Research Technical Completion Report
Project No. B-046-IDA

THE 1977 DROUGHT IN IDAHO: ECONOMIC IMPACTS AND THE RESPONSES OF IRRIGATORS AND WATER DELIVERY ORGANIZATIONS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF TABLES (Cont.)

LIST OF TABLES (Cont.)

LIST OF FIGURES

ABSTRACT

The objectives of this study were to use survey methods to document changes in cropping patterns, irrigation systems, and water management strategies caused by the 1977 drought; to document the way institutions such as water delivery organizations and government agencies respond to drought; to measure the economic consequences of drought in southern Idaho; to draw implications regarding probable farmer response in future droughts; and to make suggestions for drought management strategies.

While some farmers changed crops and varieties or idled land in anticipation of water shortage, the majority proceeded with normal cropping patterns. When water shortage occurred, the result was reduced yield, or in some cases complete loss of the crop. These yield declines and lost crops comprised the largest part of the economic impact of the drought.

Results suggest however that water was managed much more efficiently than usual during the summer of 1977. Many crops got less water but didn't suffer corresponding yield declines. Some of this resulted from better water management, and from improvements in application systems. Many delivery organizations responded to water shortage by implementing delivery rotation programs.

The study concludes that:

1) There is a need for continued improvement in the accuracy of drought warnings, especially regarding the probable severity, distribution, and timing of water shortage.

2) There is also need for more detailed information regarding crop response to water shortage, to allow farmers to make optimal decisions about which

crops to plant and how best to allocate available water amongst crops.

3) There is a need to install more and better water measuring devices so water use can be monitored and controlled more carefully by farmers and water delivery organizations. The use of rotation as a mechanism to allocate limited water supplies may conflict with a farmers efforts to make optimal use of water.

4) There is a need to carefully consider the system wide consequences of actions taken during drought. Changes that improve application efficiency can have devastating impacts on downstream farmers who use return flows or groundwater as irrigation supplies.

CHAPTER 1

INTRODUCTION

Drought has been a recurrent feature of life in the semiarid western states. Because of the central role of water in the west, a role dictated by its scarcity, drought has the potential to cause severe hardship. During drought or the threat of drought, western agriculture has evolved ways of coping with the water shortage. The institutions which control storage, distribution, and allocation of water, and the physical systems--the dams, canals, headgates, pumps, and sprinklers--all bear the imprint of the possibility of drought. If irrigators face a growing season when water might run short, they have a range of options for dealing with the shortage. Their actions or nonactions in response to water shortage have implications both for themselves and for their neighbors. This report presents results from a study of how farmers of irrigated land in southern Idaho reacted to the drought of 1977, and what consequences resulted from these farmer reactions.

Because it is hard to define simply when a condition of drought exists, it is difficult also to describe its progress simply. Drought depends on the degree and timing of precipitation shortfall and on the opportunities for manipulation of supplies through storage, access to groundwater, etc.

The mid 1970's gave the western states one of the worst episodes of drought since the depression years of the 1930's. While localized water shortage appears somewhere in the west nearly every year, the shortage

in the 1970's was notable for its pervasiveness. Reports of below normal rainfall began to come from California in 1975. By 1976 its storage reservoirs and watersheds were sufficiently depleted to cause problems for both municipal and irrigation use. The precipitation shortfall spread to include the Pacific Northwest. During the winter of 1976-77 various parts of the Snake River Basin in southern Idaho got between 10 percent and 60 percent of normal moisture. While most reservoirs in southern Idaho were at nearly normal levels that spring, the shortfall in precipitation caused streamflow to lag below usual levels. As the season progressed and streamflows proved inadequate to meet crop needs for water, farmers began to draw on stored water much earlier than usual. Thus for many farmers the drought was very real--streamflow and stored water together were less than what they needed to irrigate their farms as usual.

Of course the farmers had warning that drought was likely to limit irrigation for at least the summer of 1977--and perhaps even longer unless precipitation patterns returned to normal. Farmers actions in response to the drought of 1977, and the consequences of these actions are the topic of this report. Specifically, study objectives were to:

1. use survey techniques to document cropping pattern changes, irrigation system changes, water management changes and other management strategies used by farmers in responding to and coping with water shortage.
2. document the way institutions such as water delivery organizations and government agencies responded to drought.
3. evaluate the economic consequences of drought in southern Idaho, including both the costs of adjustments made by farmers and costs

of drought caused yield reductions and crop failures.

4. draw implications regarding probable farmer response in the event of future drought, and to make suggestions for drought management strategies that can be used by farmers, water delivery organizations, and others when drought recurs.

A. Origin of This Study.

The proposal to monitor Idaho farmers responses to drought first emerged during the summer of 1977 when very little was yet known about what responses were occurring. At that time the end of the drought was not yet in sight. As originally proposed the study was to document drought responses in 1977 in order to help predict what to expect should the water shortage continue into 1978. The lessons of 1977 could help formulate drought policy for 1978.

Two events interrupted that scenario--the study was not funded at that time, and it started to rain in southern Idaho. At least the lack of answers matched nicely with the lack of crucial immediate need for answers. When funds for a study became available in 1979, the study became more of a postaudit--an examination, well after the fact, of what happened in the summer of 1977. Certainly farmers actions in 1977 should help our understanding of what happens during periods of water shortage, and should help in formulating policies to help minimize and mitigate the impacts of the next drought.

B. Organization of the Study and This Report

The surveys on which this report is based were gathered in June of 1979. A team of five researchers completed 158 personal interviews

with irrigated farmers in three areas of southern Idaho. The sample included 71 farmers from the Boise River drainage near the cities of Caldwell and Boise in Ada and Canyon Counties, 46 farm operators in the Big and Little Wood River drainages in the Bellevue-Carey-Shoshone area of Blaine and Lincoln Counties, and 41 farmers on the Upper Snake River drainage in Bingham and Bannock Counties near Blackfoot (Figure 1.1). Seven of these questionnaires (1 from Boise, 3 from Blaine and Lincoln Counties, and 3 from the Upper Snake study area) were later dropped from the data set because of incompleteness and other problems. This left 151 surveys as the data set on which much of this report is based.

An attempt was made to get a balance between sprinkler and flood irrigators, and obtain subsamples of farmers specializing in hay and grain, annual cash crops, and perennial crops. (The sample stratification is shown in table 1.1). All of the farmers included in the sample used surface water to some extent in their irrigation.

Farmer cooperation in agreeing to be interviewed was completely voluntary. Farmers were first contacted by telephone to arrange the interview. The sample was subject to a voluntary response bias at that point. The telephone calls were made from lists of farm operators provided by county extension agents, ASCS directors, the Hops Commission, the Mint Commission, and Amalgamated Sugar Company. Thus the sample was subject to any biases inherent in these lists. This bias may have been slanted toward the selection of older, more established farmers, who may be community leaders, or at least were known to cooperate with academic researchers.

Another set of 24 personal interviews was conducted with officials

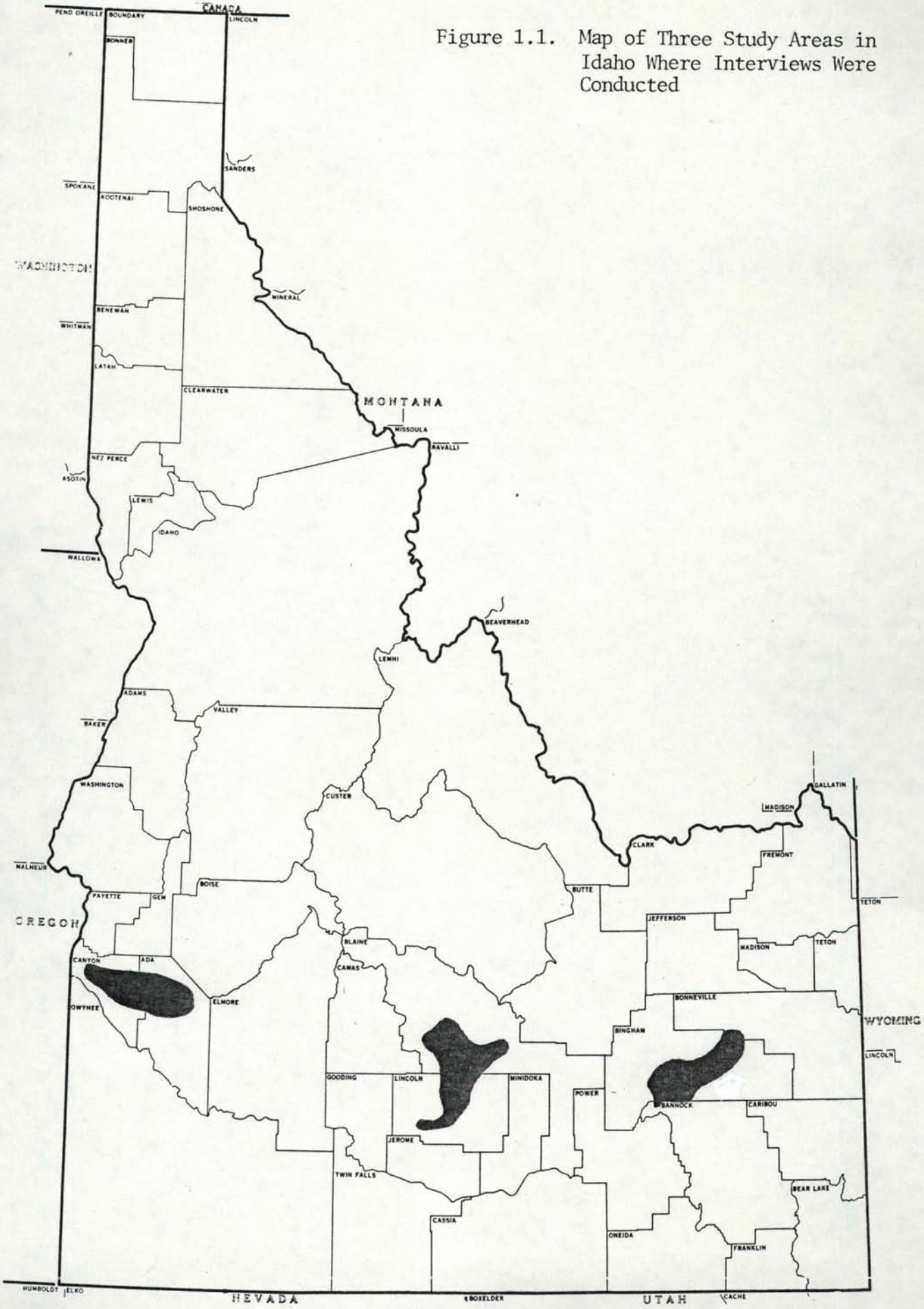


Figure 1.1. Map of Three Study Areas in Idaho Where Interviews Were Conducted

Table 1.1. Farmer Interview Sample Stratification

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Type of Crops Grown								
Hay and Grain	11	15.7	39	90.7	14	36.8	64	42.4
Cash	14	20.0	0	0.0	19	50.0	33	21.9
Perennial	29	41.4	0	0.0	0	0.0	29	19.2
Cash & Perennial	12	17.1	0	0.0	0	0.0	12	8.0
Mixed	4	5.7	4	9.3	5	13.2	13	8.6
Initial Application System								
Sprinkler	4	5.7	4	9.3	12	31.6	20	13.3
Gravity	51	72.9	21	48.8	20	52.6	92	60.9
Both	15	21.4	18	41.9	6	15.8	39	25.8
Water Source								
Surface	48	68.6	28	65.1	28	73.7	104	68.9
Both	22	31.4	15	34.9	10	26.3	47	31.1
Total Observations Used	70	100.0	43	100.0	38	100.0	151	100.0
Observations Discarded	1	-	3	-	3	-	7	-
Total Interviews Conducted	71	-	46	-	41	-	158	-

[1/] Percent of observations.

of water delivery organizations. These were selected from the same three study areas (11 from Ada and Canyon Counties, 3 from Blaine and Lincoln Counties and 10 from the Upper Snake), and represented a range of organization types such as canal companies, irrigation districts, and ditch companies.

Chapter 2 of this report outlines in a general way some of the drought response options open to irrigated farm managers, and some of legal institutions which limit and guide that response. Chapter 3 reports on the results of the farmer interviews, documenting what farmers actually did, and what the results were. Chapter 4 focuses on the economic impacts of drought--both the costs of actions taken, and the costs of yield depression due to water shortage. Chapter 5 shifts attention to the roles played by water delivery organizations in managing the water shortage. Chapter 6, in examining study implications looks both to prediction of future drought responses, and to suggestions for more nearly optimal responses to drought.

CHAPTER 2

RESPONSE OPTIONS AND LEGAL ISSUES IN WATER MANAGEMENT UNDER DROUGHT CONDITIONS

In documenting drought impacts on Idaho irrigated agriculture during the summer of 1977 it is useful to look first at the response options available to farmers. When attempting to manage water in a way to minimize drought impacts on their farming operations, irrigators face a bewildering array of constraints imposed by water law. Many of the constraints are supposed to prevent a farmer acting in his own self-interest from injuring his neighbor. Yet, the inflexibility in Idaho water law undeniably impedes some adjustments that could otherwise mitigate the impacts of a drought.

For the farmer, decisions about how to respond to drought must be made in a climate of uncertainty:

> "It is easy to observe that you have had a drought. It is fairly easy to determine that you are in a drought. It is very difficult, however, to determine whether weather excursions in the direction of drought will in fact require the application of a particular drought strategy, and if so, which one." 1/

Because of southern Idaho's reliance on streamflow and storage, a farmer typically will be faced early in the season with a warning that below average snowpack in the mountains and low reservoir levels point to water supply problems later in the season. At the time when crops must be planted and other decisions made, the extent of water shortage remains a matter of guesswork since it depends on subsequent weather patterns

and on the success of users attempts to conserve water.

Among the options open to the irrigator is to proceed with his usual cropping pattern and water management and take his chances on what happens later in the season. Or he could take drastic and costly measures to deal with expected water shortage and then perhaps discover that late season precipitation had made his preparations unnecessary.

Any study of drought impacts must look not only at the actions of individual irrigators but also at the interrelations among water users in the larger community.

> "In general at the individual level, decisions are made primarily on the basis of assessment of individual cost effectiveness with little attention given to the larger community or to secondary effects. Ironically, nominally efficient use, by standard definitions of water use efficiency, is often least effective in mitigating the adverse socio-economic impacts of drought. An irrigation farmer may accomplish 100 percent efficiency (i.e., zero deep percolation and tailwater runoff losses) and still lose most of his crop. And, tailwater and deep percolation are very often the next farmer's water supply. So both lose their crops! At best, under drought conditions improved efficiency in the classical usage of the term may simply shift the adverse impacts of drought from one individual to another. This results in substantially increased costs for both and no assessment of optimal strategy for the larger universe of two or more." 2/

A. Some Basic Principles of Idaho Water Law

Water rights in Idaho are governed by the doctrine of prior appropriation.3/ Generally the initiation of a water right requires diversion of water from the source of supply and application of it to a beneficial use.4/ The one exception is that a few state agencies have been authorized by statute to make appropriations for various instream flow purposes even though there is no diversion. Under current statute, no one may initiate a water right without first obtaining a permit from the Department of

Water Resources.[5] For many years, however, the permit system was optional. There was an alternative system, which came to be called the constitutional method of appropriation,[6] whereby one could initiate a right simply by diverting water and putting it to beneficial use without a permit.[7] Although the Legislature acted in 1971 to abolish the so-called constitutional method,[8] there is no question that constitutional method rights initiated before then are still valid. Thus, Idaho has two types of appropriations based on the method of initiation, namely, permit system rights and constitutional method rights.

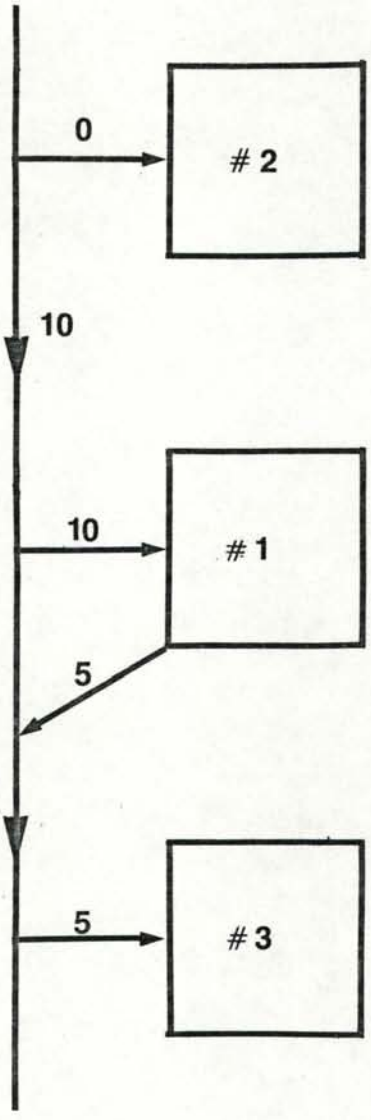
The final step in the permit procedure is the issuance of a license by the Department of Water Resources. A permit holder may obtain a license by proving to the Department that he has put water to beneficial use in accordance with the terms of his permit.[9] A license is only prima facie evidence of a water right, however.[10] Definitive confirmation of water rights requires a judicial decree. Judicial determination or adjudication is available for both permit system and constitutional method rights.[11]

Every appropriation has a priority date. For permit system rights, that date is the time of application for a permit if water is then diverted and put to beneficial use in accordance with the terms of the permit.[12] For constitutional method rights, the priority date is the date water was first applied to beneficial use.[13] The priority date of a right is important because when there is not enough water for all those who want it, the supply is allocated under the principle that priority in time gives priority in right.[14] According to this principle, water should be totally withheld from those with junior priorities to supply fully those with senior priorities.

Administration of the priority principle is complicated by return flows. Often a significant portion of the streamflow diverted by an appropriator will return to the stream, either directly through drainage ditches or by seeping into the soil and eventually percolating back to the stream. Figure 2.1 illustrates three appropriators situated on a stream so that the holder of the number two priority is upstream, the holder of the number one priority is in the middle, and the holder of the number three priority is downstream. Assume that each has an appropriation for 10 cubic feet per second, that the return flow from number one's diversion is fifty percent, that this return flow reaches the stream channel above number three's point of diversion, and that because of drought conditions the waterflow in this segment of the river has dropped to 10 cubic feet per second. Under the priority principle, number 2 must let all the water flow past his diversion point to supply number one. Number one can divert 10 second feet (assuming no stream channel transmission losses). There will then be about 5 feet of return flow for number three to divert from the stream. Under these conditions, number one is fully supplied, number two receives no water, and number three is partially supplied.

