 plants per hill = 39,204 plants per acre
6 plants per hill = 78,408 plants per acre

** 0% – plots were not irrigated
25% – irrigated when soil contained 25% available moisture
50% – irrigated when soil contained 50% available moisture

A report by Gattis and Deere [14] shows effects of irrigation on cotton yields in Arkansas:

TABLE 7

Water-Yield Relationship for Cotton at Marianna, Arkansas

Year	No. Times Irrigated: Season	Month	Depth of Water Applied	Rainfall	Yield Irrig. Fields	Yield Non-Irrig. Fields	Increase in Seed Cotton	Percent Increase
			Inches	*Inches*	*Lbs.*	*Lbs.*	*Lbs.*	*%*
1950	2	1-July 1-Aug.	3	22	1842	1557	287	21.5
1951	2	1-July 1-Aug.	2	21	2073	1766	308	17.0
1952	4	2-July 2-Aug.	8	11	2701	1604	1097	69.0
1953	7	2-June 2-July 3-Aug.	12.9	26*	2383	1822	561	30.0
1954	5	1-June 3-July 1-Aug.	11	14	2589	1394	1195	86.0
Average	4		7.9	18.9	2318	1629	689	42.0

*Twenty inches occurred in April and May.

A study in Oklahoma [15] was conducted on irrigation with cotton, and the results follow:

TABLE 8

Effect of Various Water Treatments on Cotton Yields Oklahoma 1954-1958

Water Treatment	*Cotton Yields in 500-Pound Bales per Acre**: 1954	1956	1957	1958
W_1**	.15	.34	.94	1.20
W_2	.48	.65	1.18	2.17
W_3	.82	1.16	1.34	2.16
W_4	1.39	2.11	1.77	2.44
W_5			1.70	2.43

*No results were obtained in 1955 due to inadequate stand

**W_1 – No irrigation

W_2 – Irrigation after the plants definitely wilted at 4 p.m. for one week before each irrigation

W_3 – Irrigation 24 hours after the plants wilted at 4 p.m.

W_4 – The soil moisture constantly maintained at 17 per cent of soil moisture in the zone 6-12 inches below the soil surface

W_5 – Soil moisture maintained above 18 per cent

Similar results have been shown in other cotton-growing states. Yield responses to irrigation become greater as one moves toward the arid areas of the Southwest.

11 John R. Carreker, "Cotton Irrigation," *Plant Food Journal,* Vol. VIII, No. 4, 1954, p. 7.

12 *Crop Response to Irrigation,* p. 12.

13 Sherman A. Phillips and William F. Lytle, "More Cotton with Irrigation," *Louisiana Agriculture,* Vol. 3, No. 3, Agricultural Experiment Station, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, Spring, 1960, p. 12.

14 James L. Gattis and Runyan Deere, *Cotton Irrigation for Arkansas,* Circular No. 477, Agricultural Extension Service, University of Arkansas, Little Rock, Arkansas, June, 1956, p. 7.

15 James E. Garton and A. D. Barefoot, *Irrigation Experiments at Altus and El Reno, Oklahoma, Progress Report 1954-1958,* Bulletin B-534, Agricultural Experiment Station, Oklahoma State University, Stillwater, Oklahoma, July, 1959, pp. 4, 6, and 7.

In order to understand water requirements of cotton and how to get the greatest response from irrigation, refer to Appendix J. It should be remembered that irrigation water requirements vary with rainfall, humidity, temperature, and plant development.

Data on response of cotton to irrigation have purposely been omitted for the states of California, Arizona, and New Mexico. In these states, irrigation is a standard practice and a "must" in cotton growing. Without irrigation there is no cotton production.

Generally crops should be kept growing without the periodic lapses which may be caused by lack of moisture. Usually the higher the value of the crop being grown, the more important it is that it should not suffer from insufficient moisture. Vegetables and tobacco are crops in this category. Bennett et al.,[16] list the several benefits from irrigation of tobacco as: (1) Higher yields and value in dry seasons; (2) Better quality; (3) Less scalding in hot, dry weather; (4) Good livability at transplanting – and early and even growth; (5) Steadier growth, early maturity, and harvest; (6) Better curing; (7) Less damage from some root diseases; (8) Transplanting can be done at the best time.

The "pay-off" of irrigation is reported below:

TABLE 9

The "Pay-Off" of Irrigation of Tobacco, North Carolina, 1951-1954

Year	Not Irrigated	Irrigated	Increase
	Dollars per Acre	*Dollars per Acre*	*Dollars per Acre*
1951	598	931	333
1952	740	837	97
1953	595	900	305
1954	561	1,004	443

Results of studies in South Carolina[17] for the same four-year period are also shown:

TABLE 10

Yield Comparisons of Irrigated and Nonirrigated Tobacco, 1951-1954

Year	Irrigations	Yield with No Irrigation	Yield with Irrigation	Increased Yield
	Number	*Lbs. per Acre*	*Lbs. per Acre*	*Lbs. per Acre*
1951	4	1207	1334	127
1952	4	737	1225	488
1953	4	1555	2014	459
1954	5	1210	1616	406
Average		1183	1547	375

[16]R. R. Bennett, S. N. Hawks, Jr., and H. H. Nau, *Field Irrigation of Tobacco*, Circular 388, Extension Service, State College of Agriculture, University of North Carolina, Raleigh, North Carolina, November, 1955, pp. 4-6.

[17]H. P. Lynn, F. H. Hedden, and J. M. Lewis, *Tobacco Irrigation in South Carolina*, Circular No. 438, Extension Service, Clemson Agricultural College, Clemson, South Carolina, February, 1958, p. 7.

A report from Virginia[18] gives results of three years of study:

TABLE 11

The "Pay-Off" of Irrigation of Burley Tobacco
Blacksburg, Virginia, 1954-1957

Year	Yield with No Irrigation	Yield with Irrigation*	Yield with Irrigation**
	Lbs. per Acre	*Lbs. per Acre*	*Lbs. per Acre*
1954	2967	3630	3699
1955	2289	2550	2421
1956	2664	2972	2787
1957	2875	2973	2868

*Irrigation during growth period from knee height through bloom
**Irrigation at transplanting and throughout growing season

Significant yield increases resulting from irrigation have also been shown in Kentucky, Georgia, and other cotton-growing states.

Presley makes the following statement concerning profits from irrigation of tobacco: "Probably a greater percentage of the total flue-cured tobacco crop is produced under irrigation than any other major field crop. Experiments that have been carried out indicate that irrigation normally produces good returns when used in tobacco production."[19] (Note: Mr. Presley's entire thesis should be of special value to those interested in extending credit for irrigation of tobacco.)

Another of the many benefits from irrigated agriculture is that a greater variety of crops can be grown in the irrigated areas. By being able to control "moisture" in the soil, plant nutrient uptake is improved, and the quality and the yield of crops are better. Hence, through irrigation agriculture, a better diet for all our people is made possible.

Irrigation offers a center or nucleus around which urban and industrial development is built. A few items of interest along this line from a Reclamation Report[20] are quoted. "Out of about $80-billion collected by the Federal Government in fiscal 1957, nearly one-fifth came from the reclamation states; and the proportion is increasing. Since 1940, personal income in the West has increased from 19 per cent of the national total to over 24 per cent at present."

[18]J. Nick Jones, Jr., J. E. Moody, and J. H. Lillard, *Relating Irrigation to Stage of Plant Growth*, paper presented at 50th annual meeting of the American Society of Agricultural Engineers, East Lansing, Michigan, June 25, 1957, p. 7.

[19]Charles B. Presley, *Financing Sprinkler Irrigation Equipment With Particular Reference to Flue-Cured Tobacco Production*, The Stonier Graduate School of Banking, 1958, p. 70.

[20]*Reclamation Accomplishments and Contributions*, 86th Congress, 1st Session, Committee Print No. 1, Washington, D. C., January, 1959, p. 40.

A report [21] of the Central Valley project in California states: "This project alone through supplementing the water supply of many privately built and highly successful irrigation ventures and the irrigation of some new land is estimated to provide a new market for a million pairs of shoes each year, part of which will be made in Massachusetts, New York, Pennsylvania, or Missouri; for $10-million worth of tobacco products which will come largely from North Carolina, Virginia, Kentucky, Florida, and Pennsylvania; for 8,000 vacuum cleaners, 8,000 refrigerators, 8,000 ranges, 8,000 washing machines, 8,000 radios and television sets which will come from many states but largely from Ohio, Michigan, Illinois, Connecticut, New Jersey, New York, and Pennsylvania.

"The increased purchasing power of this one project translates into an annual market for 15,000 new cars, some from Detroit and South Bend and other cities, but many assembled in California from parts manufactured in Michigan, Indiana, Illinois, Ohio, and Wisconsin; for hundreds of thousands of dollars' worth of textiles from New England and the South Atlantic States; and for thousands of automobile tires and accessories, home appliances, office machines, and all the assorted gadgets of the day produced in all corners of the country."