The Department of Water Resources is charged with supervising the distribution of water from streams to canals and ditches.[15/] For administration purposes, the Department has divided various portions of the state into water districts.[16/] Within each district, day-to-day distribution of water is handled by a watermaster who is elected by water right holders in the district.[17/] The watermaster is directed by statute to distribute water under the principle that priority in time gives

Figure 2.1. Illustration of How Priority Principle Applies to Return Flows



priority in right.[18/] The statute also directs the watermaster, however, to treat any claimed constitutional method right that has never been adjudicated or decreed as subsequent to all adjudicated, decreed, permit or licensed rights, regardless of the alleged priority date of the un-adjudicated constitutional method right.

Water rights vary considerably in reliability. Some rights are normally useable only in spring periods of high streamflow, and their use often reflects this unreliable nature--irrigation of pasture land. But drought, under a strict application of the appropriation doctrine means progressively shutting off holders of the most junior, but normally good, water rights. During the summer of 1977 the media were reporting daily what priority date cutoffs were being used in severely impacted areas. By midsummer some users with priority dates as old as 1890 had been cut off. Some rights fluctuated on and off depending on streamflow conditions.

B. Some Possible Responses to Drought

Idaho law is quite clear as to who should bear the burden of drought--the junior appropriator. Yet the law also may leave open a range of options, for irrigators acting either singly or as groups, to mitigate and/or spread the drought impact.

1. Rotation

The Idaho Supreme Court has long recognized the right of water users to contract among themselves for a system of rotation rather than continuous supply of water, e.g., so that three users each having the right to a continuous flow of one cubic foot per second might instead

each take three second feet every third day.[19] This may give each a more manageable head of water, reduce seepage and evaporation losses, and may reduce the labor and management effort needed to achieve efficient water use. In one case, the Court observed: "Rotation in irrigation undoubtedly tends to conserve the waters of the state and to increase their duty and service, and is, consequently, a practice that deserves encouragement insofar as it may be done within legal bounds."[20]

The hard question is whether a watermaster, administrative agency or court may impose rotation when not all the users affected have agreed to it. Because the principle that first in time is first in right is guaranteed by the Idaho Constitution,[21] imposed rotation would not be allowed against an appropriator's wishes if it violates that principle. The argument has been advanced that true rotation, where each user receives as much or more water over time as with continuous flow supply, does not violate the priority principle but is merely a variation in its administration.[22]

In 1920 the Idaho Supreme Court refused to impose a rotation system on appropriators during low flow periods because it was thought to be too great a departure from customary continuous flow administration, upon which people had relied in establishing water rights.[23] The Court did not close the door entirely on rotation, though, noting that it would enforce water rotation contracts and added that "perhaps when property rights have grown up, or common practice and usage have made [rotation] . . . . a settled and fixed practice in a particular community, it might be the duty of courts to [impose] . . . . it."[24] The Court was careful, however, to leave the question of imposed rotation "entirely to future

investigation and determination."[25/] In a 1944 case, the Court ruled that established appropriators "were entitled to a continuous use of . . . . water as of the dates of their priorities" and could not be forced to accept rotation.[26/] Thus, the status of imposed rotation in Idaho is doubtful at best.

2. Prorationing

Prorationing of the water supply in time of shortage means giving all appropriators some set percentage of their full supply right. Prorationing has some basis in the egalitarian purpose of softening the appropriation doctrine treatment of junior appropriators. They may be friends and neighbors. Prorationing also recognizes that the senior water rights usually allow diversion of more water than is absolutely necessary to grow a crop.[27/] If there is slack in the system, perhaps everyone can use a little less water and no one will be hurt much if at all.[28/]

Water users may agree among themselves to a prorationing plan by formal contract, consent decree in a judicial proceeding, or otherwise. If they do, they are bound by the plan. Whether a court may impose prorationing upon unwilling users presents difficulties similar to those discussed in the section on "Rotation" immediately above. Imposed prorationing would not be allowed if it violates the priority principle of the Idaho Constitution. In the 1920 case discussed above, in which the Idaho Supreme Court refused to impose a rotation system during low flow periods, the proposed system also included a prorationing feature. Under continuing trial court orders entered in 1919 (Stewart decree) and 1933 (Bryan decree), water rights on the Boise River have in fact been

administered ever since on a prorationing basis during periods of low flow. Neither of these decrees has ever been appealed to the Idaho Supreme Court, so the legal propriety of imposed prorationing has never been definitively settled.

When water users do not directly divert from the source of supply but instead receive water from a delivery organization such as an irrigation district or canal company, allocation among users in time of shortage of supply to the delivery organization usually does not follow the priority principle. By custom, charter, by-law provision or contract, a number of such entities prorate the supply among members, shareholders, or contract users in time of shortage.

If a water delivery organization has more than one water priority by reason of enlarging its service area from time to time, a state statute directs that the rights of the land being irrigated shall be divided into classes, with rights of the first class belonging to lands reclaimed between the dates of the first and second priorities, rights of the second class belonging to lands reclaimed between the dates of the second and third priorities, etc. Then the statute adds: "but all the rights belonging to the same class shall be equal."[29/] This statute has been held not to violate a constitutional guarantee that if more than one person has settled upon or improved land with the view of receiving water for agricultural purposes from a delivery organization, "priority in time shall give superiority of right to the use of such water in the numerical order of such settlements or improvements."[30/] The Idaho Supreme Court reasoned that the statute was intended merely as a simple and expeditious way of handling the rights of water users in the absence of and until their

actual priorities have been adjudicated by the courts.[31/] The Court added that the statute "may be the means of preventing much litigation over the priorities of the rights of different consumers of water from the same canal, in that the classification made as therein provided may be satisfactory and may be accepted by the consumers, and thereby much litigation and expense may be saved to the consumers."[32/]

The Court's prediction, made in 1911, seems to have proved out. Numerous water users supplied by irrigation districts and perhaps entitled at one time to adjudication of individual priorities for purposes of distribution of water internally within the system have never sought such an adjudication. Now, after many years of equal treatment within a class and likely reliance by district members upon such treatment, the earlier settlers in a given class of landowners may be estopped to assert individual priorities in an internal adjudication action.[33/]

Both prorationing and rotation are based at least partly on the premise that improved water use efficiency is possible, and is good. Under prorationing improved efficiency by senior users allows water to be saved for use by junior rights. Rotation allows water delivery and application systems to be operated in a manner that reduces seepages from canals, and evaporation, runoff and deep percolation from fields.

Only water used by plants and water lost to evaporation is truly lost to irrigation. In southern Idaho most of the water lost to percolation, runoff, and canal seepage becomes someone else's water supply. Prorationing and rotation may be very sensible from an individual or even a district perspective, yet they have a potential for injury to the larger community. The injury may be concentrated (an irrigator whose

water supply was a now dry drainage ditch) or it may be diffuse (hundreds of wells whose levels have declined slightly). The "no injury" rule of Idaho law discussed below would not apply, however, unless the point of diversion or place of use (or perhaps the nature or period of use) of all of some of the water is changed.

i. Surface Water Rights: Flow and Storage

So far the discussion of the legal aspects of water rights has ignored the very important distinction between flow rights and storage rights. Flow rights apply to diversions from the natural flow of the stream during the irrigation season, whereas storage rights refer to the use of water impounded in reservoirs or natural lakes. The reason for this division reflects differences in the way the rights are allocated and measured, and differing restrictions on timing of use.

Most water storage projects involve a water delivery organization. Instances in which streamflow is directly diverted into privately owned storage involve a flow right and are subject to the usual appropriation doctrine restrictions on flow rights. It is useful to note, however, how this distinction between flow and storage rights functions within the institutional framework of water delivery organizations.

A major physical distinction between flow and storage rights relates to the measurement of each. Flow rights, as described within the appropriation doctrine, are measured as flow rates. These are expressed in either cubic feet per second (CFS) or miner's inches (MI). (In Idaho there are 50 MI per CFS.) Storage rights, referring to a specified quantity of static water, are commonly measured in acre feet or acre inches.

The flow right entitles the appropriator to a continuous flow of water under the restrictions set forth under the appropriation doctrine. Since most irrigators in southern Idaho belong to some type of water delivery organization, they are also governed by any bylaw provisions regarding the allocation of flow water within the physical limitations of the canal system, and the allocation of flow water in times of shortage. The continuous flow diversion under flow rights must conform to the "beneficial use" concept which restricts the use to the irrigation season (normally April 1 to October 31) though these dates are sometimes adjusted to reflect local conditions.

Flow rights, according to Idaho law, are appurtenant to specified lands. The amount of water that can be diverted from a stream is generally limited by law to one miners inch per acre, although exceptions can be made to reflect local conditions such as very porous soil or high delivery system losses. Flow rights held by delivery organizations often list "lands within the district" or "lands served by the company" as the description of where the water is to be applied. Even when precise legal descriptions of the land to be served are given, the rights are often comingled, providing all members with equal amounts of water on a per acre or per share basis. When some flow rights are cut, in order of priority date as streamflow falls during the irrigation season, the reduction is often spread over all users. Because most water organizations have several flow rights with different priority dates, the amount of flow water available on a per acre or per share basis can vary considerably over the

irrigation season, depending on the security of those rights.

The precision with which water is allocated to users within a water delivery organization varies from organization to organization. Some have only a flow measuring device at the point of diversion from the stream (this is the minimum required by Idaho law) or only on the main laterals. Often no attempt is made to precisely measure water for each user and allocation is left to the individuals. In many such cases allocation is dictated by the physical limitations of the canal system, or is regulated by informal agreement of the users. Other water delivery organizations have water metering devices of varying precision for each user, and use these devices to allocate water based on each users share.

Storage rights apply to water that has been impounded in reservoirs or natural lakes specifically for irrigation. Water rights to fill the storage follow the usual appropriation doctrine rules, with a right issued for a given quantity of water with a priority date. A water right for filling storage applies to the time period outside the irrigation season, or to flood waters in excess of irrigation use during the season. Water organizations with storage rights in a reservoir have rights to a specified number of acre feet of storage. This is often designated as a percentage of the total capacity of the facility, implying the method of allocation in case the reservoir does not fill.

The development of storage facilities resulted primarily from large Bureau of Reclamation projects where reservoirs and canals were developed as integrated systems for an irrigation district. Since early projects already had senior claim to the better flow rights, the stored water gave new junior water right holders a supply of water adequate for irrigation.

As a general rule, users with the less secure junior water rights had the first opportunity to buy storage rights.

Water held in storage for irrigation is subject to most of the same laws applicable to flow rights, the major difference being the timing of use. The time when a flow right can be used is determined by nature, by the level of streamflow. These flow rights must be exercised when the water reaches the point of diversion or the water is forfeited to other downstream users. Flow right water can not be stored for use at a later time. In contrast, the holders of a storage right can determine when to exercise its use. They can withdraw the stored water as they see fit as long as they conform to water law provisions such as beneficial use, etc. Water delivery organizations vary in how they allocate stored water. Some organizations pool flow water and stored water so that the individual user sees little distinction between the two. The stored water is used to keep a constant amount of water in the system. As flow rights are cut off according to priority date, the delivery organization draws enough from storage to compensate for the lost flow water. At the other extreme are delivery organizations that individually account for each users consumption of stored water. Each user begins with a full storage account, but as natural flow decreases and it becomes necessary to start withdrawing stored water, the users accounts are debited for the storage water used.

What happens to storage rights not used in a given year depends on organization bylaws, on the weather, and on the terms of individual contracts with the Bureau of Reclamation. Generally unused water rights are lost if the reservoir fills--all users start out with a full water account. However some organizations allow rights to unused storage water

to be carried over into years when the reservoir does not fill.

How each water organization handles allocation of stored water depends on several factors; the size and type of organization, the relative importance of flow and storage rights in their total water supply, and the type of metering devices and records used.

3. Transfers

In times of drought some farmers will still have water in excess of their needs and might be willing to sell or lease some part of their water right to another user whose supply has been cut off. A user growing relatively low value crops might, for a price, be willing to give up water to growers of high value crops or perennial crops that might be permanently damaged by water shortage. Allowing transfer of water between willing buyers and willing sellers would superficially appear to put the water to its best possible productive use, and thus promote laissez faire economic efficiency. Yet Idaho law recognizes that water right transfers are neither as simple, nor as clearly beneficial, as they seem. Idaho water law, as is typical of western water law, rigidly restricts transfers of water rights.

A water permit or license is required to state the point of diversion, place of use, nature of use, and period of use of the water right.[34/] Under modern law, the same is true of a judicial decree adjudicating water rights.[35/] Older decrees do not always give all this data about the right[36/] but the right might nonetheless be limited as to point of diversion, place of use, etc. by the historic pattern of actual use of the right.[37/] The transfer of a water right, whether the transfer be permanent or temporary,

may involve changing its point of diversion, place of use, nature of use, or period of use.

In discussing transfers, it is useful to distinguish between water that is directly appropriated by the actual user and water that is supplied to the user by a water delivery organization.

i. Direct Appropriation By An Individual User

Changes in point of diversion and place of use are regulated by statute and will be discussed first. Prior approval of the Department of Water Resources is required to change either the point of diversion or the place of use of water right without loss of the original priority date. The Department has long been authorized to approve such changes if two conditions are met: (1) the change must not injure any other water rights and (2) it must not constitute an enlargement in use of the original right.[38/] In 1981 the Idaho Legislature added a third requirement, namely, that the change must be in the local public interest.[39/]

The no injury limitation appears to be part of an appropriation doctrine tradition of seeking to give appropriators a secure water right as a way to encourage people to invest in water resource development.[40/] It protects junior appropriators from the alteration of stream conditions upon which they might have relied in making their appropriations.[41/] Application of the rule perhaps most often involves return flow patterns, and figure 2.1 used earlier to illustrate how return flows affect administration of the priority principle can also be used to show how the no injury limitation operates. Under the conditions assumed in that diagram, the number three appropriator was getting about 5 second feet of water because he was situated to take advantage of number on'e return flow.

Suppose now that number one wants to transfer his point of diversion and place of use downstream below number three. If number one is allowed to transfer his full right of 10 second feet downstream, number three will no longer receive water. Number three's water right will be injured. Therefore, the Department of Water Resources must either disapprove the transfer, or, if partial transfer is feasible, approve it only to the extent that injury to number three is avoided.[42/]

In two of its more recent decisions, although both are now more than a quarter century old, the Idaho Supreme Court allowed water transfers under circumstances that create some uncertainty about the no injury limitation. Colthorp v. Mountain Home Irrigation Dist.[43/] involved appropriations from a particular stream for the Lockman and Ake ranches. The Lockman ranch was upstream, and the Ake ranch was immediately below it. Both ranches had decreed water rights recognized in a 1914 adjudication. By subsequent agreement, the decree was modified to give the two ranches equal priorities for 110 inches of water each. When the point of diversion and place of use of the Lockman water right were transferred some years later, the owner of the Ake ranch brought suit and alleged that before the downstream transfer at least 75% of the 110 inches diverted to the Lockman ranch had returned to the stream and been diverted from there for the Ake ranch, that the transfer cut off the return flow and reduced the supply to the Ake ranch by at least 82.5 inches (110 inches x 75%), and that as a result the plaintiff was required to allow 80 acres of the Ake ranch to remain idle and unproductive. In denying the plaintiff any legal relief against the transfer, the Court said that the injury the plaintiff asserted:

> "is not the kind of an injury that will prevent the making of the change. To prevent a change in the point of diversion and place of use of water, the injury, if any, must be to a water right. In the case at bar, it must be kept in mind, appellant [owner of the Ake ranch] does not plead that a change in the point of diversion and place of use of the Lockman water would in any way injure the water or the right to use the water, decreed to the Ake ranch. Undoubtedly, if a change of the point of diversion and place of use of the Lockman water actually injured appelant's use of right to use the water decreed to the Ake ranch, the change could not be made." 44/

The Court's last sentence acknowledges the no injury limitation. Yet, the plaintiff lost the case, and it is hard to understand why his allegations of injury were insufficient. The Court's acknowledgement of the no injury limitation is also hard to reconcile with its statement later in the opinion that the defendant "could not be required to waste 75% of the water decreed to it, for the benefit of the appellant (plaintiff)."45/

One can only speculate about what the court meant in Colthorp. The briefs filed by the parties are interesting in this regard. They are not definitive, though, since there is no way of knowing whether the court was influenced by points that were made in the briefs but were not articulated in its formal opinion. The respondent's brief argued that at trial the appellant had failed to allege a violoation of the no injury rule because: (1) the Ake ranch's decreed water right was in fact fully supplied during the period in controversy, (2) the owner of the Ake ranch was complaining about the loss of additional water consisting of run off from the Lockman ranch back into the stream, and (3) the owner of the Ake ranch had alleged no legal right to continue to receive the additional water. The respondents made two principal arguments in support of the last point: (a) the return flow did not partake of the character of the flow of the . . . . stream46/ and was not subject to appropriation

as against the paramount owner who originally appropriated it (the owner of the Lockman ranch); and (b) if the return flow were treated as part of the flow of the stream, it must be delivered to the decreed rights in their order of priority, and the appellant having received full delivery of his decreed rights cannot complain. Which of these arguments, if either or both, the court had in mind in ruling the appellant had failed to allege injury is hard to say. Perhaps it was leaning toward the first argument because the respondents' brief cited Sebern v. Moore[47/] in support of that argument, and the Colthorp opinion quotes from Sebern the statement that "surface waste and seepage water may be appropriated under the provisions of C.S., sec. 5562 (now Sec. 41-107 supra), subject to the right of the owner to cease wasting it, or in good faith to change the place or manner of wasting it, or to recapture it, so long as he applied it to a beneficial use."[48/]

Application of Boyer[49/] is similar to the Colthorp case. Junior appropriators downstream from a senior appropriation for section 30 of a particular township were unable to stop transfer of the senior right further downstream. The juniors alleged that they would be injured by the alteration of return flow, but according to the Court:

> "they had made no definite study or determination of a definitive amount of water that would get back into the river from use of water on respondent's lands in Section 30, or to the extent the flow of the river would be augmented thereby and directly available to other users, certainly not as to any specific user or ditch." 50/

The Court states its legal rationale for allowing the change in point of diversion and place of use as follows:

> "It is axiomatic that no appropriator can compel any other appropriator to continue the waste of water whereby the former may benefit. [Here the Court cited several cases, including Colthorp as authority for this principle.] If respondent, by a different method of irrigation in Section 30 could so utilize his water that it would all be consumed in transpiration and consumptive use . . . . and thus no waste water return by seepage or percolation to the the river, no other appropriator from the evidence herein could complain . . . . Instead of thus changing the method of use, respondent accomplished the same result by changing the point of diversion . . . . The rule that a junior appropriator has the right to a continuation of stream conditions as they were at the time he made his appropriation, could not compel respondent to continue to waste his water by use on Section 30 . . . .
>
> "Therefore, we cannot say the finding of the trial court that there would be no substantial injury to others is not sustainable." 51/

The Court's reference to "the evidence herein" and its earlier characterization of the junior appropriators' evidence of injury suggests they might have lost because of inadequate marshalling of evidence of injury at trial. The rest of the Court's rationale, however, seems to suggest a more basic infirmity in their position if their source of supply depended upon the waste of water on Section 30.

In sum, Colthorp involved inadequate pleading of injury and Boyer involved inadequate proof of injury. Yet, there seems to be more to both opinions. A National Water Commission study, in an effort to make sense of Idaho law, says that although the no injury limitation protects junior appropriators from return flow alterations to their detriment through the transfer of senior right, "if the return flow is so excessive from the original appropriator as to be wasteful, then there is no right to have this wasteful return flow pattern maintained for the benefit of the downstream users."[52] Thus, there may be an exception to the no injury limitation for wasteful return flow patterns.

This exception is an inroad upon the appropriation doctrine tradition of affording high security of investment to water rights to encourage new development. Junior rights dependent on upstream return flows are less secure in the face of possible transfer of the senior rights. Presumably the reason for the exception is to enable the transfer of inefficiently used water rights to more productive uses.

Whether it will have this effect is not clear because of conceptual difficulty with the exception and the resulting uncertainty as to its meaning. There is a well-established rule in appropriation doctrine states prohibiting the waste of water, and the references to waste in Colthorp and Boyer may be traceable to semantic confusion with that rule. The established rule requires that water be put to beneficial use without unreasonable waste.[53/] In the case of irrigation, this means diverting and using no more water than reasonably necessary according to the standards and practices of good husbandry.[54/] If an irrigator has been diverting 10 second feet but would need only 6 feet with minimally adequate practices, his water right will be for only 6 feet, not 10. In the Colthorp case, the senior water right at the Lockman ranch was for 110 inches, with at least 75% of that returning to the stream. If the diversion and use were unreasonably wasteful, the senior right should initially have been for less than 110 inches, so that more water was left in the stream to flow down to the Ake ranch. Perhaps the Court did not view this as an option because the senior right had previously been confirmed by judicial decree. For the Court to invent an exception to the no injury rule for unreasonably wasteful return flow, however, produced a very different result from what would have obtained if the established rule against waste in the

appropriation of water had been applied. The new concept of wasteful return flows, as distinguished from waste in the diversion and application of water to beneficial use, is of uncertain meaning. To fall outside the traditional rule against waste, it would have to involve return flow that is somehow excessive but yet not produced by unreasonably wasteful diversion and application to beneficial use.

The question of who has the burden of proof on the issue of injury to other appropriators is difficult to answer. One commentator has construed a 1934 Idaho case[55/] as holding that "[t]he burden is upon the one seeking to change the place of use to show that it does not interfere with the rights of others."[56/] In fact, that case appears to be ambiguous on the burden of proof regarding injury, and the Boyer case may be an indication that opponents of the transfer have the burden of proving they will be injured or at least the burden of producing credible evidence of injury.

The second limitation on changing the point of diversion or place of use of a water right is that the change must not constitute an enlargement in use of the original water right. This limitation, which was added by the Legislature in 1969,[57/] is not further defined in the statute and has never been construed by the Idaho Supreme Court. The Department of Water Resources interprets an "enlargement in use" to mean an increase in the net volume of water consumed under a water right.[58/] This interpretation turns on a distinction between the amount of water diverted and the amount consumed by an appropriator. Referring again to Figure 2.1, which was used to illustrate the effect of return flows, appropriator number one diverts 10 second feet but consumes only 5 feet

and the remaining 5 feet returns to the stream. Suppose number one now changes the place of use of the water right, still diverting 10 second feet but consuming 6 feet and returning only 4 feet to the stream. This would violate the prohibition against enlargement in use.

The procedure for changing the point of diversion or place of use of a water right is to file an application with the Department of Water Resources. The Director of the Department then publishes notice of the proposed change once a week for two consecutive weeks in a newspaper of general circulation within the county where the water is diverted. Persons who wish to challenge the transfer have until ten days after the last publication to file a protest with the Department. If a protest is filed, the Director or a hearing officer he appoints must hold a hearing on it and seek input from the watermaster of the district in which the water is used. Any person who feels aggrieved by the Director's decision on the application for transfer has 60 days thereafter to appeal the decision to district court.[59/]

The discussion so far has focused on changing the point of diversion or place or use of a water right because those changes are specifically authorized and regulated by statute. If the transfer involves a change in the nature or period of use of a water right, either alone or in combination with a change in point of diversion or place or use, the situation has been more complicated. At the time of the 1977 drought and before the Department of Water Resources had taken the position that it had no statutory authority to approve a water transfer involving a change in the nature of use of the right.[60/] Subsequent to the drought, the Idaho Supreme Court upheld that interpretation.[61/] The Idaho Legislature responded in 1981 by giving the

Department authority to approve changes in nature or period of use generally under the same three conditions that apply to changes in point of diversion or place of use. That is, any such change (1) must not injure other water rights, (2) must not constitute an enlargement in use of the original right, and (3) must be in the local public interest. In a given case, however, any of several additional constraints may apply. First, a permanent change in period or nature of use for more than 50 c.f.s. or for a storage volume greater than 5,000 a.f. requires legislative approval. A lease for less than three years for use in state is not deemed a permanent change. Second, the Department may not approve a change from agricultural use to another use where that would affect the agricultural base of the local area. Third, once a change in nature of use has been approved, the Department may not approve another change in nature of use of the right except back to the original use.62/

Given the need for administrative approval to change the nature of use of a water right, it is important to know what is deemed a change in nature of use. Generally, changes in cropping pattern by an irrigator would not constitute a change in nature of use. The Idaho Supreme Court has said:

> ". . . . the users of water may change the character of crops grown at will from those that require much water to those that require little and vice versa, and the extent of a user's permanent right may not be limited by the character of crops raised unless the soil is adapted only to one, or to limited kinds of crops." 63/

Arguably, at least, the Court indicated in another case that classifying by nature of use requires division only into generic category, e.g., domestic use, agricultural use, manufacturing use, mining use, etc.64/ The 1981 legislation on change in nature of use seems to take this approach, also.

Some water rights, such as for domestic use, are likely to be used year

round. Others, such as agricultural rights for irrigation are seasonal. A transfer from one agricultural user to another generally will not involve a change in period of use though, because of leeway in the permitted period of use of a seasonal appropriation. The license for an irrigation right, for example, might describe its period of use as being from April 1 to October 15 each year.

ii. Supply to User by a Delivery Organization

When water is supplied by a delivery organization, such as a canal company or an irrigation district, the rules governing transfer by the user vary depending upon whether the land supplied was developed and patented under a federal law known as the Carey Act.[65/] Change in point of diversion, place of use, period of use or nature of use by a water user with non-Carey Act land are governed by the same statutes as apply to persons who have directly appropriated water.[66/] There is one special statutory requirement: if a right to water or to use diversion works or an irrigation system is represented by shares of stock in a canal company or other corporation or if the system is owned or managed by an irrigation district, no change in the point of diversion or place of use is allowed without the consent of the corporation or irrigation district.

Two other differences between a water user supplied by a delivery organization and a direct appropriator should be noted. First, the organization might have adopted more restrictive transfer rules for its members than the generally applicable Idaho legal rules. Second, if the organization's water license or decree lists the place of use of the water as being all the land served by its system, then a change from one farm within its

service area to another farm within that service area would not even constitute a change in place of use so far as appropriators outside the organization are conserned.[67/] The outsiders would lack standing to block the transfer on the ground of injury or enlargement in use.

Water rights made appurtenant to land through the Carey Act were governed exclusively by special transfer statutes prior to 1981. Now such rights are governed by the general transfer rules described above, but since the special transfer statutes for Carey Act projects were not expressly repealed, they probably continue to operate also. The special rules are described below.

Water users supplied by Carey Act corporations may sell their rights or lease them for periods not exceeding one year, but only to other land that can be served and irrigated by the same Carey Act system.[68/] Consent must first be requested from the board of directors of the corporation operating the Carey Act irrigation system.[69/] If the board refuses to consent, permission to make the transfer may then be sought from the Director of the Department of Water Resources. The Director can override the board's refusal if he finds the transfer will not be prejudicial to the corporation or to the other water users under its irrigation system.[70/] Transfer is subject to a no injury limitation,[71/] but there is no procedure for scrutiny of the proposed transfer by the Director of the Department of Water Resources except in connection with an application to review a refusal of consent to transfer by the board of directors of the corporation.

Thus far the focus has been on transfer by a water user who is supplied by a delivery organization. The next topic is transfer by the delivery organization itself. Once water supplied by an irrigation

district has been applied to beneficial use on land within the district, it becomes dedicated to use on such land and any attempt by the directors of the district thereafter to obligate such water for use outside the district when it is needed with the district is ultra-vires (beyond their legal authority) and void.[72/] Thus, the directors of an irrigation district are able to sell or lease only surplus water not needed by district members. The same is likely to be true of canal companies, including Carey Act Corporations.[73/] A change in point of diversion or place of use would also be subject to the regular statutory no injury, no enlargement in use, and local public interest limitations. A change in period or nature of use would be subject to possible additional limitations described above.

iii. Operation of the Water Supply Bank

The federal Drought Emergency Relief Act of 1977 authorized the Secretary of the Interior to purchase water from willing sellers and to redistribute such water to irrigators based on priorities to be determined by the Secretary within the constraints of state water laws, with the objective of minimizing losses resulting from the drought. Payments for water the Secretary acquired from willing sellers were required to be at a negotiated price that would not confer an undue benefit or profit compared to that would have been realized if the sellers had used the water in the normal irrigation of crops. Purchases from the Secretary were required to be at a price set by the Secretary sufficient to cover all expenditures made in acquiring water. This

emergency legislation was effective only during the 1977 irrigation season.[74/]

In 1979 the Idaho Legislature directed the state Water Resource Board to establish a water supply bank.[75/] The Board adopted regulations implementing the water bank legislation on April 23, 1980.[76/] To facilitate transfers, the Board may purchase, lease or otherwise acquire water rights, divide or combine the rights into more marketable blocks, and then sell or lease the water rights to others.[77/] All of this is subject to the standard no injury, no enlargement in use, and local public interest limiations.[78,79/] If the right to use water, or diversion works, or an irrigation system is represented by shares of stock in a corporation or if the system is owned or managed by an irrigation district, consent of the corporation or district is required.[80/] Apparently water may be purchased or leased from the supply bank only if the proposed nature of use will be the same as the old use.[81/]

The Director of the Department of Water Resources processes applications to purchase or lease water rights from the Board.[82/] Prior to the sale of a water right or lease for a period encompassing portions of two or more water years, the Director must give the same notice as required for nonwater bank transfers, i.e., publication once a week for two consecutive weeks in a newspaper of general circulation in the county where the water is diverted.[83/] For shorter leases, the Director need only give notice as he deems necessary.[84/] The Director is authorized to take final action on leases for up to two water years; applications

for purchase or for longer leases must be referred to the Board for final decision.[85] The Board or the Director may conduct a lottery or auction if the applications to purchase or lease water exceed the amount available.[86]

The water bank machinery also contemplates the appointment by the Water Resource Board of local committees to facilitate the lease of stored water.[87] A local committee may be the board of directors of a canal company or irrigation district or board of county commissioners.[88] A local committee's procedures or by-laws must comply with the Board's rules on transfer.[89] The lease form used by the committee must be approved by the Director of the Department of Water Resources, but apparently the committee need not give the Water Resource Board or the watermaster notice of individual leases unless water will be moved from within the boundaries of an irrigation district.[90] Any water right holder who thinks a lease is interfering with a supply of water to which he is entitled, may petition the Director of the Department of Water Resources to revoke or modify the lease.[91]

iv. Operation of the Transfer Rules Under Drought Conditions

In a drought, water transfers typically may be needed on short notice and for a short time. Under the traditional procedure, prior approval of transfers by the Director of the Department of Water Resources is generally required and he cannot act, at the earliest, until after two weeks of newspaper publication. Perhpas the new state water bank rules will allow some leasing to be accomplished a little faster.

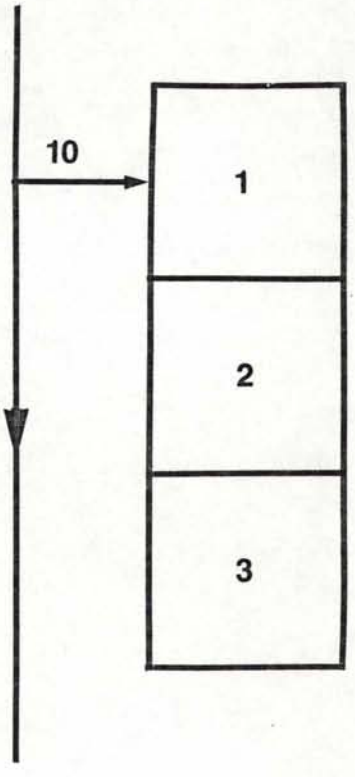
The no injury and no enlargement in use limitations can impede water

transfer to alleviate the effects of a drought, both because of their substantive prohibitions and because of the disincentive associated with the potential costs in time, effort and legal and expert witness fees needed to deal with the no injury and no enlargement in use limitations. (It should be remembered, though, that these limitations may serve to protect the supply of water to established junior appropriators.) With respect to the limitation against enlargement in use, the Department of Water Resources has acknowledged enforcement difficulties when additional acres are irrigated under a water right but there is no increase in the rate of diversion and injury to others is diffuse.[92/] The extent to which drought inspired short-term water transfers may occur without detection by the Department or by persons who would be inclined to object is hard to assess.

4. Direct Improvements in Water Use Efficiency

Each of the drought responses examined so far, prorationing, rotation, and transfer, have spinoff effects on water use efficiency. There are a range of other practices open to the irrigator who is trying to stretch a limited amount of water over his crops. These water conservation practices include lining ditches with concrete, installing a sprinkler system, constructing sumps to capture water for reuse, irrigation scheduling, or switching to less water intensive crops. It may be difficult to tell whether adoption of such water use practice is really a drought response, or whether drought was just the stimulus causing farmers to act to adopt practices which were in their long term best interests, anyway. It is conceivable that drought can benefit a region by nudging it in the direction of longer term improvements in water management and water use efficiency.

Figure 2.2. Illustration of the Impacts of Water Conservation Practices



These water conservation practices may not only reduce the amount of water needed by the irrigator who implements them but may also affect the supply available to others. To illustrate, suppose in figure 2.2 that A owns parcel 1, B owns parcel 2 and C owns parcel 3. A has an appropriation of 10 cubic feet per second from the stream to irrigate parcel 1. Water applied to parcel 1 but not consumed on it (often called waste and seepage water) flows or percolates through parcel 2 and reaches parcel 3, where C captures it and uses it to irrigate parcel 3.

Then A installs a sprinkler system that will enable him to reduce his diversion from the stream to 6 second feet and still accomplish the same irrigation results as before on parcel 1. The waste and seepage flow to C will be drastically reduced or cut off, however. At the same time, A has several options regarding the 4 second foot difference between what he formerly diverted and will now need to accomplish the same results as before. First, but probably least likely, he can simply let it go down the stream and assert no claim on it. Second, if his previous water supply was marginal or he wants to change to a more water intensive use, he may want to continue to divert the 4 second foot differential and apply it to parcel 1, either immediately or after storing it for awhile. Third, he may want to continue to divert the 4 second feet and apply the water to new land he owns or acquires that was not previously irrigated under the water right. Fourth, he may want to sell or lease the 4 second feet to another person who will apply it to land not previously irrigated under the water right.

In analyzing the legal status of the parties, the starting point is the following statement by the Idaho Supreme Court:

" . . . . surface waste and seepage water may be appropriated . . . . subject to the right of the owner to cease wasting it, or in good faith to change the place or manner of wasting it, or to recapture it, so long as he applies it to a beneficial use. His control is not dependent upon continuous actual possession, and in the absence of abandonment or forfeiture of his right to its use, he may assert his right, which is not affected by his once having applied it to a beneficial use." 93/

In the diagram, then, C can appropriate A's waste and seepage water. This appropriation would enable C to prevent B from commencing to capture the waste and seepage as it flows across parcel 2 if that will interfere with C's supply. C's appropriation is subject to an infirmity, however. A, the original appropriator, has the right to take the waste and seepage away from C so long as he puts it to a beneficial use and has not abandoned or forfeited the right to do so.

Though the applicable rule is easy to state, it is hard to apply in specific cases. This is because of a scarcity of caselaw on what constitutes abandonment or forfeiture of the original appropriator's right to cut off the flow of waste or seepage from his land. Abandonment requires proof of intent to abandon plus a showing of actual relinquishment of the water. In an early case, a canal company had for eighteen years allowed waste and seepage to pass from its shareholders' lands into a natural channel physically tributary to the stream from which the water had originally been diverted. The company had never manifested any intention to recapture or again use the waste and seepage water on shareholder lands, and another person had been appropriating the waste and seepage flowing in the natural channel for five years without objection from the canal company. The court seemed to indicate that the canal company should be deemed to have abandoned its right to recapture or

again use such water on shareholder lands. The actual holding in the case, however, was only that the canal company could not under such circumstances reclaim the waste and seepage water and dispose of it to a third person for use on other land.[94/]

In a very recent case, the Court allowed an appropriator to cut off seepage from a ditch used to transport water from the place of origin to the place of use by lining the ditch with a steel pipe.[95/] The seepage had escaped for many years before that. For the seven years preceding installation of the pipe, the seepage had been collected by another person and put to beneficial use. The Court found there had been no abandonment by the original appropriator of its right to the seepage because it had tried repeatedly (albeit unsuccessfully until installation of the steel pipe) to reduce the seepage loss from the open ditch. This showed the original appropriator never intended to abandon the seepage water.