This is to say nothing of the increased purchases on the farm; the greatly increased need of operating capital for irrigation.

Still another example of an irrigation project is listed.[22] "In 1915 the U. S. Government undertook to construct in the State of Utah what is known as the Strawberry Reservoir Project . . . which cost $3⅓-million. Forty-four years later we find that it has paid back 80 per cent of its initial cost, with interest. In addition, it has made possible the growing of $78½-million worth of crops, which represents 22 times the value of the original investment. Power, municipal water, and recreation associated with the project bring in one-half million dollars per year. Personal incomes directly attributable to this project amount to $18-million per year. Twelve thousand people live on land made livable by this little project, and Federal taxes paid into the Federal Government from income made possible by this project amount to some $4½-million a year, which is more than a million dollars a year in excess of its entire cost. All of this, as a result of a mere $3⅓-million investment — and this is just the beginning."

[21] *Report by the Bureau of Reclamation, Department of the Interior, for the use of the Committee on Interior and Insular Affairs,* House of Representatives Committee Print No. 27, Washington, D. C., October, 1954.

[22] Remarks of the Honorable David S. King of Utah, in the House of Representatives, *Congressional Record,* September 2, 1959.

Part II

FINANCING IRRIGATION SYSTEMS

General

A dramatic growth in the use of farm equipment has taken place during the past generation. Many farm experts feel that a somewhat similar expansion in the use of irrigation will occur during the next few decades. Such rapid expansion and application of capital in our farm businesses will require large amounts of borrowed money, and this credit should never be refused because of the loaning officer's inadequate knowledge or understanding of the type of loan being requested. This manual, therefore, is designed to be a guide for our country's bankers who will be called upon to handle many thousands of such irrigation loan applications.

In today's highly commercialized agriculture, the farmer is constantly being faced with decisions concerning the investment of relatively large sums of money. Adopting an irrigation system is one such important change. The farmer, therefore, must clearly determine if such a purchase would constitute the proper use of capital for his business. If credit is to be used, it is also the banker's responsibility to see that proper attention is given to this question of alternative use of capital.

The discussion in Part One concerns the many aspects of irrigation; e.g., water supply, prudent water use, development of new water supplies, legal rights, government participation, and irrigation systems. A general knowledge of these problems of water use should serve as a guide in establishing a broad bank policy on (1) the extent to which this type of financing is desirable for the individual bank, and (2) the eventual benefit a good financing program might bring to farmers, the community, and the bank.

The decision to adopt such a financing program must be followed by a good, sound plan; and Part Two of this manual is designed to offer guideposts for establishing loaning procedures. One cardinal rule must be kept in mind: the program should be tailored to the bank's policy, be adaptable to usage by farmers, and be within the statutory requirements of the state concerned. In addition, it is important that the program be properly organized internally and that loaning officers be well prepared to process loan requests.

There are two general approaches to handling the financing of irrigation systems: the "direct," where the bank deals with the farmer; and the "indirect," where a dealer makes the original credit arrangement with the farmer-customer and creates a time sales financing contract which, if acceptable, is subsequently sold by assignment to the financing bank.

Some variation in the nature of direct loan requests should be expected. In many instances, the bank will be asked to consider the financing of irrigation systems as part of the overall farm loan portfolios. These requests will generally come from present customers, although they may stem from other farmers who desire to transfer all their credit needs to the bank and to consolidate their indebtedness into a well-balanced program. Still other direct requests may be solely for irrigation system financing and may be the single credit requirement of the farmer. Direct lending offers some advantages in the handling of the loan itself since it gives the bank better control of the credit. In addition, by working directly with the farmer-customer, the bank is in a better position to develop a good customer who may use other banking services.

Indirect lending follows a rather definite pattern and requires specialized treatment. All parties involved must be considered, but special attention should be given to the dealer and the part he plays in the transaction. This method of lending usually offers the advantage of developing a larger volume of business in a shorter period of time than is possible through a direct loan program. In addition (depending on the original agreement), the dealer has a greater interest in assisting the bank in collections and in the handling of repossessions and resales should the occasion arise.

Regardless of the bank's approach to financing irrigation systems, it is imperative that the bank consult with its attorney regarding conformance to state statutes in types of forms used, terms allowed, loan limitations imposed by law, and general procedures in handling liens.

Direct Loans

Under the direct loaning method, only the farmer and the bank are concerned. This calls for a fairly close relationship — one which permits a complete understanding of the financing program involved. To conduct a direct lending program such as this, the banker must know a great deal about the farmer and his business and certainly must have complete confidence in him. Likewise, the farmer needs to be assured that a complete financing program is available to him and that, upon legitimate request and under proper terms, additional credit extensions will be made.

Loans under a direct program will, of course, be made with normal, sound credit considerations in mind. These include the farmer's

responsibility and reputation, past credit record, present overall financial position, production records, managerial ability, and general success in farming. Special attention must be given to the suitability, including the flexibility, of the irrigation system to be employed and the increased earning capacity anticipated for the farm operation.

Generally, the bank should expect that if the farmer requesting financing for an irrigation system has a loan outstanding, he is going to need borrowed money to cover most of the cost since his excess earnings are now going into debt reduction. This will be especially true if irrigating is to be a new practice and there is no equipment available to trade in for equity purposes. By working directly with the farmer, the bank is in a much better position to provide this complete credit service.

The bank may find that, to obtain a proper balance in the farmer's loan portfolio, some adjustment is needed in both the long- and short-term portions when resetting the loan. In fact, it will be important to both the bank and the farmer to balance the terms of the overall loan so that the new projected earning capacity of the farm operation will be sufficient to carry the debt schedule requirements. It should be mentioned that, by adopting irrigation practices, farmers have not only realized increased net incomes, but have also added to the stability of their income, thus making it possible to program more accurately debt-repayment schedules over longer periods of time.

The type of farming involved determines the nature of the farmer's income; and this, of course, will dictate the timing of repayment. It is important to have the repayment schedule coincide with anticipated income periods. A complete repayment schedule should be arranged for the total amortization of the loan, but allowance should be made for reasonable changes. Many banks find it desirable to review at least annually the farm loan program and to make any necessary adjustments. These may include changes in the repayment schedule.

In this overall approach to farm lending, interest rates on the irrigation system will fall in line with the bank's normal charges on farm loans. Generally speaking, the farmers eligible for this "package-type" credit at a bank have the best of credit standards and are justified in receiving the bank's most desirable interest rate available on agricultural loans.

The use of security will depend on the farmer's financial position and on how he "stacks up" in regard to other credit standards. An unsecured loan may sometimes be justified. More often, a chattel mortgage will be used with a partial or blanket lien against the farm equipment, including the portable parts of the irrigation system, and livestock if applicable. From a lender's standpoint, blanket coverage on personal property is desirable since it tends to encourage one-stop financing. Avoiding a split line of credit is advantageous to the farmer, too, for it helps insure him against excess borrowing.

In many areas, bankers are being faced with the problem of financing expensive equipment such as pipes and weed screens which are either buried or in some way attached to the land. Special attention must be given to the use of lien contracts when these particular situations exist. Often banks find it necessary to use the real estate mortgage in conjunction with a regular chattel on the personal property.

The type of lien contract used must fit the circumstances involved and conform to the state statutory requirements. It is suggested that banks give special attention to state laws in renewing recorded contracts and that they establish a good internal procedure for refiling.

Prior to obtaining a chattel mortgage on a farmer's personal property, the bank must be assured that the title of the property is actually in the borrower's name. A lien search of the proper public records will determine whether any prior lien exists.

In direct lending it is imperative that the bank keep complete and continuous records on the individual farmer's loan program. This can best be done by using a credit file which incorporates a physical and financial history of the farmer and his operation. The use of the credit file will be covered later in this manual.

The direct approach will allow for overall financing of an irrigation system including the development of an adequate water supply and the purchase of necessary equipment. It may also cover part of the initial operating expenses. If the farmer is going to need credit on phases of his irrigation program other than the purchase of equipment, it will usually be in his best interest (as well as the bank's) to discuss his complete credit requirements before he starts to develop his irrigation system.

In the arid regions of the West, where the water supplies are scarce, the development and operation of irrigation systems is extremely expensive. The development of adequate water supplies, leveling of land, and construction of concrete-lined ditches comprise some of the major costs. In addition, pump-back systems are used to conserve the limited water supply. Many banks have found that, because of the costly and permanent nature of this type of irrigation system, the long-term real estate mortgage best fits the farmer's financing program. It also will allow for a reasonable pay-out schedule based on the overall improved earning capacity of the farm. This type of loan necessarily requires a close, direct working relationship between the bank and its farmer-customer.