In that case, the Court also construed an Idaho statute that says all rights to the use of water shall be forfeited by a failure for five consecutive years to apply it to the beneficial use for which it was appropriated.[96/] It ruled this statute would not cause forfeiture of the original appropriators right to cut off the seepage so long as the amount of water lost through seepage in transporting the water from its place of origin to its place of use was reasonable and the water which arrived at its destination was put to beneficial use. If A, the owner of parcel 1 in figure 2.2, had been putting the 10 second feet he diverted to beneficial use, albeit with a fair but not unreasonable amount of runoff and seepage, then apparently the forfeiture statute would not operate against his right to reclaim or cut off the flow of runoff and seepage water from parcel 1.

If A wished to take the 4 second feet made available by installing the sprinkler system and either use it on new land he owns or acquires, rather than on parcel 1, or sell or lease it to a third person for use on new land, additional legal issues beyond the question of abandonment or forfeiture arise. There would be a change in place of use of part of A's original water right, and the no injury and no enlargement in use limitations discussed earlier in the section on "Transfers" would apply. C will claim he is injured because of the loss of his supply of waste and seepage. A will argue C's right was always subject to an infirmity, namely, A's reduction or elimination of the supply of waste and seepage; and therefore, C's loss of supply is not an "injury" in the legal sense that is protected by the no injury limitation. Similarly, C will claim A is enlarging his use. A will argue any increase in his consumptive use of water is not the kind of enlargement in use against which B is protected by statute because his right is subject to an infirmity. These are issues upon which Idaho law is not yet well enough developed to supply a clear answer.

If A wishes to use the 4 second feet made available by installing the sprinkler system on parcel 1 but switch to a more water intensive use on that parcel, then the question would arise of whether A is changing the nature of use of the water right. As indicated in the earlier section on "Transfers," an irrigator has some latitude to change cropping patterns without that constituting a change in nature of use so far as the law is concerned. If A's more intensive use will involve a change in the nature of use, however, then the legal issues related to changing the nature of use noted in the section on "Transfers" would arise in

addition to the legal question of abandonment or forfeiture by A of the right to reduce the flow of waste or seepage to C. The same is true if A wants to change the period of use.

It has been suggested that drought may induce irrigators to adopt practices that lead to long term improvements in water use efficiency. If this means that more water is available for appropriation in normal years, and a growth in irrigated land, then some of the cushion of excess water that allowed farmers to get through a drought will have disappeared:

> "Drought is a problem because, obviously, the supply of this renewable, natural resource fluctuates; even though on an average over a long period of time it has been and continues to be constant. Hence increases in water demand will in many places lead to shortages. Experience and investigations show that risks of water shortage increase rapidly with an increase in the proportion of utilization of the total available water resources in an area."

In effect, drought motivated improvements could increase the likelihood of future water shortage problems.

In many cases there is a very definite tradeoff between energy use and water use. Sprinklers, pumpback systems, and other methods for saving water tend to use large amounts of electricity. Some government programs such as those offered by the Agricultural Stabilization and Conservation Services have offered financial assistance to farmers to convert from surface to sprinkler systems. Under southern Idaho conditions this results in little or no water saved and available to other users, but would result in large new electricity demands. Given that drought also strains the hydroelectric generating capability, the increased electric demands and reduced supplies can cause problems.

5. Ground Water Augmentation of Surface Supplies

If an irrigator whose surface supply diminishes under drought conditions seeks to turn to ground water by drilling a new well, enlarging an existing well, or rejuvenating an old unused well, various legal rules not yet fully discussed come into play. Ground water, like surface streamflow, is governed by the appropriation doctrine.[98/] Since 1963, a water permit from the Department of Water Resources has been required to appropriate ground water[99/] except for domestic use.[100/] Also expressly excepted from the permit requirement, even though technically they might not even involve new appropriations, are wells constructed by the owners of irrigation works solely to recover ground water resulting from irrigation under such works for further use on or drainage of lands to which the irrigation water right is already appurtenant.[101/] Drilling a new irrigation well will require a permit, then, unless it is constructed by an owner of irrigation works solely to recapture seepage from land irrigated by the works for reuse on that land. The same is true of enlarging of an existing well.[102/] Rejuvenating an old unused well will constitute a new appropriation and require a permit, if the old water right has been abandoned or forfeited.

The terms abandonment and forfeiture are applied a little differently here than in the earlier context discussed in the section on "Improvements in Water Use Efficiency." Abandonment of a water right, as distinguished from the right to recapture waste and seepage, occurs when the owner of a water right ceases to use the water and manifests an intention to relinquish the right.[103/] Forfeiture of a water right, as distinguished from forfeiture of the right to recapture waste and seepage, occurs simply

from five continuous years of nonuse of the water.[104] The Idaho Supreme Court has said, however, that the water right revives if the original appropriator thereafter resumes use of the water prior to an intervening claim or appropriation of it by any other party.[105]

Once an application for a permit to appropriate is filed, the Director of the Department of Water Resources must give notice of it in a newspaper published in the county of the proposed point of diversion at least once a week for two successive weeks. Anyone who wishes may file a written protest against the application within ten days of the last publication of notice. A hearing upon any protest must be held within sixty days after the Department received it. If no protest is filed, the Director may forthwith approve the application provided it meets all the legal requirements.[106]

The Director has statutory authority to deny an application for a permit to appropriate on any of several grounds. Specifically a permit may be denied, or be approved only in part or upon conditions, if: (1) the proposed use will reduce the quantity of water under existing rights, (2) the water supply itself is insufficient for the purpose for which the appropriation is sought, (3) the application is not made in good faith but for delay or speculative purposes, (4) the applicant lacks sufficient financial resources to complete the project, or (5) the proposed use will conflict with the local public interest.[107]

The procedure described above applies to all permit applications, whether the source of supply is surface or ground water. If the source is ground water, some additional provisions may operate. The Director of the Department of Water Resources has been empowered, after a public

hearing is held in the areas concerned, to designate critical ground water areas in the state. A critical ground water area is defined as all or part of a ground water basin that does not have sufficient ground water to provide a reasonably safe supply of water given existing rates of withdrawal or rates projected after taking into account valid and outstanding applications and permits.[108] If an application for a permit is made in a critical ground water area, the Director may forthwith deny the application without publishing notice of it and holding a hearing on protests.[110]

Other special groundwater provisions were enacted subsequent to the 1977 water drought. When an application is filed to appropriate groundwater from an area that has not been designated as critical, the Director may require the applicant to undertake artificial recharge of the basin if (1) the proposed appropriation exceeds 10,000 acre feet per year from a single or combination of diversion points, and (2) it will substantially and adversely affect existing pumping levels or the amount of water available for withdrawal under existing rights.[111] Also, the approval of both the Director and the Idaho Legislature is required if the proposed appropriation involves (1) sufficient water to irrigate 5,000 or more acres on a continuing basis or more than 10,000 acre feet of water per year and (2) transfer of groundwater outside the immediate groundwater basin. In passing on the application, the Director and the Legislature must consider the local economic and ecological impact of the proposed project.[112]

If large numbers of irrigators were to respond to drought by drilling new wells, or increasing their pumping from existing wells,

this would have a significant impact on electricity use, and on the already stressed hydroelectric generating system. The electricity use would include that used by those farmers in question, and also some increased use by their neighbors who may suffer some groundwater declines because of the increased pumping.

C. Summary

This chapter has examined some of the options open to farmers facing a drought, including transfer of water rights, rotation, prorationing, and various other methods for improving water use efficiency. There is a complex array of laws and rules limiting farmers responses. Most of the laws were designed to protect, as much as possible, the security of water rights, creating a climate so that long term investment in water resource development would be feasible. However security of right has been purchased at the cost of inflexibility. Idaho water law certainly hampers some adjustments which would help mitigate the effects of drought.

The problem with water is that all uses and users are interconnected. Changes in irrigation practices by one user may affect the water supplies of others. The no injury rule may prevent some of these damages. Yet in other cases injury may be diffuse, or the law gives the injured party no recourse.

Some of the impacts of drought response, such as the energy impact, and the community economic impact can be very large, but for these impacts there is not a no injury rule to offer protection.

CHAPTER 3

FARMERS AND THE DROUGHT: RESPONSES, EFFECTS, AND PERCEPTIONS

So far this report has examined some of the possible responses of farmers to drought, and the legal environment in which these responses occur. This section looks at responses to the questionnaire to see what farmers actually did in 1977, and what results these actions produced.

A. What the Farmers Did in Response to Drought

1. Acreage changes.

From the range of possible actions that can be taken when drought is imminent, changes in cropping pattern are perhaps the easiest to implement. Shifts to crops or varieties that use less water and are less affected by water shortage would be expected. If shortage is likely to be severe, farmers might well choose to idle some land and concentrate what water is available on a reduced irrigated acreage. After a crop is planted, it may prove necessary to restrict water so that yields are damaged, perhaps even to the point where it is not worth harvesting the resulting crop.

Table 3.1 documents the acreage changes which surveyed farmers said they made in response to water shortage in 1977. In interpreting the table note for example that changes in crops grown in Ada and Canyon Counties included net increases of 308 acres of feed barley and 107 acres of spring wheat. Net acreage decreases due to changes in crops grown included 228 acres less corn silage and 289 acres less beans. The water

Table 3.1. Acreage Changes Resulting from Changes of Crop or Variety, and from Idle land and Crops Not Harvested, 1977.

	Ada-Canyon Counties						Blaine-Lincoln Counties						Bingham-Bannock Counties						All Three Areas					
	Change Crop	Change Variety	Idle	Change Planted Acres	Not Harvest	Change Harvest Acres	Change Crop	Change Variety	Idle	Change Planted Acres	Not Harvest	Change Harvest Acres	Change Crop	Change Variety	Idle	Change Planted Acres	Not Harvest	Change Harvest Acres	Change Crop	Change Variety	Idle	Change Planted Acres	Not Harvest	Change Harvest Acres
Hay: Alfalfa	43			43		43	-25		-43	-68	-649	-717	50			50		50	68		-43	25	-649	-624
Other	110			110	-9	101	25			25		25							135			135	-9	126
Green Chop	12			12		12	111			111	-50	61							123			123	-50	73
Wheat: Spring	107			107	-10	97	-25	55		30		30							82	55		137	-10	127
Winter	-6			-6	-8	-14		-55		-47		-47							2	-55		-53	-8	-61
Unspecified	-7		-14	-21		-21	-80		-180	-260		-260	-17			-17	-13	-30	-104		-194	-298	-13	-311
Barley: Feed	260	-50	-140	70		70	206	-700	-235	-729	-455	-1184	127			127	-30	97	393	-750	-375	-532	-485	-1017
Dryland Var.		50		50		50	15	700		715	-55	660					-70	-70	15	750		765	-125	640
Oats	45		-10	35		35			-43	-43	-40	-83			-10	-10	-20	-30	45		-63	-18	-60	-78
Rye: Dryland Var.								60		60		60								60		60		60
Mixed Grain							-115	-60	-317	-492	-25	-517							-115	-60	-317	-492	-25	-517
Corn: Grain	-28	-35		-63		-63		-15											-28	-35		-63		-63
Early Grain	9	35		44		44		15											9	35		44		44
Silage	-228	-567	-97	-892		-892	-55	-60	-186	-301		-301							-283	-627	-283	-1193		-1193
Early Silage	8	567		575		575	15	60		75		75							23	627		650		650
Seed: Alfalfa	-29			-29		-29													-29			-29		-29
Corn	20		-17	3		3													20		-17	3		3
Lettuce	10			10		10													10			10		10
Pea	18			18		18													18			18		18
Bean	-81			-81		-81													-81			-81		-81
Beans	-289			-289		-289	-40			-40		-40							-329			-329		-329
Sweet Corn	-4			-4	-20	-24													-4			-4	-20	-24
Dry Peas	140			140		140													140			140		140
Onions	-25			-25		-25													-25			-25		-25
Potatoes	-10		-40	-50		-50	-40			-40		-40	-160			-160		-160	-210		-40	-250		-250
Sugar Beets	-46			-46		-46													-46			-46		-46
Mint	-77		-72	-149	-3	-152													-77		-72	-149	-3	-152
Gross Acres Affected	1111	652	390	2153	50	2203	465	890	1004	2482	1274	3756	287	-	10	297	133	430	1863	1542	1404	4947	1457	6404
Net Acres Changed	0	0	-390	-390	-50	-440	0	0	-1004	-1004	-1274	-2278	0	0	-10	-10	-133	-143	0	0	-1404	-1404	-1457	2861
Normal Irrigated Land				24,667[1/]						18,723						16,951						60,341		

[1/] Total of harvested acreage, idle land and acreage not harvested.

required to grow a wheat or barley crop is somewhat less than is needed for beans or corn silage, and wheat and barley are more likely to produce a harvestable crop on restricted amounts of water. The variety of crops grown in the Ada and Canyon Counties gives these farmers some flexibility in responding to water shortage. A total of 1,111 acres on the 70 surveyed farms in the region were involved in drought motivated changes in crops grown. This was 4.5 percent of the 24,667 acres of irrigated cropland on the surveyed farms. For these changes in crops grown, each acre reduction in one crop was exactly offset by an acre increase in some other crop, so the net effect on total acreage was zero by definition.

In the Blaine-Lincoln County portion of the survey--reportedly the most severely hurt by the drought--only 465 acres (2.5 percent of the irrigated land) were involved in crop switches. While the changes reported by the 43 Blaine-Lincoln respondents were generally consistent with a shift to crops needing less water, the small acreage changed suggests that farmers in this area do not consider changing crops a major strategy for dealing with impending drought. This is at least partly because the region depends more on flow rights and less on developed storage than other areas so that drought is a chronic problem and farmers habitually grow water saving and drought resistant crops. Some of the changes, notably the switch to other hay and green chop reflect the importance of livestock to the region and the devastating impact of drought on dryland pasture.

Responses from the 38 surveyed farms in Bingham and Bannock Counties reflect the less severe drought impact felt in the Upper Snake area. Here storage and more secure flow rights insulate irrigators from most water

shortages. Only 287 acres of crop changes (1.7 percent) were reported.

For the three study areas drought motivated crop changes were mostly water saving or forage producing. Crop changes took place on 1863 acres or 3.1 percent of the irrigated land. The most prominent changes were the decreases in acreage of alfalfa, potatoes, beans, wheat, and silage corn and the increases in barley and dry pea acreage. When one reflects that these changes were for the summer of 1977, in the midst of one of the most severe droughts of recent years, the low numbers reflect the stability of cropping patterns and the degree to which farmers either reject or are unable to implement crop changes as an option in dealing with drought.

Changes in variety of a given crop included such shifts as the 700 acres in Blaine and Lincoln Counties which changed from the barley varieties normally grown under irrigation in that area to varieties normally grown on dryland. In this case these dryland barley varieties were actually irrigated, but presumably performed better than would normal varieties given the reduced water supply. The 567 acres in Ada and Canyon Counties which shifted from the usual silage varieties to early maturing silage corn varieties presumably reflected an attempt to get reasonable yields at reduced water application rates. Variety changes occurred on a total of 1542 acres (2.5 percent) in the three study areas.

Idled land showed up prominently in the Blaine and Lincoln County questionnaires--a total of 1004 acres on which no crops were grown either because no water was available, or because what water there was could be better used on other crops. The idle land would otherwise have grown crops such as mixed grain (317 acres), wheat (180 acres), barley (235 acres)

and corn silage (186 acres). A total of 390 acres (mostly barley and corn silage) were idled in the Ada-Canyon area, while only 10 acres were idled because of water shortage by the Bingham-Bannock County respondents.

Adding up the net acreage shifts due to crop and variety changes and idled land gives the net change in planted acreage due to the drought of 1977. For example in Ada and Canyon Counties 260 acres were shifted from some other crop into standard barley varieties, 50 acres were shifted from standard into dryland barley varieties and 140 acres that would normally have grown standard barley varieties were left idle. The net result is that standard variety barley planted acreage was up by 70 acres and dryland variety acreage was up by 50 acres in 1977.

A better perspective on the importance of drought-caused cropping pattern changes can be obtained from table 3.2. The table shows changes in planted acreage as a percent of the normal harvested acreage for each crop. For some crops these percent changes are substantial. For the combined areas under study corn silage planting was cut by over one-fifth and bean planted acreage by almost one-quarter. The 5.1 percent cut in potato acreage would also have significance for a product with inelastic demand. The only crops showing important increases in planted acreage due to drought are forage crops, barley, and other small grains. Total planted acreage was 5.4 percent below normal in Blaine and Lincoln Counties--a substantial cut. The reduction was 1.6 percent in Ada and Canyon Counties and only 0.1 percent in Bingham and Bannock Counties, reflecting the degree to which senior water rights and better developed storage in those areas insulate them from the effects of drought.

Of the acreage on which crops were planted but then not harvested,

Table 3.2. Percent Change in Planted and Harvested Acreage of Selected Crops in 1977, by Region.

	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Study Areas		
	Normal Harvested Acreage 1/	% Change Planting 2/	% Not Harvested 3/	Normal Harvested Acreage	% Change Planting	% Not Harvested	Normal Harvested Acreage	% Change Planting	% Not Harvested	Normal Harvested Acreage	% Change Planting	% Not Harvested
Hay Crops	2292	6.7	0.4	7860	-0.5	8.3	4667	1.1		14819	1.1	4.4
Green Chop	6	200.0		30	370.0	166.7				36	341.7	138.9
Wheat	538	14.9	3.3	660	-41.6		4571	-0.4	0.3	5775	-3.7	0.5
Barley	3535	3.4		2387	-0.5	21.4	1774	7.2	5.6	7696	3.1	7.9
Other Small Grains	357	9.8		1168	-40.7	5.6	266	-3.8	7.5	1791	-25.1	4.7
Corn for Grain	254	-7.5		15						269	-7.1	
Corn Silage	2147	-14.8		298	-75.8					2445	-22.2	
Seed Crops	2056	-3.8								2056	-3.8	
Beans	1182	-24.5		120	-33.3		30			1332	-24.7	
Sweet Corn	351	-1.1	5.7							351	1.1	5.7
Onions	155	-16.1								155	-16.1	
Potatoes	991	-5.0		135	-29.6		3817	-4.2		4943	-5.1	
Sugar Beets	1267	-3.6								1802	-2.6	
Mint	4137	-3.6								4137	-1.9	
Cropland.	24667	-1.6	0.2	18723	-5.4	6.8	16951	-0.1	0.8	60341	-2.3	2.4

1/ Harvested acreage plus acreage not harvested less change in planted acreage.

2/ Percent of normal harvested acreage.

nearly 90 percent was located on the farms of Blaine and Lincoln County respondents. Much of this was alfalfa for which irrigation water was not available. On about half of this unharvested alfalfa acreage the stand was actually killed by lack of water. Much of the rest of the unharvested acreage was barley that was reduced to such poor condition by water shortage that it was not worth harvesting. In all an area equal to 6.8 percent of the normal harvested acreage on Blaine-Lincoln County respondent farms was not harvested. Non-harvest was a rarer phenomenon in the other regions, accounting for less than 1 percent of the acreage.

The impact on harvested acreage due to the additive effects of planting acreage cuts and non-harvest was a 12.2 percent reduction on the 43 Blaine and Lincoln County farms. In contrast the Ada-Canyon and Bingham-Bannock County respondents cut harvested acreage by only 1.8 and 0.8 percent respectively. There may be small amounts of unharvested acreage even in normal moisture year, but it is clear that non-harvest was up sharply in 1977 in Idaho.

Of the 151 farmers responding to the survey, 76 farmers, or 50.3 percent reported making some acreage adjustments because of the drought. In hard hit Blaine and Lincoln Counties this fraction was 81.4 percent. Four out of five surveyed farmers in that area changed crops or varieties, idled land, or did not harvest crops in the summer of 1977. In Ada and Canyon Counties 50 percent reported such acreage changes, while in Bingham and Bannock Counties only 15.8 percent reported doing so.

2. Reduced water use.

A farmer has two options when he cuts back on water application.

He can irrigate a field less frequently, or he can apply less water at each irrigation. Table 3.3 shows that both options were used extensively during the summer of 1977. Of the 151 farmers who responded, 118 or 78.1 percent reported using either or both of these methods to cut water use. This percentage ranged from a high of 86.0 percent in Blaine and Lincoln Counties to a low of 68.4 percent in Bingham and Bannock Counties. In each of the three areas about one-third of the farmers interviewed were using both methods to cut water use. Clearly efforts to reduce water use were widespread during the 1977 irrigation season.

Farmers were asked to state which crops were irrigated less frequently, which crops got less water per irrigation, and how much less. The results appear as Tables 3.4 and 3.5. There are 146 separate instances where a crop was listed as irrigated less frequently. (These 146 instances occurred on 83 different farms.) Of these, 8 correspond to statements that all crops on the farm were watered less frequently. There were 143 separate instances on 88 farms where crops got less water per irrigation, and 28 of these refer to all crops on the farm. For both ways of reducing water use, about 40 percent of the occurrences involved hay or irrigated pasture. The hay-pasture percentage was even higher in Blaine and Lincoln County. Since hay and pasture are such a high percentage of the crops grown in those two counties, any cutback of water use must necessarily impact those crops. The Ada-Canyon County farmers distributed their cuts across the full range of crops including high valued crops such as hops, mint, potatoes, and seed crops.

The 143 reported instances where less water was applied per irrigation averaged a 29.8 percent cut in water applied. The extent of this cutback

Table 3.3. Methods Used to Reduce Water Use.

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
Irrigate Less Frequently	9	12.9	12	27.9	9	23.7	30	19.9
Less Water per Irrigation	21	30.0	10	23.2	5	13.2	36	23.8
Both	25	35.7	15	34.9	12	31.6	52	34.4
Number Reporting Less Use	55	78.6	37	86.0	26	68.4	118	78.1
Total Respondents	70	100.0	43	100.0	38	100.0	151	100.0

[1] Number reporting this item.

[2] Percent of questionnaires.

Table 3.4. Crops Irrigated Less Frequently

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
All crops	4	6.3	3	6.5	1	2.8	8	5.5
All Hay	11	17.2	20	43.5	13	36.1	44	30.1
Irrigated Pasture	2	3.1	8	17.4	3	8.3	13	8.9
Wheat	2	3.1	3	6.5	6	16.7	11	7.5
Barley	7	10.9	7	15.2	6	16.7	20	13.7
Other Grain	4	6.3	4	8.7	3	8.3	11	7.5
Corn Silage	9	14.1	1	2.2			10	6.8
Potatoes/Sugar beets	3	4.7			4	11.1	7	4.8
Seed Crops	8	12.5					8	5.5
Hops	4	6.3					4	2.7
Mint	8	12.5					8	5.5
Others	2	3.1					2	1.4
Total Instances	64	100.0	46	100.0	36	100.0	146	100.0
Respondents Reporting	34	48.6[3]	27	62.8	21	55.3	82	54.3

[1] Number reporting.

[2] Percent of total reported instances.

[3] Percent of questionnaires reporting less frequent irrigation.

Table 3.5. Crops Getting Less Water per Irrigation

	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Areas		
	N	%[1]	% Reported Reduction [2]	N	%[1]	% Reported Reduction [2]	N	%[1]	% Reported Reducation [2]	N	%[1]	% Reported Reduction [2]
All Crops	16	24.2	27.8	5	10.2	23.3	7	25.0	16.9	28	19.6	23.7
All Hay/Green Crop	9	13.6	30.1	20	40.8	36.0	9	31.0	25.2	38	26.6	31.8
Irrigated Pasture	3	4.5	31.0	15	30.6	34.8	1	3.4	33.0	19	13.3	34.0
Wheat	2	3.0	36.5	4	8.2	41.7	4	13.8	24.3	10	7.0	32.8
Barley	8	12.1	28.0	6	12.2	32.3	3	10.3	25.3	17	11.9	29.1
Other Grain	4	6.1	24.5	6	12.2	36.6	1	3.4		11	7.7	32.9
Corn Silage	9	13.6	32.0				1	3.4	10.0	10	7.0	29.8
Potatoes/Sugar Beets	1	1.5	33.0	1	2.0	50.0	3	10.3	24.0	5	3.5	31.0
Hops	4	6.1	31.3							4	2.8	31.3
Mint	13	19.7	24.4							13	9.1	24.4
Others	2	3.0	36.5							2	1.4	36.5
Total Instances	66	100.0	28.8	49	100.0	34.9	28	100.0	22.6	143	100.0	29.8
Respondents Reproting	46	65.7[3]		25	58.1		17	44.7		88	58.3	

[1] Percent of total reported instances.

[2] Average reported percent reductions in water use for this crop.

[3] Percent of questionnaires reporting less water per irrigation.

was surprisingly uniform across all crops, ranging generally between 25 and 35 percent.

3. Sacrificed crops.

Many of the farmers perceived their water management strategy as an exercise involving tradeoffs--some crops had to be sacrificed so that other crops could have water. The reductions in water application noted above tended to be only partial sacrifices since most of these crops produced a harvestable yield. In other cases the sacrifice was complete, with one crop lost to save another. The 59 farmers who reported making such a deliberate sacrifice made up 39.1 percent of the interview sample (tables 3.6 and 3.7). Almost half of the crop sacrifice decisions took place in hard hit Blaine and Lincoln Counties where over two-thirds of those interviewed reported having sacrificed crops, either partially or completely. In those counties the tradeoff was to divert water from irrigated pasture and grain to grow the hay needed to carry livestock through the coming winter. In Ada and Canyon Counties less than one-quarter of those interviewed reported sacrificing one crop to save another. What sacrifices occurred diverted water from hay, irrigated pasture, and barley to high valued crops such as corn silage, potatoes, sugar beets, and perennial crops.

The economically rational farmer should allocate each acre foot of water to the use that would generate the greatest marginal return. This behavior shows up clearly in the sacrificed crop responses. Blaine-Lincoln County farmers sacrificed cash crops and even irrigated pasture in order to grow the vital hay crop needed to overwinter what was left

Table 3.6. Crops Sacrificed to Save Water

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	N	%[1/]	N	%	N	%	N	%
Hay crops and Green Chop	10	38.5	8	18.6	5	20.8	23	24.7
Irrigated Pasture	4	15.4	14	32.6	6	25.0	24	25.8
Barley	7	26.9	13	30.2	6	25.0	26	28.0
Corn Silage	2	7.6	0	-	0	-	2	2.2
Other	2	7.6	0	-	0	-	2	2.2
Total Instances	26	100.0	43	100.0	24	100.0	93	100.0
Respondents Reporting Sacrifices	16	22.9	29	67.4	14	36.8	59	39.1

[1/] Percent of total reported instances.

Table 3.7. Crops Getting Water from Sacrificed Crops

	Ada-Canyon Counties		Blaine Lincoln Counties		Bingham Bannock Counties		All Three Areas	
	N	%	N	%	N	%	N	%
Hay Crops and Green Chop	1	3.8	29	67.4	3	12.5	33	35.5
Irrigated Pasture	1	3.8	2	4.7	0	-	3	3.2
Barley	1	3.8	6	14.0	2	8.3	9	9.7
Other Grains	3	11.5	6	14.0	5	20.8	14	15.1
Corn Silage	4	15.4	0	-	0	-	4	4.3
Potatoes and Sugar Beets	2	7.7	0	-	14	58.3	16	17.2
Perennial Crops	10	38.5	0	-	0	-	10	10.8
Other	4	15.4	0	-	0	-	4	4.3
Total	26	100.0	43	100.0	24	100.0	93	100.0

[1/] Percent of total reported instances.

of their breeding stock, and thus preserve their livestock enterprise. Ada-Canyon County farmers, being less dependent on livestock, were able to sacrifice hay, irrigated pasture, and barley which have lower marginal returns to water. This allowed them to grow corn grain and silage, potatoes, and sugar beets which have higher marginal returns to water, and to provide enough water to avoid permanent damage to their perennial crops.

How can this be reconciled with farmers statements about how much less water they applied at each irrigation? For most crops--hay, pasture, cash, and perennial--these reductions were in the very narrow range between 25 and 35 percent. A possible interpretation is that in normal years when water is abundant it is applied until it has a very low marginal return on all crops. Hence water application could be cut back by 25 to 35 percent on most crops without seriously damaging returns. It is when water must be totally withheld, destroying the crop, that differences between crop marginal returns to water become very important.

4. Increased use of groundwater.

Farmers were asked whether they increased their use of groundwater from existing wells in order to make up for a shortage of surface water (table 3.8). Less than one-quarter of the interviewed farmers said they had done so, indicating that physical and institutional constraints limit their ability to shift easily from one water source to another. Many application systems are not designed to be easily switched from surface to groundwater. Water law restricts pumping from wells to the amount of the water right, but strict enforcement of this limis is difficult. Ada and Canyon County farmers showed somewhat more flexibility than Blaine

Table 3.8. Increased Use of Existing Groundwater Sources

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes, Increased Use	21	30.0	10	23.3	4	10.5	35	23.2
No	49	70.0	33	76.7	34	89.5	116	76.8
Total	70	100.0	43	100.0	38	100.0	151	100.0

[1/] Percent of questionnaires.

and Lincoln County farmers--consistent with the greater frequency of wells on sample farms in the former area.

5. Use of carry-over storage.

One thing that allowed some farmers to escape the worst effects of the drought was their access to carry-over storage. Table 3.9 shows that nearly one-third of the farmers surveyed had stored water unused from previous years that they could draw on during the 1977 irrigation season. Most of those who utilized carry-over storage were Ada and Canyon County farmers. None of the Blaine and Lincoln County farmers reported having any carry-over that they could use. The difference reflects the highly developed water storage and supply facilities in the Boise area and the fragmented individual diversions and lack of storage reservoirs in Blaine and Lincoln Counties. The differences also reflect differences in by-laws of the various water delivery organizations--some have no provisions allowing farmers to carry over stored water.

6. Water transfer.

When irrigation water is short, it may be possible for some farmers to buy stored water or to lease rights to flow water. Much of the stored water would come from agencies such as the Bureau of Reclamation which still holds some unallocated storage space in certain Bureau project reservoirs. Some water delivery organizations also have excess storage or flow waters that may be available. And, some individual farmers may have storage or flow water in excess of their needs, that may be available. Table 3.10 shows that water transfer, while some was observed in 1977, was not widespread. Much of the transfer occurred in Ada and Canyon

Table 3.9. Was Carry-Over Water Available in 1977?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	37	52.9	0	0	12	31.6	49	32.7
No	23	32.9	5	11.6	15	39.5	43	28.7
Don't Know No Answer	10	14.3	38	88.4	11	28.9	59	39.3
Total	70	100.0	43	100.0	38	100.0	151	100.0

[1/] Percent of questionnaires.

Table 3.10. Significance of Water Transfer.

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham Bannock Counties		All Three Areas	
	# [1]	ave. [2]	#	ave.	#	ave.	#	ave.
Water Acquired								
Stored Water (acre feet)	18	167.6	2	77.0			20	158.5
Flow Water (miners inches)	3	74.3	5	49.4			8	58.7
Cost ($)	20	5910	8	413	1	120	29	4194
Water Transferred to Other Users								
Stored Water (acre feet)	6	76.7					6	76.7
Flow Water (miners inches)	3	102.3	1	100.0	1	115	5	104.4
Revenue ($)	9	822	1	0.0			10	740

[1] Number of farmers reporting this item.

[2] Average flow/volume/cost for those reporting.

Counties which had access to much of the extra Bureau water, and had the well developed distribution system that made possible water transfer among individuals. Only 20 out of 70 Ada and Canyon County farmers interviewed had acquired water and only 9 reported transferring water to someone else. Most of the acquired water was stored water, and carried a price tag typically between $25 and $50 per acre foot. The 20 farmers who acquired water spent an average of $5,910 per farm for the water--a quite substantial drought-caused shock to income.

The small number of water transfers among users suggests that few farmers perceived that they had excess water to give up--even for a good price. Especially in Blaine and Lincoln Counties there must have been very little water available for transfer. Perhaps uncertainty about the water transfer provisions of Idaho law contributed to farmers reluctance to sell or lease water.

The crops to which acquired water was applied are shown in Table 3.11. Much of the water in hard hit Blaine and Lincoln Counties went to hay and pasture. In Ada and Canyon much of it went into high valued and perennial crops.

7. System improvements.

There are many physical improvements which farmers could make to improve the efficiency of their irrigation systems. Some of these changes might not be profitable under normal water conditions, or so marginally profitable that a farmer might procrastinate about making the change. Drought or impending drought can make these changes look much more attractive. Thus some system changes that occurred in 1977 were directly

Table 3.11. Crops Getting Acquired Water

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
All Crops	7	29.1	3	42.9			10	32.3
Hay and Pasture	2	8.3	4	57.1			6	19.3
Grain	4	16.7					4	12.9
Corn Silage	2	8.3					2	6.5
Onions/Potatoes/Sugar beets	3	12.5					3	9.7
Hops/Mint	6	25.0					6	19.4
Total Instances	24	100.0	7	100.0			31	100.0
Respondents Reporting	19	27.1	6	14.0			25	16.6

[1/] Percent of total reported instances.

drought-motivated, while drought in other cases was only the final push that caused farmers to make a generally desirable system change. Certainly the availability of drought assistance funds to help with system improvements must have encouraged farmers considering changes to make them during 1977. The information shown in table 3.12 are the system modifications which farmers said they made in 1977 in response to drought. Unfortunately the Table does not clearly distinguish whether a given change was primarily drought caused, or whether drought was just the final push.

Of the 151 farmers interviewed, 62.2 percent said they had made system improvements because of the drought. These 94 farmers made a total of 171 specific improvements to pumps, wells, distribution systems and application systems. Nearly one-quarter of the reported improvements were new wells. These 42 new wells along with casings and pumps accounted for half of the reported spending. Nearly three-quarters of these new wells were drilled in the Ada and Canyon Counties. That region also had the highest percentage who reported making changes due to drought--71.4 percent. Harder hit Blaine and Lincoln County farmers had only 22.8 percent reporting drought caused system changes. This may reflect the greater frequency of drought in Blaine and Lincoln counties. Many of the system changes that might be justified by drought have already been made, and the lower valued crops and lack of perennials means that expensive drought mitigating schemes may not be cost effective. The system improvements that were made in Blaine and Lincoln Counties were weighted heavily toward changes in the application systems.

Drought assistance funds were apparently channelled mostly to application and distribution system improvements rather than pumps and wells.

Table 3.12. Drought Related System Improvements.

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Regions		Reported Expenditures		Reported Assistance	
	#[1/]	%[2/]	#	%	#	%	#	%	#	$	#	$
Application System	13	13.5	19	39.6	7	25.9	39	22.8	38	229,662	21	90,410
Buy Handline	4	4.2	5	10.4	6	22.2	15	8.8	15	81,770	7	9,516
Buy Wheeline	1	1.0	7	14.6	0	-	8	4.7	8	106,326	5	62,710
Buy Gated Pipe	6	6.3	5	10.4	0	-	11	6.4	10	37,876	9	18,184
Rent Handline	1	1.0	1	2.1	1	3.7	3	1.8	3	2,490	0	-
Rent Gated Pipe	1	1.0	0	-	0	-	1	0.6	1	700	0	-
Replace Spray Nozzles	0	-	1	2.1	0	-	1	0.6	1	500	0	-
Distribution System	37	38.5	16	33.3	6	22.2	59	34.5	58	327,776	36	189,577
Buy Mainline	13	13.5	7	14.6	3	11.1	23	13.5	23	89,568	11	12,707
Rent Mainline	0	-	0	-	1	3.7	1	0.6	1	403	1	174
Line Ditches	17	17.7	3	6.3	0	-	20	11.7	20	79,748	17	31,686
Level Fields	3	3.1	0	-	0	-	3	1.8	3	6,801	2	2,250
Build Storage Ponds	1	1.0	1	2.1	0	-	2	1.2	2	1,000	1	100
Ditch Maintenance	0	-	1	2.1	2	7.4	3	1.8	2	850	0	-
Cement Headgates	0	-	1	2.1	0	-	1	0.6	1	200	1	160
Pump Back System	2	2.1	1	2.1	0	-	3	1.8	3	7,981	1	2,500
Concrete Pipe	1	1.0	0	-	0	-	1	0.6	1	1,225	0	-
Mainline & Gravity System	0	-	2	4.2	0	-	2	1.2	2	140,000	2	140,000
Pumps and Wells	45	46.9	12	25.0	11	40.7	68	39.8	68	973,078	26	57,242
Well, Casing & Pump	31	32.3	4	8.3	7	25.9	42	24.6	42	726,400	19	40,200
Other Pumps	10	10.4	2	4.2	3	11.1	15	8.8	15	102,875	4	3,168
Lengthen Well Column	0	-	2	4.2	0	-	2	1.2	2	3,000	1	2,000
Replace/Repair Pumps	3	3.1	2	4.2	1	3.7	6	3.5	6	110,900	0	-
Tractor for Pump	1	1.0	2	4.2	0	-	3	1.8	3	29,903	2	11,874
Miscellaneous	1	1.0	1	2.1	3	11.1	5	2.9	5	24,110	3	5,905
Total Number of Improvements	96	100.0	48	100.0	27	100.0	171	100.0	169	1,554,626	86	343,313
Total Making Improvements	50	71.4	27	62.8	17	44.7	94	62.3				

[1/] Number reporting this improvement.