Indirect Loans

The financing of irrigation systems indirectly – or through dealers – is more involved, but many banks have found it more desirable. A successful program of this kind must be carefully planned so that it will perform a function satisfactory to not only the farmer and the bank, but also to the equipment dealer. It is imperative that the bank

and dealer agree in advance on the details of the discounting arrangement. In addition, the dealer must have full knowledge of the terms of the financing plan since he will be required to complete the contract with the farmer. *Misunderstandings should be "ironed out" immediately* so that future delays causing antagonism on the part of the farmer as well as the dealer can be avoided.

In this indirect method of financing, special attention must be given to the dealer and the part he plays in the transaction. Proper evaluation of the following factors is important:

1. Character and moral risk of the dealer
2. His financial responsibility – especially the adequacy of his working capital
3. Ability of the dealer to conduct his business on a profitable basis
4. His credit consciousness and aggressiveness in making collections
5. His sales methods and service policy in regard to irrigation systems

It remains the bank's responsibility to consider all factors and all parties involved and to extend credit which is in the best interest of all concerned. Only then can the financing arrangement be expected to meet with reasonable success.

An agreement covering the finance plan chosen should be signed by the dealer and accepted by the bank. This may be a separate agreement for irrigation equipment only, or it may be part of an agreement for other equipment being handled by the dealer. This will depend on whether the plan for discounting irrigation equipment differs from that of other equipment.

The five dealer arrangements most commonly used are:[23]

1. Full Endorsement Plan
2. Limited Recourse Plan
3. Repurchase Plan
4. Nonrecourse Plan
5. Mutual Reserve Plan

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[23]The material on dealer arrangements has been drawn largely from *Farm Equipment Financing by Banks* published by The American Bankers Association in 1956. Refer to this publication for more detailed discussion on dealer contracts and reserves.

FULL ENDORSEMENT PLAN

A full recourse arrangement makes the dealer the primary creditor. Under this arrangement, the dealer is fully liable to the bank for all defaulted obligations bearing his endorsement. In some cases, the dealer endorses each contract with full recourse. In other cases, through an executed master agreement, the full responsibility of the dealer is set forth so that he has the same responsibility he would have if he individually endorsed each contract.

Even though the paper is fully endorsed by the dealer, a bank should insist that every transaction be sound. Thorough analysis of the ability to repay and the financial condition of the farmer-purchaser is essential. Some have felt that banks lean too heavily on the recourse crutch rather than on the quality of the credit. Good credit should always be the prime requisite for making a time sale.

LIMITED RECOURSE PLAN

The limited recourse plan is an arrangement whereby the liability of the dealer is limited as to time or amount on individual or aggregate contracts bought by the bank. This type of agreement usually provides for a reserve or holdback of a certain percentage of the face amount of the note (commonly 3 to 5 per cent). This amount is credited to a dealer's reserve account and is accumulated until it equals, say, 5 to 7 per cent of the outstanding balance of all contracts. When this holdback reserve account exceeds the agreed percentage of the dealer's outstanding obligations, the bank can pay out at periodic intervals the amount of the excess reserves.

Generally, under a limited recourse arrangement, the bank makes an agreement with the dealer whereby he has full liability on a contract until a certain percentage of the time price has been paid by the buyer. After the stipulated amount has been paid, the dealer is released from his liability on the transaction. The number of payments normally equals about 25 to 30 per cent of the contract.

REPURCHASE PLAN

Under this arrangement, the dealer agrees to repurchase repossessed farm equipment for the unpaid balance of the contract. Certain legal and technical objections of the full endorsement plan are avoided. Different types of arrangements may be made under this plan. The bank can assume the responsibility for any legal action necessary. The dealer can agree to make the actual physical repossession. Also, either a portion (a holdback) can be retained from the proceeds of the balance financed, as previously mentioned under Limited Recourse Plan, or a reserve can be set up out of the finance charge. The great advantage in both the limited recourse and repurchase plans is the moral effect upon the dealer, as these plans put the dealer on a participation basis with the bank and make it to his advantage to reveal all the true facts, good or bad, to the bank.

NONRECOURSE AGREEMENTS

On nonrecourse arrangements, lenders naturally must be more selective in their purchases of paper than when they rely partly or entirely on endorsement arrangements. Under a nonrecourse agreement, there is no recourse to the dealer if the purchaser defaults.

The manufacturer usually provides a performance warranty on all new equipment, and the dealer undertakes to assemble and adjust the equipment and to instruct the purchaser in its proper operation and care. Generally, under a nonrecourse agreement, the dealer does the physical work of repossessing, reconditioning, and reselling the equipment and is reimbursed by the lender for the cost of performing the services. The nonrecourse arrangement is not popular and should be used with extreme caution. Since the bank must be extremely selective in buying this type of paper, a limitation may be placed on the volume of equipment the dealer sells.

MUTUAL RESERVE PLAN

This plan may be applied in two ways. Under the first method, a reserve is created by retaining a certain percentage (holdback) of the net proceeds on each contract purchased. While the manufacturer's cash discount for prompt payment varies, it is not uncommon for the dealer to receive a cash discount of up to 5 per cent. Thus, the dealer can authorize the bank to retain an amount up to 5 per cent on the balance of the contract without having to create the reserves out of his own cash.

Under the second method, a reserve may also be created, either with or without a holdback, by setting aside a percentage of the finance charge in a reserve account. If the reserve is accumulated out of the finance charge on the contract, there may also be a holdback of 5 to 10 per cent on each transaction until an agreed-upon minimum reserve account balance is reached.

The advantages to this plan are that the dealer sells his paper without recourse, yet a sufficient reserve is created to protect the bank against losses. This plan has appeal to many dealers; however, it is not effective unless the dealer creates a sufficiently large volume of paper so that adequate reserves are built up not only to protect the bank in case of loss, but also to give the dealer incentive to see that his paper is liquidated with a minimum loss to the bank.

The various plans outlined stress that the bank is a financial institution and the dealer a merchandiser. The merchandising responsibility is solely the dealer's. It is therefore proper for a dealer to enter into an agreement with the bank to repurchase, repossess, recondition, store, or resell the equipment involved.

Even though the contracts are accepted on a nonrecourse basis, the general practice is to provide a reserve account out of the finance charge or out of the unpaid balance of a contract (holdback) or both. This places funds at the disposal of the bank to protect it against possible losses. The reserve account should be proportionate to the amount of paper bought under a sound credit and collection program.

As the obligations are liquidated, the dealer's reserve account is adjusted and distribution is made to him every six months or at other intervals. Generally, the dealer's reserve balance should exceed an agreed percentage (5 to 10 per cent) of the unpaid balance of paper outstanding which is current or not more than 14 days delinquent, plus 100 per cent of the unpaid balance of paper which is 15 or more days delinquent, before distribution is made. When a small volume of contracts is handled for a dealer, a minimum reserve should be required below which no refunds are given.

Credit Standards

Generally, the dealer program covers the financing of equipment purchases only. Some banks have accommodated the farmer on additional phases of his irrigation program by allowing for considerable flexibility in the terms of the contract; other banks handle these extra costs by use of a separate contract or a direct loan. In doing this, the bank must take a somewhat different look at the credit standards of the loan and consider the overall credit picture in regard to equity, repayment schedule, interest rates, and type of lien used.

It is the intent of this discussion to look at the following credit standards – down payment, length of contract, interest charges, and security and type of lien – from an instalment credit point of view. This the bank is justified in doing when it handles irrigation equipment financing through dealers.

DOWN PAYMENT PROVISION

When the purchase of irrigation equipment is the only purpose of the loan, the borrower is expected to establish equity in the equipment from his own resources at the time of purchase by making a proper down payment either in cash or through a trade-in allowance. The lender must be assured that a real down payment has been made and that it has not been established through a second lien on the equipment or through credit on the dealer's books.

To establish a down payment requirement, attention should be given to the dealer's wholesale cost; and the amount being financed should be compared to it. Two other factors important in establishing down payment requirements are the timing of repayments and the period of time required for total liquidation of the loan. For example, a smaller down payment would be justified if repayment started immediately and if regular monthly reductions were to liquidate the loan within three years; a larger down payment would be necessary if the loan were to run for five years with only annual payments that

would start one year from the date of the contract.

Banks having considerable experience in financing irrigation equipment find that a 25 to 35 per cent down payment is sufficient to establish a reasonable equity at the time of purchase. These banks have made adjustments around the 30 per cent mark when circumstances have varied from the norm.

LENGTH OF CONTRACT

Since each farmer's situation is unique, a certain degree of flexibility in setting the length of repayment periods must be permitted if the bank is to have a realistic policy. The important consideration in establishing a repayment schedule is the farmer's ability to pay. To some extent, this will be based on the increased income which may be expected from the operation of the irrigation system. It is generally felt that a system should pay for itself within five years to justify the purchase. Many farmers have paid for their irrigation systems within much shorter periods of time. In the financing of surface irrigation systems, however, attention must be given to the substantial investment necessary for land improvements. Land leveling, ditching, and permanently installed structures are capital investments which increase the land value. Therefore, repayment schedules exceeding five years are necessary and certainly justified.

In instalment credit, it is important that the equipment being financed has, at all times, sale value equal to at least the balance due on the loan. Therefore, factors of depreciation and obsolescence must be kept in mind when establishing loan liquidation schedules. Depreciation schedules for portable irrigation equipment indicate an average life expectancy of 4 to 15 years for combustion gasoline engines, 8 years for sprinkler heads, and 15 years for aluminum pipe.

Banks making dealer loans on irrigation equipment have had no difficulty as long as the payments have been tailored to the farmer's ability to pay and have been scheduled to coincide with periods of expected income. Although most of these loans have been written for periods of three years, many have been written for five years if longer terms seemed justified.

INTEREST CHARGES

Interest rates should be dictated by local bank conditions and be in conformity to state laws limiting permissible rates of interest. In most instances, interest charges are somewhat higher on indirect loans through dealers since, under most dealer arrangements, a reserve account is established from a portion of the financing charges. Rates on irrigation equipment loans should be similar to rates on other farm equipment loans of comparable size. If used equipment is being financed, a higher rate is usually justified. Interest rates should be agreed upon and made a part of the dealer agreement.

SECURITY AND TYPE OF LIEN

Through the use of proper down payments and loan liquidation schedules, the loans will be fully secured at all times. To insure this, it is important for the bank to have a good system for checking loan amortizations in order to avoid excessive delinquency periods.

Generally when the sale of irrigation equipment through a dealer is involved, the conditional sales contract is used. The bank, in turn, purchases the contract from the dealer when it has been properly assigned by the seller. (The assignment form is usually printed on the reverse side of the conditional sales contract.) Many banks prefer to handle all equipment transactions on this type of contract since repossession of equipment is much simpler with this instrument than with a chattel mortgage.

If a chattel mortgage is to be used, care must be taken to see that the title to the equipment is in the name of the borrower. In addition, a lien search of the proper public records is advisable to determine whether any prior liens on the equipment exist.

Because of the differences in various state laws regarding lien contracts, it is imperative that the bank adopt forms and procedures which conform to its state statutory requirements.

The Farmer – The Farm Business – The Irrigation System

Regardless of which financing approach is developed – direct or indirect – three important questions must be answered to the bank's satisfaction before a loan is granted. They are:

1. Is the applicant a good credit risk?
2. Does his farm business warrant the credit being requested?
3. Will the irrigation system fit into the farm operation?

The bank's need for thorough and complete knowledge on each of the above will intensify as the more direct approach of lending is used.

THE FARMER

If the bank's previous experience with the applicant has been satisfactory, there may be little need for further concern about his general attitude toward farming and his handling of debt. If the bank's knowledge is limited, a rather thorough, confidential investigation should be made to assure the bank that the farmer intends to handle his credit program according to plan.

Some of the important factors to consider are: the farmer's honesty and integrity in carrying out his business dealings with others; his attention to debt obligations as indicated by his past credit record; his health – which is important in assuring the continuation of the farm operation; the family's attitude toward farm life and their willingness to assist in the operation of the farm; and the farmer's attention to business and his managerial ability in planning, production, and marketing. His basic knowledge of irrigation and his knowledge of how it will improve his farm operation should be important considerations before credit is extended for this purpose. The addition of an irrigation system does not automatically improve the earning capacity of the farm; it requires careful management.

Prior to making a loan for water development and irrigation, the banker must not fail to consider the farmer's attitude toward "conservation farming" – that is, giving proper attention to soil maintenance and improvement in the use of the land. Farmers who conduct their businesses with a complete conservation plan in mind will prove a highly desirable group of borrowers.

Seldom will all of the above considerations fall into the "blue chip" category. By weighing each against the others, however, a general impression will crystallize and a decision concerning the acceptability of the applicant can be reached.

THE FARM BUSINESS

The bank is justified in obtaining complete information regarding the farm operation. In working directly with the farmer, this should be pointed out initially so as to avoid misunderstandings later. The farmer should be assured that any information given the bank will be held in confidence.

The following information is needed:

1. *A financial statement* presenting a current picture of the farmer's financial condition. If the applicant is a new customer, it would be desirable to have statements for the past three years so that a comparative analysis can be made prior to the initial loan. Physical descriptions such as the number of acres, head of livestock, and amount of inventory should be included on the statement.

   The statement combining the physical and financial data of the business sets forth the necessary information regarding size of the farm operation to be financed. Many bankers, especially in the tobacco area of the Southeast, have stressed the importance of a sufficiently large production unit to justify the heavy investment required in installing and operating an irrigation system. For example, one bank in this area indicated that it requires a tobacco allotment of six acres as a minimum-size unit.

2. *An operating statement* showing yield and production figures as well as an accounting of income and expenses. From this the bank can determine the efficiency of the operation and the repayment ability of the farm. Operating statements are difficult to obtain. The bank can do a great deal to encourage its farmer-customers to keep records and prepare operating statements by providing simplified forms for this purpose.
3. *A comparative statement* showing the trend in both physical and dollar inventory over a period of years. This is extremely helpful to a loan officer since a quick glance reveals the growth and financial progress of the business.
4. *A farm budget* projecting the operation for a reasonable period of time. Such a plan requires a rather careful look at the farming program so that amounts and timing of all income and expenses can be pinpointed with a reasonable amount of accuracy. Budgeting is an absolute necessity if good money management is to be achieved. It guides the farmer in controlling both his business and family expenses; above all it enables the arrangement of necessary credit in advance and, in many cases, at better terms. Adopting an irrigation system may initially complicate this "possibility planning" since previous years' experience will not be satisfactory guides to the expected results. But in the long run, the problem of making projections will be eased since irrigation brings stability to the farm income picture.

Other important considerations are the continuity of management and the adequacy of the irrigation system. The bank should be a bit skeptical of financing an expensive irrigation system for a man about to retire if there are no sons or other persons interested in taking over the farm. Likewise, it must be clearly determined if an irrigation system is the proper investment at this time and if it will be a suitable and profitable addition to the present farming practices.

Looking over the many factors concerning the past operation of the farm will certainly provide a reasonable indication as to what success may be expected in the future. The bank must keep in mind the changes to be expected as a result of the farmer's use of an irrigation system. Irrigation has not only resulted in higher farm income (through greater production of higher quality products); it has also added to the stability of this income by assurance of crop production.

An additional word of caution regarding the farm operation to be financed: In some areas, farmers have extended their acreage by utilizing land in a "flood plain zone" – an area so designated under flood control programs. In many instances, this is advisable; and such lands can be profitably managed for agricultural purposes since flooding can be forecast and normally occurs only periodically. However, it is important that the banker as well as the borrower be aware of

this hazard and consider it before financing a major expenditure in land preparation and irrigation equipment.

THE IRRIGATION SYSTEM

The bank engaged in financing irrigation systems should be certain that the equipment on which it is extending credit has been properly designed and that complete plans for the operation of the system have been developed for the purchaser. Each farm will present a different problem; and therefore, the designing and planning must be on an individual farm basis.

Some of the more important matters to be considered are:

1. *The availability of an adequate water supply.* If it is not presently available, will it be feasible to develop a sufficient supply? Bank credit for expensive equipment should not be extended until an adequate supply of water is assured. The location of the source of water relative to the area to be irrigated is an important consideration since it will definitely affect the cost of operation. The ideal location would be near the center of the area to be irrigated where the water would have to be raised only a relatively few feet.

   The bank should become familiar with the state statutes governing the use of water to determine if the farmer is entitled to use the water for his irrigation project.
2. *The design of the system.* Is it correct for the particular farm to be irrigated? It must be kept in mind that irrigation is simply the storing of water as soil moisture in the root zone of the crop. This reservoir is small in sandy soils and large in loams and clay. Likewise, the rate at which water is absorbed varies with the soils, with three inches or more of water per hour going into sandy soils, but less than .2 of an inch per hour being absorbed by clay loams. In addition, each crop has a different depth of root zone. Thus, each irrigation system must be tailored to the individual farm on which it is to be used. "Packaged" irrigation systems have often resulted in disappointment when they have failed to do the job. During the planning stage and prior to any purchase of equipment, the county agricultural agent and/or extension engineer should be consulted concerning the overall irrigation project.
3. *The reputation of the dealer* from whom the farmer is buying his equipment. The bank must be assured that he will design the irrigation system properly and provide satisfactory service.
4. *Cost and return.* The success of the irrigation system will depend on the year-to-year operation. The farmer should

be reasonably well informed of these costs at the time of the original investment. Certain fixed costs will be experienced regardless of the amount of use. Such costs are depreciation, insurance, and interest on the investment. Other costs will vary with the number of hours the equipment is in service. Included in this category are labor and fuel.