[2/] Percent of total reported instances.

[3/] Number reporting the cost of this improvement.

[4/] Average cost for those reporting the cost of this improvement.

While wells and pumping equipment were half of the system improvement costs, they accounted for only one-sixth of the assistance funds. Only 5.9 percent of the well and pump costs were covered by assistance, while 39.4 percent of the application system and 57.8 percent of the distribution system costs were covered.

8. Past actions that helped in 1977.

Many farmers had taken actions and made system improvements earlier that helped when drought came in 1977. Table 3.13 indicates that about three out of four farmers recognized the benefits of these past actions. The most frequent response was that management experience gained from previous water short years and good management decisions made in the past were very helpful. The 151 farmers reported a total of 109 physical improvements made in past years that helped. Most prominent were conversion to sprinklers, lining of ditches, leveling of land, and dike and border improvements. Farmers in Blaine and Lincoln Counties cites less physical improvements, and gave less credit to management expertise from earlier droughts than did Ada-Canyon County farmers. Again this suggests that lower valued crops and small irrigation systems with individual diversions prevalent in Blaine and Lincoln Counties make system improvements to mitigate drought less feasible. One might almost say that in Blaine and Lincoln Counties occasional drought is something that must be endured, while in Ada and Canyon Counties there are things that can be done to mitigate the effects of drought.

Table 3.13. Past Actions that Helped Adjustment to 1977 Drought.

	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Counties		
	N	%[1]	% of Total Actions[2]	N	%	% of Total Actions	N	%	% of Total Actions	N	%	% of Total Actions
Nothing	16	22.9	14.7	11	25.6	22.9	13	34.2	27.1	40	26.5	19.5
Experience/Good Management	33	47.1	30.3	13	30.2	27.1	8	21.1	16.7	54	35.8	26.3
Put in Wells	3	4.3	2.8	5	11.6	10.4	2	5.3	4.2	10	6.6	4.9
Put in Sprinklers	5	7.1	4.6	7	16.3	14.6	13	34.2	27.1	25	16.6	12.2
Put in Gated Pipe	3	4.3	2.8	1	2.3	2.1	3	7.9	6.3	7	4.6	3.4
Lined Ditches	27	38.6	24.8	2	4.7	4.2	2	5.3	4.2	31	20.5	15.1
Cleaned Ditches							3	7.9	6.3	3	2.0	1.5
Level/Improve Dikes & Borders/Drain	17	24.3	15.6	5	11.6	10.4	3	7.9	6.3	25	16.6	12.2
Other System Improvements	5	7.1	4.6	2	4.7	4.2	1	2.6	2.1	8	5.3	3.9
Livestock Changes				2	4.7	4.2				2	1.3	1.0
Total Actions	109		100.0	48		100.0	48		100.0	205		100.0

[1] Percent of questionnaires.

[2] Percent of the total reported past actions.

9. Changes in use of labor.

Labor is one of the most important inputs to irrigated agricultural production. Many of the drought response options open to farm managers have implications for labor use. Most procedures to more intensely manage water use require labor to implement. Table 3.14 shows that over half of the 151 farmers reported using more labor than normal for irrigation in 1977. This ranged up to 70 percent of the farmers in Ada and Canyon Counties and down to 39.5 percent of them in Blaine and Lincoln Counties. This response is at first puzzling, considering how hard the drought hit Blaine and Lincoln Counties. Yet the results are plausible since that area made few system changes, but instead diverted water from some crops to others, idled land, and restricted water to some crops so they were not worth harvesting. Most of these actions actually released labor that could be used for what management intensification did occur. Considering the fact that Magic Reservoir was dry by mid-July and many flow rights were cut in Blaine-Lincoln Counties, farmers did not need to put extra labor in to irrigation because they were out of water.

Less than one farmer in six hired extra labor for irrigation--a ratio quite uniform across the three areas. The 151 interviewed farmers reported spending a total of $62,095 for 17,826 hours of extra irrigation labor. This was about 8.6 man-years of extra hired labor that was needed on all surveyed farms to deal with the drought.

A much more common way to meet the extra labor requirements caused by drought was either to utilize more labor from the farm family, or divert some family labor from other tasks into irrigation work. Some 47 of the 151 farmers reported doing both--both using more family labor,

Table 3.14. Inpact of Drought on Labor Requirements

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	amount[2]	#	amount	#	amount	#	amount
Percent Using More Irrigation Labor	49	70.0%	17	39.5%	19	50.0%	85	56.3%
Percent Hiring Extra Irrigation Labor	12	17.1%	6	14.0%	6	15.8%	24	15.9%
Average Extra Hours Hired Labor	10	1235 hrs.	6	686 hrs.	4	340 hrs.	20	891 hrs.
Average Cost of Extra Hired Labor	11	$3983	6	$1847	5	$1440	22	$2823
Percent Using More Family Irrigation Labor	40	57.1%	9	20.9%	12	31.6%	61	40.4%
Average Extra Hours Family Labor	28	483 hrs.	3	533 hrs.	7	373 hrs.	38	467 hrs.
Percent Using Greater Part of Family Labor for Irrigation	36	51.4%	14	32.6%	14	36.8%	64	42.4%
Average Hours Family Labor Switched to Irrigation	24	342 hrs.	10	413 hrs.	8	406 hrs.	42	371 hrs.

[1] Number reporting this item.

[2] Percent/amount/value reported.

and redirecting more family labor into irrigation tasks. In addition 14 farmers responded only that they used more family labor, and 17 responded only that they diverted family labor into irrigation work. The total added family labor requirement reported by the 151 farmers was 16 man years--8.5 supplied by extra family labor and 7.5 supplied by diversion from other tasks.

The total reported labor impact due to drought was 24.6 man years, which comes to just under 2 man months for each surveyed farm. These responses may not give a fully accurate representation of the impact of water shortage on total farm labor needs. The questions asked in the interview dealt only with increased irrigation labor use. Presumably many of those farmers who ran out of water actually used less irrigation labor. Acreage changes and crop abandonment may have resulted in less use of both irrigation and other cultural labor. Both factors suggested that the aggregate impact of drought on labor usage might have been less than what is implied by table 3.14.

Of the increased labor which farmers said they used for irrigation, table 3.15 shows that most of it is used for purposes that might be called more intensive system operation. This includes monitoring the irrigation process more carefully, making shorter sets, moving sprinklers more frequently, etc. When labor was diverted into irrigation work from some other task, the things given up include weed control and cultivation, building and equipment maintenance, care for livestock and, or course, time with family, and recreation (table 3.16).

Table 3.15. Tasks Sacrificed Because of Irrigation Labor Demands

	Ada-Canyon Counties		Baline-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
Weed Control and Cultivation	4	5.7	3	6.9	2	5.2	9	5.9
Building and Equipment Maintenance	6	8.5	5	11.6	3	7.8	14	9.2
Less Time for Livestock	6	8.5	2	4.6	1	2.6	9	5.9
Less Recreation and Family Life	15	21.4	2	4.6	6	15.7	23	15.2
Less Management	2	2.8	0	-	0	-	2	1.3
Total Tasks Reported	33	-	12	-	12	-	57	-

[1] Number reporting this item.

[2] Percent of questionnaires.

Table 3.16. Tasks Done with Extra Labor

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
More Intensive Water Mgt./System Operation	67	95.7	18	41.8	16	42.1	101	66.8
Maintain/Modify Existing System	7	10.0	0	-	4	10.5	11	7.2
Weed Control in Ditch	3	4.2	0	-	0	-	3	1.9
Total Tasks Reported	77	-	18	-	20	-	115	-

[1] Number reporting this item.

[2] Percent of questionnaires.

10. Other input reductions.

When crops get less water, they cannot make good use of as much fertilizer as might be applied when unlimited water is available. High fertilizer application rates may even burn crops and reduce yields if water is restricted. So farmers who anticipate drought could be expected to reduce fertilizer application for crops that might face water restrictions. Similar cutbacks in other inputs such as pesticides and herbicides would also be possible.

Table 3.17 shows that one-third of the interviewed farmers reported making such input reductions. The percentage rose to 69.8 percent in Blaine and Lincoln Counties, but was far lower in the other two regions. Cutbacks in fertilizer use dominated other input reductions both in frequency and dollar value. The 151 farmers reported a $137,052 total reduction in fertilizer use, but only a $2,658 total reduction in pesticide and herbicide use. The extent of cutbacks of fertilizer use in Blaine and Lincoln Counties confirms that farmers there expected drought to critically restrict water to crops, while farmers in other areas expected various mitigation measures to provide nearly adequate water to most crops justifying full fertilizer use in many cases.

Table 3.18 shows which crops were affected by input reductions. The hay, pasture, and barley crops were most impacted, mainly because these were the dominant crops grown in the area where the reductions took place.

B. Results of Actions Taken by Farmers in Response to Drought.

The last section has described some of the decisions made by farmers attempting to cope with drought during the 1977 irrigation season. They

Table 3.17. Reduced Use of Fertilizer and Other Inputs

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	ave $[1]	#	ave $	#	ave $	#	ave $
Nitrogen	10	1125	9	1771	5	262	24	1272
Phosphorous			4	2090			4	2090
Fertilizer	12	2141	30	2398	2	350	44	2231
Pesticides	1	144	1	120			2	132
Herbicides	3	583	4	162			7	342
Total Instances	26		48		7		81	
Number Reporting	16	22.9%	30	69.8%	5	13.2%	51	33.8%

[1] Average for those reporting cost reduction.

Table 3.18. Crops for Which Inputs were Reduced

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1]	#	%	#	%	#	%
All Crops	4	15.4	12	25.0			16	19.8
Hay/Pasture/ Green Chop	4	15.4	14	29.2			18	22.2
Wheat			2	4.2	2	28.6	4	4.9
Barley	2	7.7	15	31.3	3	42.9	20	24.7
Other Grain	3	11.5	3	6.3			6	7.4
Corn Silage	8	30.8	2	4.2			10	12.3
Others	5	19.2			2	28.6	7	8.6
Total Instances	26	100.0	48	100.0	7	100.0	81	100.0

[1] Percent of total reported instances.

made changes in acreage of some crops, and decisions about how to allocate what water they had among crops, and they made alterations to their irrigation systems and practices which they felt would help them better use the available water. This section shifts to an examination of the consequences of these decisions--primarily the impacts on crop yields and quality and impacts on irrigation labor requirements.

1. Summary of drought impact severity.

Based on responses to a number of questions in the interview each farmer was rated on the severity with which he was impacted by curtailment or cutoff of his water supply. Out of 151 responses, 59 farmers were rated as having experienced moderate to severe impacts (table 3.19). Two-thirds of these were Blaine and Lincoln County farmers and most of the remainder were in Ada and Canyon Counties. A total of 93.0 percent of Blaine-Lincoln County respondents were moderately to severely hurt, but only 24.3 percent of the respondents from Ada and Canyon Counties. In contrast 94.7 percent of Bingham-Bannock County farmers experienced no or slight drought impacts. Clearly the effects of water shortage rested most heavily on the farmers of Blaine and Lincoln Counties.

2. Yield impacts.

The impact of drought on crop production has two components--a shift in crop acreage, and yield changes. Farmers were asked to report, for each crop grown, both the adjusted normal yield (adjusted for any non-drought factors) and the yield actually obtained in 1977. Table 3.20 gives reported normal yields for some of the more important crops grown on surveyed farms. Ada and Canyon County farmers reported the

Table 3.19. Impact of Water Curtailment or Shutoff

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
None	26	37.1	0	-	17	44.7	43	28.5
Slight	27	38.6	3	7.0	19	50.0	49	32.5
Moderate	16	22.9	7	16.3	2	5.3	25	16.6
Severe	1	1.4	33	76.7	0	-	34	22.5
Total	70	100.0	43	100.0	38	100.0	151	100.0

[1/] Percent of questionnaires.

Table 3.20. Reported Normal Yields for Selected Crops, 1977 and 1977, by Region

	Ada-Canyon Counties				Blaine-Lincoln Counties				Bingham-Bannock Counties			
	1977		1978		1977		1978		1977		1978	
	N[1]	Yield[2]	N	Yield	N	Yield	N	Yield	N	Yield	N	Yield
Alfalfa Hay	43	5.965	37	5.885	63	4.394	51	4.185	39	4.609	40	4.754
Irrigated Pasture	32	10.858	27	11.020	43	9.298	29	9.386	20	8.500	18	8.333
Wheat: Spring	4	90.00	5	99.60	3	56.67	3	75.83	3	84.33	3	95.83
Unspecified	5	101.00	5	97.74	5	80.80	2	90.00	23	85.09	34	90.32
Feed Barley	34	104.12	29	108.03	17	83.53	27	89.07	18	89.06	18	98.28
Corn Silage	21	26.57	26	25.44	1	19.00	7	16.86	4	22.25	4	21.83
Potatoes	9	373.9	9	381.8	3	308.3	2	356.5	26	252.3	28	266.8
Sugar Beets	14	27.66	13	26.70	-	-	-	-	4	16.63	4	17.25

[1] Number who reported yields for this crop.

[2] Average reported yield for this crop.

highest normal yields for most crops, and Blaine and Lincoln County farmers usually reported the lowest. Presumably the frequency of drought is factored into what Blaine and Lincoln County farmers consider to be "normal" yields. The relatively high yields reported for potatoes in that area suggests that even if water is short, enough can be found to meet the needs of the seed potato acreage grown in that area. The higher normal yields reported for Ada-Canyon County farms stem largely from better soils and a more favorable climate.

For comparison, reported normal yields for 1978 are also shown. For the post-drought year acreage shifts meant that crops were being grown on different lands with different yield capabilities. The shift in expected yields between the two years probably results from this.

Table 3.21 shows actual 1977 yields as percentages of adjusted normal yields. The 151 farmers reported a total of 671 different crop/yield estimates, for an average yield that was 83.3 percent of adjusted normal. Drought, for the surveyed farmers, reduced yields by 16.7 percent. Both the Ada-Canyon and Bingham-Bannock interview areas managed to get yields averaging only 10 percent below normal--evidence both of the success of drought mitigating measures and the security of senior upstream water rights and well developed storage and distribution systems. In contrast, Blaine and Lincoln County farmers reported yields averaging 38.2 percent below adjusted normal. The severity of the water shortage and lack of suitable mitigating measures found expression in sharp yield declines.

The estimates of yield reduction by crop provide an interesting perspective on the impacts of drought on irrigated agriculture. In severely affected Blaine and Lincoln County, irrigated pasture was most

Table 3.21. Irrigated Crop Yields in 1977 as Percent of Normal

	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Areas		
	#[1]	% Yield[2]	Acres[3]	#	% Yield	Acres	#	% Yield	Acres	#	% Yield	Acres
Hay:												
Alfalfa	43	86.3	2,335	62	66.6	7,003	39	90.6	4,717	145	79.0	14,055
Other	4	92.5	101	4	73.3	165	2	90.9	112	10	84.5	378
Irrigated Pasture	32	83.8	1,412	44	44.3	6,033	20	85.2	1,057	95	66.0	8,502
Green Chop	3	77.8	18	3	64.4	91	-	-	-	6	71.1	109
Wheat:												
Spring	4	83.3	310	2	68.3	51	3	95.6	680	10	84.1	41
Dryland Variety	-	-	-	2	90.0	63	-	-	-	2	90.0	63
Unspecified	5	89.8	258	5	73.3	275	23	88.1	3,656	33	86.1	4,189
Barley:												
Feed	32	90.3	3,469	16	63.7	1,258	18	87.3	1,151	66	83.0	5,878
Malting	2	91.2	136	-	-	-	3	87.0	650	5	88.7	786
Dryland Variety	2	94.1	50	8	72.7	605	-	-	-	10	76.9	655
Oats	8	87.3	233	4	49.0	399	5	95.0	168	17	80.5	800
Rye:												
Irrigated	1	100.0	44	-	-	-	-	-	-	1	100.0	44
Dryland Variety	-	-	-	1	45.0	60	-	-	-	1	45.0	60
Mixed Grain	3	86.7	115	5	61.5	169	1	97.9	68	9	73.9	352
Corn:												
Grain	5	92.5	201	-	-	-	-	-	-	5	92.5	201
Early Grain	1	94.4	35	1	100.0	15	-	-	-	2	97.2	50
Silage	20	87.9	971	1	63.2	12	4	95.5	105	25	89.1	1,088
Early Silage	15	89.9	859	2	77.8	60	-	-	-	17	88.5	919
Seed:												
Barley	3	100.5	83	-	-	-	1	100.0	17	4	100.3	100
Wheat	1	93.5	42	1	82.3	11	-	-	-	2	87.9	53
Oats	1	100.0	18	-	-	-	-	-	-	1	100.0	18
Alfalfa	14	83.0	1,113	-	-	-	-	-	-	14	83.0	1,113
Clover	1	100.0	8	-	-	-	-	-	-	1	100.0	8
Corn	7	101.7	351	-	-	-	-	-	-	7	101.7	351
Lettuce	2	125.0	46	-	-	-	-	-	-	2	125.0	46
Onion	3	100.0	84	-	-	-	-	-	-	3	100.0	84
Pea	1	100.0	18	-	-	-	-	-	-	1	100.0	18
Bean	5	84.7	214	-	-	-	-	-	-	5	84.7	214
Vegetables:												
Green Beans	3	103.6	48	-	-	-	-	-	-	3	103.6	48
Other Beans	2	92.9	145	-	-	-	-	-	-	2	92.9	145
Dry Beans	3	85.5	700	1	100.0	80	1	59.6	30	5	82.4	810
Greens, Spinach	2	108.3	64	-	-	-	-	-	-	1	108.3	64
Sweet Corn	9	86.7	327	-	-	-	-	-	-	9	86.7	372
Dry Peas	3	80.0	140	-	-	-	-	-	-	3	80.0	140
Onions	3	93.3	130	-	-	-	-	-	-	3	93.3	130
Potatoes	9	97.8	941	3	97.0	95	26	94.1	3,657	38	95.2	4,693
Sugar Beets	14	95.2	1,221	-	-	-	4	80.6	535	18	92.0	1,756
Tree Fruits	29	100.1	1,944	-	-	-	-	-	-	29	100.1	1,944
Strawberries	-	-	25	-	-	-	-	-	-	-	-	25
Hops	10	97.0	1,963	-	-	-	-	-	-	10	97.0	1,963
Mint	46	90.5	3,988	-	-	-	-	-	-	46	90.5	3,988
Total Harvested Acres	353	90.7	24,192	165	61.8	16,445	153	89.5	16,808	671	83.3	57,445

[1] Number reporting yield for this crop.