One bank in the southeastern United States has developed a special irrigation financing loan request form which requires the applicant to take a very close look at the design of the equipment, water source, and expected returns before the loan will be considered. (See page 49.)

The applicant, his farm business, and the irrigation system he wishes to finance are all important to the eventual payout of the loan. The banker cannot afford to overlook these vital considerations.

Servicing the Irrigation Loan

The second important phase of the loaning process is providing service. This is an all-embracing word and may be taken to include the various contacts and relationships between the bank and the borrower from the time the loan is made until it is repaid. This service involves maintaining a credit file on the customer, making an occasional farm visit, and even lending additional funds.

The servicing of loans on irrigation systems should become a part of the bank's overall interest in the farmers with whom it is working directly. Dealer loans usually require less service to the farmer-customer, but greater attention should be given to the dealer and the bank's service to his account.

CREDIT FILE

The man who initiated the loan should usually service it until the final payment has been made. On occasion, however, the original loaning officer is not available; and someone else must assume the responsibility for servicing the loan. This is one of several reasons why a credit file on each borrower should be fully and accurately maintained.

The file can and should be a running record of the progress or lack of progress made by the customer. This can be achieved by keeping up to date the following information:

1. History sheet including loan action, important conversations, and pertinent comments
2. Annual financial statements
3. Annual operating statements
4. Comparative analysis made annually (both financial and physical) indicating business trend
5. Inspection and appraisal reports, including record of liens
6. Copies of correspondence

Purchaser's Loan Application for

IRRIGATION FINANCING

WATER SUPPLY

SOURCE: Pond______ Stream______ Well______ Other______

QUANTITY: Gal. p/min.______ Cu. Ft. p/sec.______ QUALITY______

AVAILABILITY: Year-Round Delivery______ Other (Explain periods of short supply)______

EXPECTED ANNUAL INCOME FROM IRRIGATION FARMING

CROP	NO. ACRES TO BE IRRIGATED	AV. YLD. PER ACRE NOW	ANTIC. YLD. PER ACRE IRRIGATED	NET INCR. YIELD PER ACRE	AVERAGE UNIT MKT. PRICE	INCREASED INCOME PER ACRE	TOTAL EST. INCREASED INCOME	MONTH IN WHICH INCOME IS RECEIVED
Tobacco								
Corn								
Cotton								
Peanuts								
Grain								
Hay								
Pasturage								
Other								

IMPORTANT: Each farmer must get accurate information on what crops to irrigate, how much water to apply and when to apply it, how much fertilizer to use, etc., in order to get an idea of what the increased yield will be using irrigation.

DEALER QUESTIONNAIRE

1. Does rate of water application for the proposed system meet all requirements of the District Soil Conservationist or other recognized authority?______

2. Does proposed system have the capacity to meet peak moisture demands during the growing season as recommended by local County Agent?______

3. Does operating pressure and sprinkler spacing designed for the proposed system meet the requirements and recommendations of the manufacturer?______

4. Has proposed system been designed at minimum cost to the purchaser in order to produce the increased income shown above?______

PURCHASER AND DEALER WARRANTY

This is to certify the necessary information on soil and crop requirements has been obtained from responsible agricultural technicians and written instructions have been furnished by dealer to purchaser covering operating requirements which are mutually understood to be the basis of design of the equipment.

SIGNED______ PURCHASER ______ DEALER ______ DATE

The reward of a good credit file comes to the bank when the loan servicer, fortified by accurate and complete information, can discuss each borrower's business affairs with him — not only in a general way, but specifically, as well.

THE FARM VISIT

There are two types of farm visits which banks should utilize in their farm loan programs. The first is the initial inspection made prior to the extension of credit when a general impression is obtained and appraisals of collateral are made. Additional inspection visits should be made at varying intervals during the term of the loan. The frequency of these visits should depend on the quality of the loan and the manner in which it is being handled by the farmer.

The second type of visit is the occasional "general interest" call which not only provides the bank with a means of observing the farm operation at first hand and of obtaining a progress report for the credit file but, if handled with diplomacy, also goes a long way in cultivating the farmer as an all-around bank customer.

Timing of visits is important. The inspection call should be prescheduled with the farmer so as not to interfere with other important work. The "hello" call is more difficult to make at the proper time since, generally, it is not prearranged. The bank should try to know the customer well enough so that a visit will not conflict with the farmer's busy schedule. A visit of this type during the operation of the new irrigation system would certainly indicate the bank's interest in the farmer's accomplishments. A little mud on a banker's boots at the right time can make a big difference!

ADDITIONAL LOANS

A loan program for a particular farm operation should never be considered "set"; the bank must expect changes and be prepared and willing to make needed adjustments. A farmer is justified in expecting his banker to discuss additional credit needs with him. The initial loan for an irrigation system will cover, necessarily, financing for the entire system so that the farmer can place it in operation. Purchasing the equipment on a piecemeal basis has little value. Additional financing may be needed if the farmer finds the system operating to his satisfaction and if he wants to expand his crop acreage under irrigation.

A bank's attention to loan servicing can vitally affect the outcome of the loan as well as the bank's relationship with the farmer as a bank customer.

APPENDICES

APPENDIX A

State Water Laws

All of the states have laws that affect water developments and use either directly or indirectly. The Western States and some of those in the East have specific agencies established to administer the water laws as to acquisition and use of water. All states have some kind of control over public water supplies used for municipal or industrial purposes.

In those states having water under administration, there are two basic water laws which generally govern:

1. *Riparian right.* Under a strict interpretation of this doctrine, a man is entitled to have water flow past his property unpolluted in quality and undiminished in quantity.

2. *Appropriation.* This law allows a man to file on water for beneficial uses and, between users, first in time is first in right.

In addition, there are several adaptations of these basic laws including:

1. *Reasonable use.* As the name implies, each owner of land or other water user is entitled to a fair use of the water he needs for a beneficial purpose.

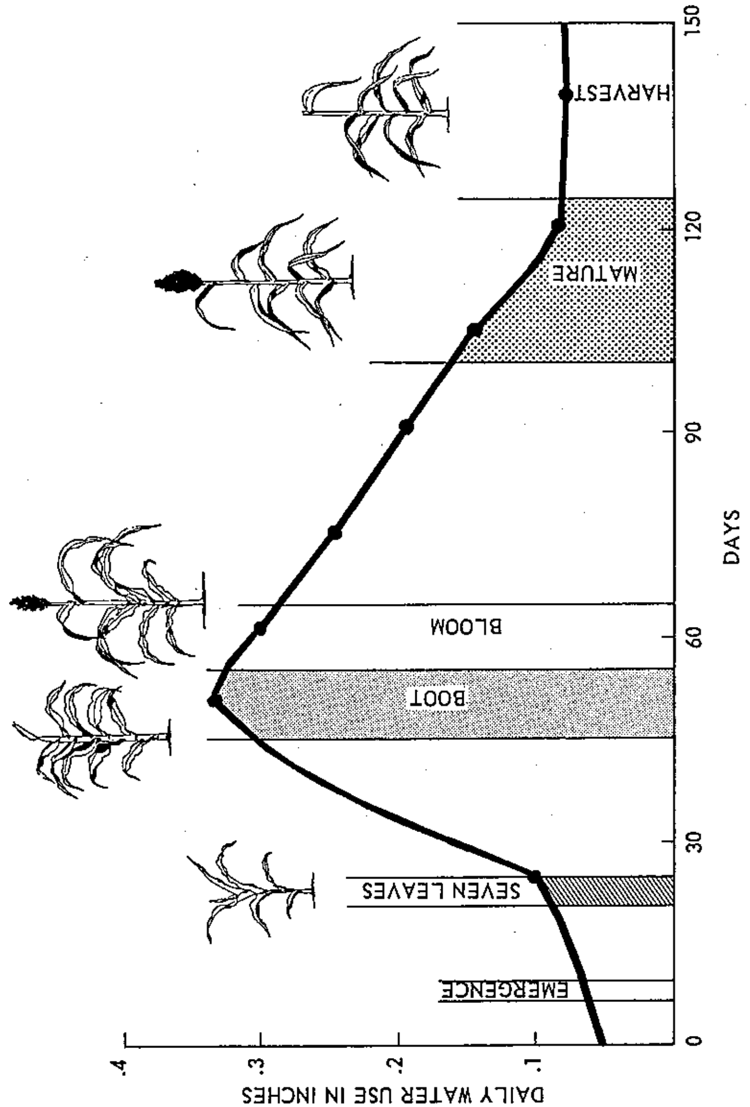
2. *Common law.* This law assumes that each user is entitled to his proportionate share of the available water.

3. *Special permit.* This allows for regulation of a specific area where water supplies are becoming critical.

4. *Correlative right.* This assumes that each man pumping from underground is entitled to the water under him as is each of the other pumpers of the area.

A summary of the basic laws of each state and the agency responsible for administering them and for controlling the pollution and health aspects is given in the following table.

APPENDIX E
Daily Water Use in Inches
DAYS
Daily water use from planting to maturity



Source: Ben R. Spears and Lee C. Coffey, *Growing Grain Sorghum*, Bulletin B-210, Agricultural Experiment Station, Texas A. and M. College, College Station, Texas, 1959.

APPENDIX F

Consumptive Water Requirement of Crops During Frost-Free Periods at Selected Spots in Western United States

State	Town	Crop (Consumptive use in inches) Alfalfa	Small Grains	Corn	Potatoes	Beans	Cotton	Sorghum
Arizona	Phoenix	46	20	–	–	–	31	21
	Parker	49	20	–	–	–	33	23
	Window Rock	27	15	18	16	12	–	–
Colorado	Durango	23	14	17	17	14	–	–
Idaho	Ft. Hall	24	16	22	15	14	–	–
	Lapwai	32	15	23	20	13	–	–
	Coeur d'Alene	26	16	22	20	14	–	–
Kansas	Arkansas City	36	17	26	–	–	–	23
Montana	Billings	27	20	20	20	–	–	–
	Crow Agency	27	20	20	20	–	–	–
	St. Ignatius	23	19	20	20	–	–	–
Nevada	Carson City	20	15	17	16	–	–	–
	Reno	25	14	19	18	–	–	–
	Yerington	21	15	19	18	–	–	–
	Fallon	23	15	20	18	14	–	–
	Owyhee	16	14	–	–	–	–	–
New Mexico	Shiprock	28	15	18	16	12	–	–
	Albuquerque	34	14	21	–	17	–	22
N. Dakota	Devils Lake	23	16	17	20	9	–	–
Oklahoma	Lawton	41	–	23	–	–	29	21
Oregon	Pendleton	28	17	21	17	–	–	–
	Klamath Falls	20	16	–	18	–	–	–
S. Dakota	Mobridge	26	16	22	19	14	–	–
	McLaughlin	24	16	21	19	14	–	–
	Pierre	19	16	23	20	14	–	–
	Martin	28	16	22	20	14	–	–
Utah	Brigham City	29	16	21	17	16	–	–
	Ft. Duchesne	22	15	19	17	15	–	–
Washington	Toppenish	31	16	24	21	14	–	–
	Nespelem	27	17	24	21	15	–	–
	Spokane	31	15	21	19	13	–	–

Source: Information developed by Wayne D. Criddle.

APPENDIX G

Recommended Criteria for Land Leveling for Various Methods of Surface Irrigation

ITEM	METHOD OF IRRIGATION				
	BORDER	FURROW	CORRUGATION	BASIN	RICE BASIN
Maximum allowable slope in direction of flow.	Alfalfa or grain—2% Pasture (Established)—6%.	3%	8%	0.1%	0.1%
Allowable variation in grade in direction of flow.	1. Steepest should not exceed 2 times the flattest. 2. Undulating slopes are not allowed.	1. Increasing slope—steepest should not exceed 2 times flattest. 2. Decreasing—steepest should not exceed 1½ times flattest.	1. See Furrow, No. 1 2. See Furrow, No. 2 3. Increasing slope should not change more than 2%. 4. Decreasing slope should not change more than 1%.	0 to 0.1%	Variation in level of contour dike should not exceed 0.1 ft.
Maximum allowable cross-slope.	0.1 ft. border strip on flat slopes.	Soil* Furrow Depth — H-M % — L % — C % 9 in. — 8 — 5 — 2 6 in. — 5 — 2 — 1 3 in. — 0.5 — 0.3 — –	Should not exceed ¼ grade in direction of flow or 0.5% whichever is smaller.	None	Maximum vertical interval between contour dikes of 0.3 ft.

*H = Heavy texture, M = Medium, L = Light, and C = Coarse.

Source: Information developed by Wayne D. Criddle.

APPENDIX H

Furrow Irrigation Relationships for Various Soils, Slopes, and Depths of Application

SOIL TEXTURE		COARSE				MEDIUM				FINE			
Furrow slope	Maximum allowable nonerosive furrow stream*	Depth of irrigation application — inches											
		2	4	6	8	2	4	6	8	2	4	6	8
Per cent	Gallons per minute	MAXIMUM ALLOWABLE LENGTH OF RUN – FEET											
0.25	40	500	720	875	1000	820	1150	1450	1650	1050	1500	1750	2140
0.50	20	345	480	600	680	560	800	975	1120	730	1020	1250	1460
0.75	13	270	380	480	550	450	630	775	900	580	820	1000	1150
1.00	10	235	330	400	470	380	540	650	760	500	750	850	990
1.50	7	190	265	330	375	310	430	530	620	400	570	700	800
2.00	5	160	225	275	320	260	370	450	530	345	480	600	675
3.00	3	125	180	220	250	210	295	360	420	270	385	470	550
5.00	2	95	135	165	190	160	225	270	320	210	290	350	410

*For bare furrows. With some vegetative cover such as grain or sparse grass, this may be increased 25 per cent or more.

Source: Information developed by Wayne D. Criddle.

APPENDIX I

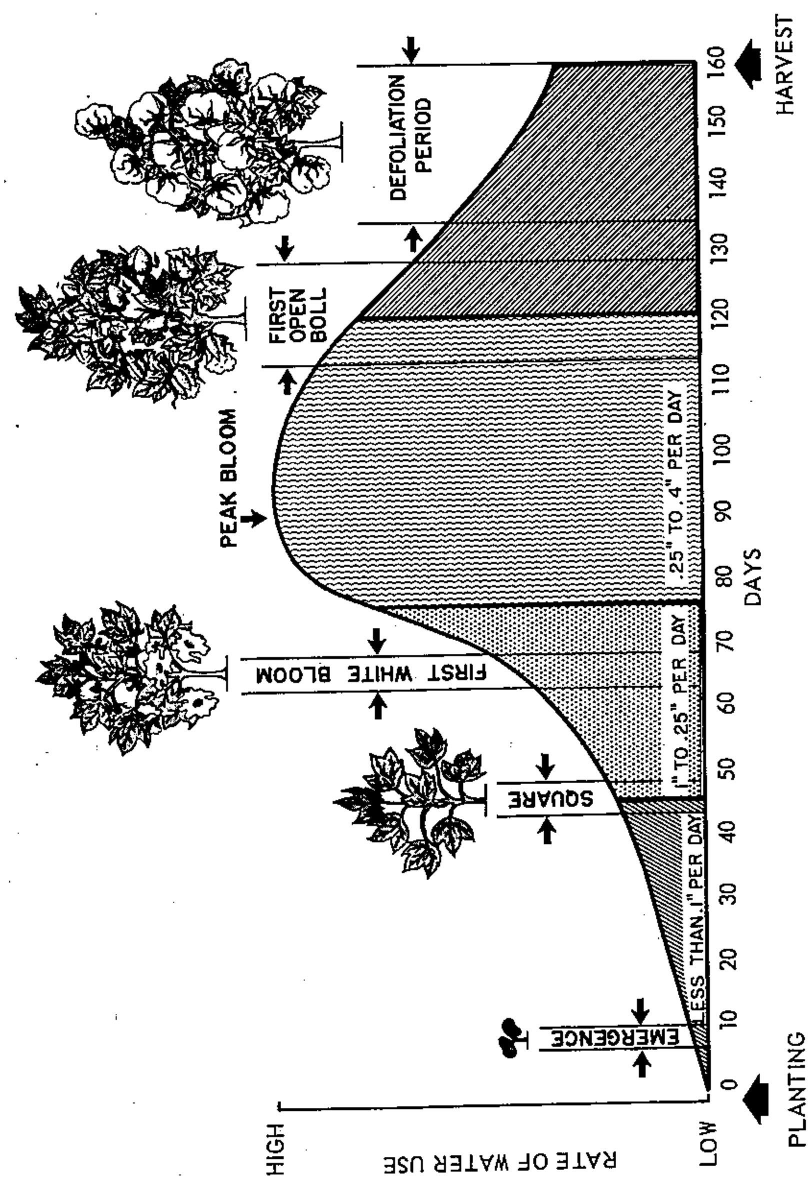
Border Irrigation Relationships for Various Soils, Slopes, and Depths of Application

Soil	Slope of land	Depth of application	Suggested border-strip size Width	Length	Size of irrigation stream
Texture	*Percent*	*Inches*	*Feet*	*Feet*	*C.F.S.*
Coarse	0.25	2	50	500	8.0
		4	50	800	7.0
		6	50	1320	6.0
	1.00	2	40	300	2.75
		4	40	500	2.50
		6	40	900	2.50
	2.00	2	30	200	1.25
		4	30	300	1.00
		6	30	600	1.00
Medium	0.25	2	50	800	7.0
		4	50	1320	6.0
		6	50	1320	3.5
	1.00	2	40	500	2.5
		4	40	1000	2.5
		6	40	1320	2.5
	2.00	2	30	300	1.0
		4	30	600	1.0
		6	30	1000	1.0
Fine	0.25	2	50	1320	4.0
		4	50	1320	2.5
		6	50	1320	1.5
	1.00	2	40	1320	2.5
		4	40	1320	1.25
		6	40	1320	0.75
	2.00	2	30	660	1.0
		4	30	1320	1.0
		6	30	1320	0.67

Source: Information developed by Wayne D. Criddle.