[2] Reported yeilds as a percent of reported normal yields averaged across respondents.

[3] Total reported acreage of this crop.

severely impacted, with estimated yields averaging only 44.3 percent of normal. This agrees with earlier results which showed water being diverted away from pasture. Hay yields held up somewhat better, as expected, since hay crops received some of the diverted water. Wheat yields were not hurt as much as other small grains such as barley, oats, and rye which also lost water. The few potatoes grown on surveyed Blaine-Lincoln County farms had almost normal yields. In Ada and Canyon Counties yields of most seed and vegetable crops, potatoes, sugar beets, hops, mint, and fruits were hurt very little. It was the hay and pasture crops along with barley from which water was diverted, and thus showed the larger yield declines.

The general rule appears to be that low valued crops--those with low marginal returns to water relative to other crops grown in the area--are given less water in a drought and thus suffer yield declines. If a crop has high marginal returns to water--and if it is necessary to a farmer's long run operation such as fruit trees or hay for winter maintenance of livestock--then it gets what water is available and its yields are sustained. In this sense the interviews suggest that farmers are acting very much as economic profit maximizing theory says they should.

3. Crop quality impacts.

For some crops the impact of water shortage on product quality could be almost as important as its impact on yield. Water shortage can reduce nutritional value of forage crops and cut bushel weights of grain crops. It can damage pollination in corn crops, reduce tuber size in potatoes and damage marketability of vegetable crops. All these things would hurt price. Of the 151 surveyed farmers, 45 perceived some crop quality losses

(table 3.22). In Blaine and Lincoln Counties quality problems centered on hay, pasture, and barley. In Ada and Canyon Counties, barley along with various corn crops accounted for most of the quality problems. Potato quality seemed to be a problem only in Bingham and Bannock Counties.

4. Carryover of yield effects into 1978 crop year.

One might expect that residual effects of a drought as severe as that in 1977 might carry over into subsequent years. Reservoirs might not completely fill, soil moisture might not be fully replenished, stream and aquifer conditions might be slow in returning to normal, crop rotations could have been disrupted, and stands of perennial crops could have been damaged. Table 3.23 shows that the residual effect was actually very small. For all 151 farmers, 1978 yields averaged 98.3 percent of adjusted normal yields. Only Blaine and Lincoln Counties reported significantly lowered yields--6.9 percent below adjusted normal. Much of the problem in that area appears to be due to damaged stands of hay and pasture. The other two areas showed a remarkable recovery just one year after quite a severe drought.

5. Gross crop income losses due to drought.

Chapter 4 will examine in detail the economic impact of the 1977 drought on study area farmers. In this section we will take only a cursory look at one aspect of this economic impact--farmers estimates of the effect of water shortage on their gross incomes from crops.

Of the 151 farmers interviewed, 69.5 percent reported a loss of gross income, but only 30.5 percent (46 farmers) reported the amount

Table 3.22. Crop Quality Impacts of Drought in 1977

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
Hay: Alfalfa	2	9.5	13	38.2	1	7.7	16	23.5
Other	1	4.8	1	2.9	1	7.7	3	4.4
Irrigated Pasture	-	-	7	20.6	1	7.7	8	11.8
Dryland Pasture	-	-	1	2.9	-	-	1	1.4
Wheat: Spring	-	-	1	2.9	-	-	1	1.5
Unspecified	1	4.8	1	2.9	4	30.8	6	8.0
Barley: Feed	3	14.3	7	20.6	2	15.4	12	17.6
Oats	1	4.8	2	5.9	-	-	3	4.4
Dryland Rye	-	-	1	2.9	-	-	1	1.5
Mixed Grain	-	-	1	2.9	-	-	1	1.5
Corn: Silage	7	33.3	-	-	-	-	7	10.3
Seed	1	4.8	-	-	-	-	1	1.5
Sweet Corn	2	9.5	-	-	-	-	2	2.9
Potatoes	1	4.8	-	-	4	30.8	5	7.4
Sugar Beets	1	4.8	-	-	-	-	1	1.5
Mint	1	4.8	-	-	-	-	1	1.5
Total Inspected Cases	21	100.0	35	100.0	13	100.0	68	100.0
Total Farms Impacted	17	24.3[3]	18	41.9	10	26.3	45	29.8

[1] Number reporting quality impacts.

[2] Percent of cases where quality was impacted.

[3] Percent of questionnaires.

Table 3.23. Crop Yields in 1978 as a Percent of Normal

	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Areas		
	#[1]	% Yield[2]	Acres[3]	#	% Yield	Acres	#	% Yield	Acres	#	% Yield	Acres
Hay:												
Alfalfa	37	100.1	2,035	57	95.2	6,611	40	99.4	4,486	134	97.8	13,182
Other	-	-	-	7	100.0	782	3	100.0	90	10	100.0	872
Irrigated Pasture	38	100.0	1,130	40	91.5	5,953	19	99.7	1,042	87	96.1	8,125
Green Chop	-	-	-	1	100.0	26	-	-	-	1	100.0	26
Wheat:												
Spring	5	100.0	260	3	82.4	118	3	100.0	290	11	95.2	668
Unspecified	5	100.0	223	3	100.0	170	34	99.5	4,418	42	99.6	4,811
Barley:												
Feed	30	100.1	3,412	31	94.1	2,741	17	100.0	870	78	97.7	7,016
Malting	-	-	-	-	-	-	3	100.0	850	3	100.0	850
Oats	5	100.0	210	7	91.7	483	5	100.0	165	17	96.6	858
Irrigated Rye	1	100.0	16	-	-	-	-	-	-	1	100.0	16
Mixed Grain	7	100.0	209	12	99.3	459	4	100.0	878	23	99.6	1,546
Corn:												
Grain	19	100.0	819	-	-	-	-	-	-	19	100.0	819
Silage	26	96.7	1,732	10	88.4	297	4	100.0	119	40	95.0	2,148
Seed:												
Barley	1	100.0	35	-	-	-	-	-	-	1	100.0	35
Wheat	1	100.0	16	-	-	-	1	100.0	98	2	100.0	114
Alfalfa	11	100.0	991	-	-	-	-	-	-	11	100.0	991
Clover	1	100.0	20	-	-	-	-	-	-	1	100.0	20
Corn	7	98.6	326	-	-	-	-	-	-	7	98.6	326
Lettuce	2	100.0	75	-	-	-	-	-	-	2	100.0	75
Onion	1	100.0	74	-	-	-	-	-	-	1	100.0	74
Bean	4	100.0	143	-	-	-	-	-	-	4	100.0	143
Sunflower	-	-	-	1	60.0	10	-	-	-	1	60.0	10
Sorghum & Milo	2	100.0	30	1	100.0	8	-	-	-	3	100.0	38
Soybeans	2	100.0	52	-	-	-	-	-	-	2	100.0	52
Vegetables:												
Green Beans	1	100.0	32	-	-	-	-	-	-	1	100.0	32
Other Beans	6	100.0	247	-	-	-	-	-	-	6	100.0	247
Dry Beans	13	100.0	1,006	3	100.0	223	2	100.0	55	18	100.0	1,284
Sweet Corn	7	100.0	638	-	-	-	-	-	-	7	100.0	638
Dry Peas	1	100.0	57	-	-	-	1	100.0	80	2	100.0	137
Onions	3	100.0	150	-	-	-	-	-	-	3	100.0	150
Potatoes	9	100.0	990	3	100.0	200	28	100.0	3,598	39	100.0	4,748
Sugar Beets	13	100.0	1,258	-	-	-	4	100.0	430	17	100.0	1,688
Tree Fruits	29	100.7	2,079	-	-	-	-	-	-	29	100.0	2,079
Strawberries	-	-	30	-	-	-	-	-	-	-	-	30
Hops	11	100.0	2,148	-	-	-	-	-	-	11	100.0	2,148
Mint	45	98.9	3,822	-	-	-	-	-	-	45	98.9	3,822
Total Harvested Acres	333	99.8	24,315	180	94.1	18,081	168	99.7	17,462	691	98.3	60,458

[1] Number reporting yield for this crop.

[2] Reported yields as a percent of reported normal yields averaged across respondents.

[3] Total reported acreage of this crop.

of that loss (table 3.24). These farmers reported a total crop loss of $1,092,886--for an average loss of $23,758 for each of the 46 farmers. When the total reported dollar impact is divided by the total irrigated acreage on surveyed farms, the result is an $18.42 loss of gross income for each irrigated acre.

Over 90 percent of the Blaine and Lincoln County farmers said that they suffered gross income losses in 1977. This is well above the 60.0 percent for Ada-Canyon County and the 63.2 percent for Bingham-Bannock County. The reported per farm losses were highest in Ada and Canyon Counties in spite of the smaller size farms found in this area. Presumably this was partly due to the higher valued crops grown there. Clearly the drought impacts on gross crop income were significant--$13,000 to $30,000 loss per farm for those farms reporting the amount of their loss. Losses per irrigated acre ranged from a high of $22.79 in Ada and Canyon Counties down to $10.68 in Bingham and Bannock Counties.

Several cautions are in order. These are the farmers own estimates of gross crop income losses, and some farmers who had losses declined to estimate the amount of the loss. It will be the task of chapter 5 to try to get a more complete picture, to verify whether these farmer estimates agree with their responses for acreage, yields, prices, and livestock impacts and to compute the impact in instances where the farmer declined to estimate it himself. These results deal only with gross crop income, while farmers presumably focus interest on net income. Savings of over $100,000 from fertilizer, pesticides and herbicides not applied to crops have already been detailed. The idled acreage and crops not harvested imply that other input costs were also saved.

Table 3.24. Reported Gross Income Loss in 1977

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	amount[2]	#	amount	#	amount	#	amount
Number Reporting Lost Gross Revenue	42	60.0%	39	90.7%	24	63.2%	105	69.5%
Number Reproting Value of Loss	19	27.1%	13	30.2%	14	36.8%	46	30.5%
Total Reported Loss	19	$558,760	13	$353,400	14	$180,726	46	$1,092,886
Average Loss per Reporting Farm	19	$29,408	13	$27,184	14	$12,909	46	$23,758
Total Irrigated Acres all Farms	70	24,516	43	17,890	38	16,920	151	59,326
Reported Loss per Irrigated Acre	-	$22.79	-	$19.75	-	$10.68	-	$18.42

[1] Number reporting this item.

[2] Percent/amount/value reported.

The carryover of gross income impacts into 1978 follows the pattern already seen for yield effect carryover. The 1978 impacts shown in table 3.25 are only about one-tenth the per acre gross income impacts claimed for 1977. The main effects on 1978 gross incomes were felt in Blaine and Lincoln Counties, with over half of surveyed farmers there reporting some effect. They reported losses amounting to $3.47 per irrigated acre. For the other two areas apparently the drought impacts did not appreciably extend beyond 1977.

6. Impact of drought on wells.

One would expect drought to have an effect on wells. The large number of new wells drilled and reduced recharge because of lowered precipitation and improved irrigation efficiency should combine to lower water tables. Table 3.26 shows that some well problems were encountered, mostly in Blaine and Lincoln Counties. The number of new wells drilled in Ada and Canyon Counties seems not to have caused problems for existing wells. In Blaine and Lincoln Counties, 5 wells had drawdown problems severe enough to require lengthening the well column or drilling the well deeper.

The drought also had another effect on wells. The moratorium on new electric hookups for irrigation pumps imposed by Idaho Power Company was at least partly motivated by the drought-caused shortage of water at their power generating dams. Of the 151 farmers, 21 said that they were impacted by the moratorium--13 in Ada and Canyon Counties, 7 in Blaine and Lincoln Counties and only 1 in Bingham and Bannock Counties which are primarily served by Utah Power Company. Of these 21 impacted farmers,

Table 3.25. Reported Gross Income Loss in 1978

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1/]	amount[2/]	#	amount	#	amount	#	amount
Number Reporting Lost Gross Revenue	8	.4%	24	55.8%	3	7.9%	35	23.1%
Number Reporting Value of Loss	3	4.3%	6	14.0%	2	5.3%	11	7.3%
Total Reported Loss	3	$36,600	6	$61,500	2	$10,500	11	$108,600
Average Loss per Reporting Farm	3	$12,200	6	$10,250	2	$5,250	11	$9,873
Total Irrigated Acres all Farms	70	24,779	43	17,715	38	17,717	151	60,211
Reported Loss per Irrigated Acre	-	$1.48	-	$3.47	-	$0.59	-	$1.80

[1/] Number reporting this item.

[2/] Percent/amount/value reported.

Table 3.26. Impact of Drought on Irrigation Wells

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	%[2]	#	%	#	%	#	%
Some Impact	2	2.5	3	24.2	2	8.7	12	8.8
Significant Impact	3	3.8	10	30.3	0	-	13	9.6
Number of Wells	80	100.0	33	100.0	23	100.0	136	100.0
Drilled Deeper or Lengthened Well Column	0	-	5	15.2	0	-	5	3.7

[1] Number reporting this impact.

[2] Percent of wells.

4 said the moratorium had prevented them from drilling a well and 10 others responded that they had to use gasoline, diesel, or L.P. gas for powering pumps rather than electricity. The drought-caused fears of electricity shortage clearly limited some farmers options for dealing with the drought.

7. Impacts on livestock enterprises.

Our attention has been focused on the effects of drought on crop production. The sample of farmers was chosen specifically to include only farmers having crops at least partly dependent on surface water sources. But, using that criterion the sample contains many farmers with livestock. On many sample farms the crops are grown primarily as livestock feed. Thus it is worthwhile to examine the impacts of drought on sample farmers livestock operations.

There are three main kinds of impacts that drought may have on a livestock enterprise. First, the feed shortage may mean that hay and other feeds must be purchased, and pasture rented. Second, it is neither practical nor economically rational to entirely replace the feed lost to drought, so livestock production is reduced. The calves and lambs come off pasture at lighter than normal weights, reducing their value when sold. For a dairy operation, feed shortage usually means less milk per cow. Third, if feed is short enough, then some breeding stock must be sold to leave enough feed to overwinter the remainder. When drought ends, breeding stock must be purchased and heifers and replacement ewes held back to return the herd to its normal size.

Table 3.27 shows that all three factors were at work, and were quite

Table 3.27. Effects of Drought on Livestock Enterprises

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	# [1]	Total Loss [2]	#	Total Loss	#	Total Loss	#	Total Loss
Beef								
Light Cattle Loss 77	2	1,560	18	5,998,120	9	843,922	29	6,843,602
Additional Breeding Stock Sold 77	3	370,592	17	526,986	3	483,864	23	1,381,442
Light Cattle Loss 78	0	-	2	393,335	2	1,153,791	4	1,547,126
Additional Breeding Stock Bought 78	1	630	6	109,495	3	37,560	10	147,685
Additional Pasture Cost 77	0	-	7	36,320	2	2,400	9	38,720
Additional Feed Cost 77	4	2,455	15	144,191	6	21,635	25	168,281
Additional Pasture Cost 78	0	-	2	3,100	0	-	2	3,100
Additional Feed Cost 78	0	-	6	38,330	0	-	6	38,330
Sheep								
Light Lamb Loss 77	0	-	3	12,670	0	-	3	12,670
Additional Ewes Sold 77	0	-	1	2,100	0	-	1	2,100
Additional Feed Cost 77	0	-	2	13,780	0	-	2	13,780
Dairy								
Additional Cows Culled 77	2	4,343	7	202,425	0	-	9	206,768
Additional Cows Purchased 78	1	1,500	3	39,700	0	-	9	41,200
Additional Pasture Cost 77	0	-	1	1,100	0	-	1	1,100
Additional Feed Cost 77	7	65,260	13	163,501	2	2,600	22	231,361
Additional Feed Cost 78	0	-	2	19,330	0	-	2	19,330

[1] Number reporting loss for this item.

[2] Total value of loss for those reporting.

large, during the drought year of 1977 and the recovery year that followed. The reliance of Blaine and Lincoln County farmers on livestock is evident in the size of the losses they experienced. While they made large purchases of feed, they still sold calves at light weights and had to make large adjustments to breeding stock numbers. There was simply not enough feed available for purchase to replace that lost to drought. The low value of cattle at this time coupled with several previous years of poor prices, meant that additional cash expenditures were not warrented.

8. Assistance from drought aid programs.

During the 1977 crop year farmers had access to a number of aid programs. Some of these programs are permanent features, but proved a useful vehicle for drought assistance. Other programs have been created especially to deal with natural disasters such as drought. Some of the aid programs were noted earlier in connection with drought motivated improvements in irrigation system. Grants or loans to help pay for these system improvements comprised a large part of what drought aid was given (table 3.28). Other types of aid including the feed grains and wheat disaster payments and the emergency feed program are in essence compensation to a farmer for part of his crop losses. Aid may also take the form of a new loan or an extended payment schedule on an old loan to enable a farmer to survive a drought caused cash flow problem.