APPENDIX J

Rate of Water Use in Relation to Plant Development



Source: R. V. Thurmond and Fred C. Elliott, *Texas Guide for Growing Irrigated Cotton*, Bulletin B-896, Agricultural Experiment Station, Texas A. and M. College, College Station, Texas, 1958.

APPENDIX K

ASAE RECOMMENDATION:*

Minimum Requirements for the Design, Installation and Performance of Sprinkler Irrigation Equipment

This recommendation was sponsored by the Subcommittee on Sprinkler Irrigation of the Committee on Irrigation, Soil and Water Division, American Society of Agricultural Engineers, and received the official endorsement of the Sprinkler Irrigation Association at its annual convention at Biloxi, Miss., in November, 1952. It was approved February, 1953, as an official ASAE Recommendation.

These minimum requirements pertain to the design, installation, and performance of sprinkler irrigation equipment, and include dealer-purchaser responsibilities. The design and performance requirements are concerned particularly with those factors that are directly related to land, crops, and farm operations. The dealer-purchaser responsibilities recognize successful operation of a sprinkler system as depending on both buyer and seller.

PART I. DESIGN AND PERFORMANCE

1. Application Rate. A portable sprinkler irrigation system, when properly designed and operated, shall meet the following conditions with respect to water application:

(a) Apply water at a rate which does not cause runoff during the normal operating period nor cause water to stand on the surface of the ground after the sprinkler line is shut off.

(b) Determination of the proper rate of application *shall be the responsibility of the person designing the system.* Values for bare ground infiltration rates for different types of local soils may be obtained from responsible agricultural technicians. In the absence of such technical advice, the designer may estimate the proper application rate on the basis of past experience with similar soil types.

2. System Capacity.

(a) For regularly irrigated areas, the system shall have the capacity to meet the peak moisture demands of each and all crops irrigated within the area for which it is designed. Sufficient time must be allowed for moving laterals and for permitting cultural practices on the land. The capacity must also allow for reasonable water losses during application periods with the system operating in accord with design conditions.

**Agricultural Engineers Yearbook,* 7th edition, American Society of Agricultural Engineers, St. Joseph, Michigan, 1960, pp. 157 and 158.

(b) For supplemental irrigation and/or special uses, the system shall have the capacity to apply stated amount of water to the design area in a specified net operating period.

3. Depth of Water Application. In the design of the system, total depth of application (equivalent rainfall) per irrigation shall be governed by the capacity of the soil for moisture storage and the depth of the principal root zone of the crop irrigated. Information on both of these factors may be obtained from agricultural technicians or may be estimated by the designer on the basis of his past experience with similar soil types and crops.

4. Uniformity of Water Application. Since uniformity of water application is affected by both pressure in the line and spacing of sprinklers, recommendations for desirable operating pressures and spacing for different types of sprinkler and nozzle sizes shall be obtained from the sprinkler manufacturer.

Differences in pressures at the sprinklers shall be kept to a minimum to assure reasonably uniform distribution of water over the entire design area. A common rule, *which should be adhered to as closely as practicable,* is to limit pressure differences along a sprinkler lateral to 20 per cent of the higher pressure.

Excessive pressure differences in the main or supply line result in widely varying pressures at the head of the laterals. In many instances these excessive variations cannot be controlled by pipe size alone. Then the only practical alternative is to design for adequate pressure at the lateral take-off where pressure in the main will be lowest, and instruct the operator in regulating pressures into the other laterals by adjusting the take-off valve openings.

5. Crop Damage. Water shall be applied in a manner which will not cause direct physical damage to plants or fruit.

PART II. DEALER-PURCHASER RESPONSIBILITY

A. Dealer Responsibility

1. Proper Design. When the system is planned by a dealer, or his representative, the dealer shall assume full responsibility for the proper design of the system he proposes to furnish. Design requirements to fit the system to conditions of soil, topography, water supply and crop enterprise shall be ascertained by the dealer either directly or by obtaining such information from recognized reliable sources.

When design requirements are furnished in writing by the purchaser, the dealer's responsibility shall be limited to the design of the system to meet the stated conditions.

When plans and specifications are furnished in writing by the purchaser, the dealer's responsibility shall be limited to supplying equipment which will satisfy the requirements of the specifications furnished.

When the purchaser buys the system piecemeal, he absolves all dealers of responsibility for the performance of the system as a unit.

2. Proper Installation. The dealer or his representative shall assume full responsibility for the proper installation of the system.

Pumps and power units shall be set on a firm base and care shall be taken to keep the pump and the motor or engine in proper alignment.

Wiring and starting equipment for electrically operated plants shall comply with approved standards. Electric motors shall be provided with overload and low-voltage protection.

Internal-combustion engines shall be provided with protective devices. Thermostats shall be supplied that stop the engine when water or oil temperatures exceed the safety point. Where conditions are such that a failure of the water supply might result in the pump losing its prime, the pumping plant shall be protected by a device that stops the engine. These devices may be dispensed with where conditions are such that there is little probability of water supply failure, or when the pumping plant is constantly attended.

3. Operating Instructions. The dealer or dealers furnishing equipment required for a complete sprinkler system shall furnish to the purchaser, in writing, such instructions, performance charts and layout drawings as are required to insure proper operation, in accord with design conditions and normal expected life for the type of equipment furnished.

4. Performance Warranty. When a dealer or associated group of dealers assumes responsibility for the design and installation of a sprinkler irrigation system, a warranty shall be furnished, stating specially the performance expected for water-application rate, capacity, rate of coverage for a specific design area serving specific crops and crop acreages as stated by the purchaser and mutually understood to be the basis of design.

Warranty shall be based on trial of the system during operation under the range of operating conditions imposed on the system. The warranty shall not be expected to cover any conditions encountered which were beyond reasonable control of the dealer either in design or installation. Values used for infiltration rate, peak-use rate of moisture by crops, or capacity of soils to retain water for plants cannot be expected to be accurate for every local condition of soil. Evidence that the dealer has made reasonable efforts to obtain values from reliable sources shall be sufficient reason to absolve him from responsibility if such values do not represent local conditions.

When a dealer or dealers assume responsibility for the installation of a system in accord with specifications supplied by the purchaser, a warranty shall be furnished, stating the performance expected as to friction loss in the system, pump and engine motor characteristics, and other pertinent data pertaining to the specifications.

5. Equipment Warranty. The dealer or dealers assuming responsibility for the installation of the system shall furnish warranties covering the quality of material and workmanship of each piece of equipment furnished in accord with the original manufacturer's guarantee, and shall provide for replacement of defective parts shown to have failed because of poor quality materials or poor workmanship.

6. Maintenance and Repair Service. Dealers selling sprinkler irrigation systems in a territory shall maintain an inventory of replaceable parts and required equipment repair service. The extent of this available service shall be such that users in the territory will be assured of reasonable service which will avoid crop loss due to shutdown of a system for replacements or repairs.

B. Purchaser Responsibility

1. Operations in Accord with Instructions. The purchaser and user of a sprinkler irrigation system shall assume responsibility for failure of the system to perform properly if, after receiving all data furnished by the dealer, he fails to operate the system in accord with all conditions assumed in the design of the system. To obtain the full life of all equipment the user shall observe the stated limits of operating conditions set forth by the manufacturer.

2. Care and Maintenance Recommendations. The purchaser shall follow the dealer's recommendations for care and maintenance of the equipment. This applies to periods of use as well as non-use of the equipment.

Part III. Definitions

Design Area. The specific land area which the supplier or designer and the purchaser mutually understand is to be irrigated by the sprinkler system.

Sprinkler Irrigation System. This includes all equipment required to apply water to the design area, from the source of water supplying the system to the revolving sprinkler, nozzles, or perforated pipe.

If water is already available to the design area, the system includes only the equipment required to develop the necessary pressure and apply the water to the area.

If both water and pressure are available, as in the case of an existing pressure line, the system includes only the equipment required to take water under pressure from the supply line and apply it to the design area.

Sprinker Lateral. A line of portable pipe or tubing with sprinklers, nozzles, or perforations along the line. A lateral may be one of several operated from a common main supply line, or it may be a single unit supplied directly from the water source.

Application Rate. The equivalent rainfall rate expressed in inches of water depth per hour (acre-inches per acre per hour). For systems with rotating sprinklers, the rate is computed on the basis of the spacing of lateral settings, the spacing of the sprinklers along the lateral, and the average discharge of the sprinklers. For perforated pipe systems, the application rate is computed from lateral spacings, length of lateral, and average flow into the lateral.

Infiltration Rate. The rate at which soil will take in water during the irrigation period, expressed in inches of water depth per hours (acre-inches per acre per hour).

Peak Moisture Demand. Peak moisture demand of any crop is considered to be maximum that occurs during periods of maximum temperature and crop growth. This peak demand for moisture on the part of a crop results from transpiration by the plants, and direct evaporation from the soil.

ASAE TENTATIVE STANDARD:*

Approved January, 1957

Sprinkler Irrigation Technical Data Sheet**

FARM INFORMATION

Name of Owner.................Address.................Date.................

Section.................Range.................Township.................County.................State.................

IRRIGATION SYSTEM DESIGN AREA:

Topography — Include profile of proposed main pipeline locations. Give elevations of points around field boundaries, water level, pump locations, highest and lowest points in design area, and natural gas or electrical power line location.

Soils — Show predominating soil types and location on map.

Field Nos.	1	2	3	4	5
Available moisture-holding capacity.................(in/ft)					
Intake rate (in/hr)					
Effective depth of soil (ft)					

WATER SUPPLY

Source.................Amount available.................gpm.................acre-feet

Seasonal variation gpm.................to gpm.................

Delivery scheduling.................

POWER SOURCE

Electrical.................Internal combustion engine.................Fuel type.................Other.................

If electrical give power phase.................Voltage.................HP limitations.................

LABOR AVAILABILITY

Hours of operation per day................. Operation days per week.................

IRRIGATION REQUIREMENTS

DESIGN AREA				REQUIREMENTS		
Crops	Field No.	Acres	Effective root zone depth, feet	Moisture to be replaced each irrigation, inches	Peak moisture use rate, in per day	Peak use period irrigation frequency, days

*Agricultural Engineers Yearbook, 7th edition, American Society of Agricultural Engineers, St. Joseph, Michigan, 1960, pp. 151-154.

**This data sheet was developed by ASAE Sprinkler Irrigation Research Committee in cooperation with the Sprinkler Irrigation Association, U.S. Farmers Home Administration and U.S. Soil Conservation Service.

DESIGN AND SPECIFICATION INFORMATION

SYSTEM CAPACITY REQUIREMENTS

Minimum system capacity............................gpm

Field Nos.	1	2	3	4	5
Application rate (in/hr)					
Time of lateral operation per set (hrs)					
Depth applied per set (inches)					
Number of lateral sets per day (no.)					
Operation period to cover area (days)					
System capacity required (gallons)					
Water application efficiency (percent)					
Depth moisture replaced each irrigation (inches)					

SPRINKLER SELECTION

Application rate..........................in. per hr. Sprinkler spacing on lateral..........................ft.
Lateral spacing on main line..........................ft. Sprinkler discharge..........................gpm.
Diameter of circle covered..........................ft. Type..........................Nozzle sizes................" x................".
Required operating pressure..........................psi.

LATERAL DESIGN

Lateral spacing on main line..........................ft. Sprinkler spacing on lateral..........................ft.
Lateral length..........................ft. Area covered per lateral setting..........................acres.
No. sprinklers per lateral..........................Lateral discharge..........................gpm.
No laterals required.........................., to cover design area in..........................days.
Pipe size required: Length..........................ft. Diameter..........................in. Gage pipe..........................
Length..........................ft. Diameter..........................in. Gage pipe..........................
Rise or fall (circle applicable condition) in lateral..........................ft.
Pressure loss in lateral due to friction..........................psi or..........................ft.
Pressure required (at main line) to operate lateral..........................psi or..........................ft.

MAIN LINE DESIGN

Portable..........................or Permanent.......................... Material: Steel...............Aluminum...............or Other................
Main line length..........................ft. Discharge capacity..........................gpm.
Rise or fall (circle one) in main line..........................ft.
Allowable head loss due to friction..........................ft.
Pipe sizes required..........................ft. of..........................in. pipe..........................gage.
..........................ft. of..........................in. pipe..........................gage.
..........................ft. of..........................in. pipe..........................gage.
Head loss due to friction..........................ft. Outlet spacing on main line..........................ft.

SUPPLY LINE DESIGN (That portion of main line outside design area)

Supply line length..........................ft. Discharge capacity..........................gpm.
Pipe size required..........................in. Friction head loss..........................ft.

TOTAL DYNAMIC HEAD REQUIREMENTS

Pressure required at lateral..........................psi..........................ft.
Friction head loss in main line..........................psi..........................ft.
Friction head loss in supply line..........................ft.
Friction head loss on suction line..........................ft.
Elevation difference between pump and highest point of lateral line..........................ft.
Elevation difference between water source and center of pump..........................ft.
Miscellaneous friction head loss in special valves and fittings..........................ft. Total..........................ft.

PUMP REQUIREMENTS

Capacity..........................gpm at head..........................ft. Size..........................in.

PUMP SPECIFICATIONS

Type.......................... Capacity..........................gpm. Efficiency..........................%, at..........................ft. head.
Rpm @ required discharge.......................... Brake hp @ required discharge..........................

POWER REQUIREMENTS

Water hp.......................... Efficiency..........................%. Brake hp.......................... Rpm..........................

POWER UNIT SPECIFICATIONS

Type.......................... Make.......................... Model.......................... Size..........................
Continuous hp rating..........................at..........................rpm.
Cu-in displacement.......................... Stroke..........................in.
Piston speed at design load.......................... Bmep at design load..........................psi.
Type of power conversion.......................... Speed ratio..........................
Electric motor: Voltage.......................... Phase.......................... Rpm..........................

ECONOMIC ANALYSIS OF IRRIGATION

SYSTEM COST

ITEM	Quantity and unit	Unit cost, dollars	Total cost, dollars	Annual fixed cost
Well unit				
Pumphouse unit				
Power unit				
Pump unit				
Power line extension	ft.			
Main pipe line (complete with valves)	ft.			
Lateral pipe lines (complete)	ft.			
Sprinklers and risers	no.			
Special equipment:				
List:				
Total Material Costs				
Cash outlay for installation				
Farm costs, Labor				
Tractor use				
Other				
Total Farm Costs				
Total Cost				

LABOR COSTS

Moving laterals (per irrigation)..........................hrs. Moving mainline (per irrigation)..........................hrs.
Starting and stopping pump (per irrigation)..........................hrs.
Other time required (per irrigation)..........................hrs.
Total labor (per irrigation)..........................hrs. @ $..........................per hour..........................
Seasonal cost = Cost per irrigation..........................X No. of irrigations..........................

INVESTMENT COST

Water development — (well, pond, sump, etc.) $..........................
Land development — (leveling, clearing) ....
Equipment ....
Materials ....
Labor ....
Other — (rights of way, legal and technical costs) ....
Total investment $..........................

ANNUAL FIXED COSTS

Annual depreciation of investment $..........................
Interest on average investment ....
Taxes—(irrigation equipment) ....
Insurance ....
Total fixed cost $..........................

ANNUAL OPERATING AND MAINTENANCE COST

Hours of operation per year..........................
Fuel or electricity $..........................
Lubricating oils, grease, attendance ....
Labor, irrigating ....
Maintenance irrigation system ....
Total operating and maintenance costs $..........................
Total cost of irrigation = Fixed cost plus operating and maintenance costs $..........................
Cost per acre inch = Total cost of irrigation divided by total acre inches applied $..........................
Cost per irrigated acre = Cost per acre inch multiplied by inches applied $..........................

Remarks:..
....

Made by..........................
Title..........................
Date..........................

MAP OF AREA TO BE IRRIGATED

Other Agricultural Committee Publications

AGRICULTURAL CREDIT PLUS TRENDS AND DEVELOPMENTS IN FARM REAL ESTATE. Annual. Free.

AGRICULTURAL CREDIT AND RELATED DATA. Annual. $.50.

AGRICULTURAL CREDIT CONDITIONS. Semiannual. Free.

AGRICULTURAL PRODUCTION FINANCING. 1952. $1.00.

AGRICULTURALLY TRAINED MEN IN BANKING. 1959. $.50.

AMERICA INVESTS IN ITS FUTURE. 1954. Free.

BANKING AND THE RURAL DEVELOPMENT PROGRAM. 1958. Free.

BUILDING FOR THE FUTURE WITH FARM YOUTH. 1950. $.85.

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