C. Farmers Perceptions of Drought and Drought Related Institutions.

This section will address topics that are somewhat more subjective

than the actions taken by farmers in response to drought, and the results of those actions. The water shortage did however affect people's perceptions of drought and the institutions that are supposed to help farmers adjust to drought. Drought should bring into clearer focus both the purpose and the performance of many agencies.

1. Perceptions of drought.

It is difficult even to get concensus on the meaning of the word drought. The existence of drought depends on the timing and location of precipitation and on the existence of storage and conveyance systems to manage the water. Thus even in a water short year like 1977, not all farmers agreed that it was a drought year (table 3.29). Some 8.6 percent of farmers, all in the Ada-Canyon and Bingham-Bannock interview areas denied that it was a drought year. Presumably these were farmers with very senior water rights and adequate storage water. Probably some of them relied heavily on groundwater. The only unanimity was in Blaine and Lincoln Counties where all 38 interviewed farmers agreed that 1977 met the requirements to be called a drought.

The frequency of expected drought is one factor that could affect a farmer's reponse to drought. If he encounters a dry year, but expects future droughts to be rare, he may make few adjustments, preferring to wait it out. In contrast, when frequent future droughts are expected, then any capital intensive improvements can be ammortized over many future dry years. Likewise if frequent droughts are expected, then many farmers will have already adopted management practices and technologies for mitigating the effects of water shortage.

Table 3.28. Assistance to Farmers from Drought Aid Programs

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#[1]	Total $ [2]	#	Total $	#	Total $	#	Total $
Sought Aid from ASCS	26	-	35	-	15	-	86	-
Received Aid from ASCS								
Conservation Program	30	70,940	32	64,200	11	20,500	73	162,380
Wheat Disaster Program	0		3	4,988	0		3	4,988
Feed Grain Disaster Program	0		13	53,398	2	2,100	15	55,498
Emergency Feed Program	0		9	27,396	0		9	27,396
Sought Aid from ASCS	1	-	3	-	2	-	11	-
Number and Total of Loans								
Major Adjustment to Real Estate Loan	0		4	97,000	1	20,000	5	117,000
Drought Loan	0		2	19,400	1	20,000	3	39,400
Sought Aid from SBA	1	-	3	-	0	-	3	-
Number and Total of Loans	0		1	32,000	0		1	32,000
PCA Loans	0		4	48,500	0		4	48,500
Commercial Bank Loans	1	30,000	4	65,346	0		5	65,346
Bureau of Reclamation Aid	0		4	104,731	0		4	104,731
Other	0		2	6,500	0		2	6,500
Total Farmers Receiving Assistance	30	100,940	33	523,459	11	62,600	74	686,999

[1] Number reporting.

[2] Total value of assistance.

Table 3.29. Did You Feel 1977 Was a Drought Year?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	62	88.6	43	100.0	33	86.8	138	91.4
No	8	11.4	0	-	5	13.2	13	8.6
Total Responses	70	100.0	43	100.0	38	100.0	151	100.0

[1/] Percent of questionnaires.

When farmers were asked about the expected frequency of drought in their area (What is the probability of drought next year?), the regional patterns were very obvious (table 3.30). Nearly 8 out of 10 Blaine and Lincoln County farmers gave a probability between 10 and 25 percent or answers such as "good chance." In contrast nearly half of Ada-Canyon County farmers estimated the probability as 0 to 5 percent or responses such as "no chance" or "not much chance." Bingham-Bannock County farmers were intermediate between the two extremes. It seems clear that a higher probability of drought is perceived by Blaine and Lincoln County farmers and is presumably factored into their decision making. The other two areas are more insulated from the impact of water shortage by their better developed water storage and distribution systems.

A similar picture emerged when farmers were asked to rank six crop hazards (hail, insects, drought, frost, disease, and wind) according to severity for their operation (1 for most severe, 6 for least severe). The average rankings are given in table 3.31. Across the entire sample, the hazard with the lowest average rank (meaning greatest severity) was insects, followed closely by frost, with drought a distant third in importance. Drought was rated the principal hazard only in Blaine and Lincoln Counties, but was relegated to fourth place in Bingham and Bannock Counties and tied for last in Ada and Canyon Counties. It is clear that farmers in the latter two areas face a range of crop growing hazards that are perceived as much more important than drought, and thus likely to get more weight in management and facilities decisions.

Table 3.30. What Do You Think Are the Chances of a Drought Next Year?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Not Much Chance/5 Percent/No Chance	32	45.7	6	14.0	14	36.8	52	34.4
10 to Over 25 Percent/Good Chance	25	35.7	34	79.1	24	63.2	83	55.0
Don't Know/No Answer	13	18.6	3	7.0	0	-	16	10.6
Total Responses	70	100.0	43	100.0	38	100.0	151	100.0

[1/] Percent of questionnaires.

Table 3.31. Ranking of Hazards Causing Crop Loss

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	average rank 1/	order 2/	average rank	order	average rank	order	average rank	order
Hail	3.91	4	4.63	5	4.43	6	4.24	6
Insects	2.38	1	3.08	3	2.86	2	2.70	1
Drought	4.10	5	1.93	1	4.14	4	3.50	3
Frost	3.24	2	2.29	2	2.19	1	2.71	2
Disease	3.27	3	5.01	6	4.30	5	4.02	5
Wind	4.10	5	4.04	4	3.08	2	3.83	4

1/ A lower average rank implies greater importance as a cause of crop loss.

2/ Rank ordering of hazards.

2. Sources of information.

During a period of water shortage farmers must have good information in order to make good management decisions. The necessary information includes:

- the severity of the drought and the likelihood and timing of water supply cutoffs,
- guidance on management options and strategies for mitigating the effects of drought,
- and information about what assistance programs are available and what eligibility criteria are imposed.

Table 3.32 lists 12 information sources that were accessible to farmers. The sources appear in ranked order according to the number of operators who said they used the source and found the information obtained to be useful. While the results may have been colored by the two years of elapsed time between the drought and the survey, they indicate that proximity was very important in an information source. Farmers found most useful those sources with which they had almost daily contact; the ditchrider, the media, the water master, and other farmers. The least useful information source--the drought task force--was of course not really intended as a vehicle for information dissemination, but primarily as a group to enhance communication and coordination among the various agencies dealing with the drought.

3. Agency performance.

The summer of 1977 was a critical test of how well various agencies and institutions could perform during a drought. The Idaho governmental

Table 3.32. Usefulness of Various Sources of Drought Information

	Source Used		Source Was Somewhat/Very Useful		Source Was Not Useful		No Answer on Usefulness	
	#	%[1/]	#	%	#	%	#	%
Ditch Rider	98	64.9	79	80.6	14	14.3	5	5.1
Media	120	79.4	76	63.3	35	29.2	9	7.5
Water Master	78	51.6	66	84.6	9	11.5	3	3.8
Other Farmers	83	54.9	63	75.9	19	22.9	1	1.2
ASCS	80	52.9	63	78.7	10	12.5	7	8.7
SCS	64	42.3	54	84.3	7	10.9	3	4.6
County Extension Agent	47	31.1	38	80.8	5	10.6	4	8.5
IDWR	44	29.1	31	70.4	11	25.0	2	4.5
Bureau of Reclamation	34	22.5	22	64.7	8	23.5	4	11.7
USGS	17	11.2	10	58.8	6	35.3	1	5 8
ARS	12	7.9	6	50.0	5	41.7	1	8.3
Drought Task Force	8	5.2	5	62.5	3	37.5	0	-

[1/] Percent of questionnaires.

agency with the greatest role to play was the Idaho Department of Water Resources (IDWR). Farmers were asked what IDWR did to help in 1977. Their responses are summarized in table 3.33. Nearly one-third of the 151 farmers said that IDWR did nothing to help. Nearly one fourth were not even sure what role IDWR was supposed to play. A large number of farmers correctly characterized the IDWR role as coordination and dissemination of information and advice, and monitoring and controlling water use. However, the answers suggested that some farmers overrated IDWR's role in monitoring and controlling water use. The monitor/control function is primarily vested in the water delivery organizations. IDWR's main control activity is its role in granting water rights and permits for wells. It also has a role in resolving water use conflicts. Its monitoring function is mainly focused on the big picture and long range planning rather than the micro concerns that become important during drought. People's confusion is further revealed in the response that IDWR provided drought aid--which it in fact did not do. There were 8 farmers who actually felt that IDWR made a negative contribution to the 1977 drought situation. Given the complexity of water administration it is not surprising that there would be some general antipathy, and some confusion over agency roles.

A second question, which asked what IDWR should do differently in the future is summarized in table 3.34. About one-quarter of those interviewed saw no need for any changes. Many others saw room for change, especially in the monitor/control area and the information dissemination functions. Presumably those who thought IDWR had a detrimental effect chose this opportunity to suggest that IDWR should keep out of it in

Table 3.33. What Did IDWR Do to Help in 1977?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Coordinate and Disseminate Information and Advice	21	30.0	5	11.6	14	36.8	40	26.4
Monitor and Control Water Use	21	30.0	8	18.6	5	13.1	34	22.5
Gave Aid	5	7.1	2	4.6	1	2.6	8	5.2
Had Negative Effect	6	8.5	1	2.3	1	2.6	8	5.2
Nothing	18	25.7	17	39.5	13	34.2	48	31.7
Not Sure	18	25.7	9	20.9	9	23.6	36	23.8
Other	1	1.4	1	2.3	1	2.6	3	1.9
Total Items Mentioned	90	-	43	-	44	-	177	-

[1/] Percent of questionnaires.

Table 3.34. Do You Think IDWR Should Do Anything Different in the Future?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
No, Don't Do Anything Different	24	34.2	8	18.6	8	21.0	40	26.4
Yes, No Recommendations Given	11	1.4	0	-	2	5.2	3	1.9
Monitor and Control Water Better	19	27.1	11	25.5	5	13.1	35	23.1
Stay Out of It	1	1.4	3	6.9	3	7.8	7	4.6
Get More Accurate Information to Farmers	3	4.2	2	4.6	3	7.8	8	5.2
Don't Know/Not Sure of IDWR Function	14	20.0	4	9.3	3	7.8	21	13.9
Other	10	14.2	8	18.6	9	23.6	27	17.8
Total Items Mentioned	72	-	36	-	33	-	141	-

[1/] Percent of questionnaires.

any future drought. The role confusion still comes through, with 21 farmers saying "don't know" or indicating that they were "not sure" of IDWR's role. In addition a number of farmers suggested water use control options that go well beyond the current authorized role of IDWR.

Some federal agencies probably had at least as large a role during the drought as did IDWR. Farmers were asked if Federal agencies should do things differently in the future. Their responses are tabulated in table 3.35. Many farmers responded only in terms of Federal agencies in general, without specifying which agency. Of 151 farmers, 29 responded that Federal Agencies did a good job and that nothing different was required. One hundred seventeen farmers made either criticisms or suggestions of how these agency programs should be changed. Because of the diversity of these responses they are very difficult to summarize, so a compilation of these responses is included as Appendix A. The appendix also lists a number of suggestions made about specific agencies.

The interviewed farmers were apparently much more satisfied with the management of their water delivery organizations. Over 84 percent of them expressed this satisfaction and only 12 farmers were clearly dissatisfied (table 3.36). Again, when farmers were asked to comment on the reasons for their satisfaction or dissatisfaction with the operation of their water delivery organization, the responses were diverse and difficult to categorize. These responses are tabulated in Appendix B.

When farmers were asked what practical improvements could be made to their water delivery systems, over 40 percent responded that none of the possible improvements were practical (table 3.37). There were a number of suggestions for system modifications, including lining of

Table 3.35. Do You Think Federal Agencies Should Do Anything Different in the Future?

	Did a Good Job		Gave a Criticism or Suggested Change	
	#	%[1/]	#	%
Federal Agencies in General	29	19.2	117	77.4
Extension Agent	1	0.6	0	-
ASCS	5	3.3	28	18.5
SCS	2	1.3	3	1.9
Bureau of Reclamation	1	0.6	9	5.9
FHA	0	-	4	2.6
Corps of Engineers	0	-	5	3.3

[1/] Percent of questionnaires.

Table 3.36. Were You Satisfied with the Management of Your Delivery System?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	62	88.5	33	76.7	32	84.2	127	84.1
No	4	5.7	3	6.9	5	13.1	12	7.9
Not Applicable/ No Answer	4	5.7	7	16.2	1	2.6	12	7.9

[1/] Percent of questionnaires.

Table 3.37. What Practical Improvements Could Be Made to Your Delivery System?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
None Practical	29	41.4	12	27.9	21	55.2	62	41.0
More Maintenance	11	15.7	2	4.6	5	13.1	18	11.9
Line Ditch	14	20.0	6	13.9	0	-	20	13.2
More or Better Monitoring Devices	4	5.7	5	11.6	2	5.2	11	7.2
Better Management or Ditchrider	6	8.5	4	9.3	6	15.7	16	10.5
Other	15	21.4	10	23.2	7	18.4	32	21.1
Total Items	79	-	39	-	41	-	159	-

[1/] Percent of questionnaires.

ditches, and suggestions that better maintenance would help.

Idaho's sharply independent, anti-bureaucratic spirit shows up in the severity of some of the criticisms of Federal agencies. Conversely, farmers proximity to water delivery organization, and sense of participation in running them seems to result in greater satisfaction. Or, perhaps this proximity results in greater sympathy for the limits to what a water delivery organization can do, compared to inflated expectations and disillusionment with the performance of the more distant Federal agencies.

4. Performance of other water institutions.

The interviews shed some light on the perceived performance of two other water institutions; the appropriation doctrine and the Water Bank Act. When farmers were asked if the appropriation doctrine had worked adequately during the drought, three-quarters of them answered yes (table 3.38). Only 10 farmers actively disagreed, while 27 either chose not to answer or didn't understand the appropriation doctrine well enough to answer. Any regional differences are hardly significant. Farmers were asked to suggest changes in the appropriation doctrine which would improve its operation. Nearly half of those who responded to this question answered (contrary to the intent of the question) that the appropriation doctrine had worked well and should not be altered. Only 17 farmers had significant suggestions for things that could or should be changed. These responses are tabulated in Appendix C. Most of these comments were suggested changes in the basis for allocating water--presumably changes that the respondent thought would be more equitable than the pure application of the appropriation

Table 3.38. Did the Appropriation Doctrine Function Effectively During the Drought?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	50	71.4	34	79.0	30	78.9	114	75.4
No	7	10.0	1	2.3	2	5.2	10	6.6
Don't Know/ No Answer	13	18.5	8	18.6	6	15.7	27	17.8

[1/] Percent of questionnaires.

doctrine.

Clearly the appropriation doctrine is deeply entrenched in Idaho society and its economy and enjoys wide popular support in spite of some obvious inflexibilities, inefficiencies, and inequities in its results. Any proposals for institutional change to mitigate drought must start from that realization.

The Water Bank Act, adopted in 1979, the same year as the interviews were conducted, was an attempt to operate within the appropriation doctrine, but to achieve more flexibility in water distribution by encouraging markets for unneeded water, bringing together willing buyers and sellers. Its operation was described more fully in Chapter 2. Farmers were asked if they were familiar with the Water Bank Act. Table 3.39 shows that only one in seven answered yes. It is not obvious whether this low level of awareness was due to the recency of passage of the Act, or to lack of urgency of the issue since water was abundant in 1979 when the survey was conducted. At any rate, awareness would need to be increased before such a program could be at all successful.

After the terms of the Water Bank Act were explained to farmers, they were asked whether such a program would be useful in a future drought. Over half of those farmers interviewed said yes (table 3.40). However, Blaine and Lincoln County farmers were the most skeptical about the program. When asked for reasons, farmers from that region overwhelmingly answered that no water was available for transfer in their area (Appendix D). Perhaps the most revealing reason, encountered in 5 different interviews, was the statement that the Water Bank Act would only legitimize what was already taking place within the jurisdiction of the water delivery

Table 3.39. Are You Aware of the Water Bank Act?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	7	10.0	8	18.6	6	15.7	21	13.9
No	61	87.1	32	74.4	30	78.9	123	81.4
No Answer	2	2.8	3	6.9	2	5.2	7	4.6

[1/] Percent of questionnaires.

Table 3.40. Do You Think Water Bank Act Would Be Useful During a Drought?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Yes	38	54.2	12	27.9	26	68.4	76	50.3
No	15	21.4	13	30.2	9	23.6	37	24.5
Not Sure	6	8.4	10	23.2	1	2.6	17	11.2
No Answer	11	15.7	8	18.6	2	5.2	21	13.9

[1/] Percent of questionnaires.

organizations. A study of IDWR has adequately documented that transfers do take place with some frequency.[113/] These transfers are both formal and informal, and occurred under existing legal structures in the absense of the Water Bank Act. That study pointed to a lack of knowledge of transfer opportunities and legal ramifications as an impediment to wider use of water transfers. Perhaps the Water Bank Act can perform a useful service in publicizing the transfer option. However, given the lack of knowledge about the effects of transfer on downstream users dependent on runoff or recharge as a water source, perhaps it is fortunate that transfer is not too frequent and water rights are jealously guarded.

5. Knowledge of water rights.

When the questionnaires were coded, each was subjectively rated according to the respondent's apparent degree of knowledge about water rights. A very strong pattern emerges where Blaine and Lincoln County farmers were rated as quite well informed and Bingham-Bannock County farmers were much less informed. Presumably it is not coincidence that this is exactly the reverse order of the severity of the 1977 drought. There is nothing like a drought to teach farmers the impacts of water shortage, and to cause farmers to inquire about the security of their own water rights. Part of the reason why Blaine and Lincoln County farmers were much better informed is their much greater reliance on individual water rights rather than group, district, or canal company structures. Individual rights require individual vigilance to maintain, and that promotes knowledge.

D. Probable Farmer Behavior in a Future Drought.

It is an objective of this study to predict farmer behavior in the event of a future severe drought. Certainly what farmers did in 1977 gives some guidance about probable future behavior. In a future drought farmers can be expected to again reduce acreage of those crops which give the lowest marginal returns per unit of water. Water to these lower value crops will also be restricted, causing yield reductions occasionally to the point where the crop is not worth harvesting. The limited crop and variety changes observed in 1977 suggest, however, that cropping patterns are remarkably stable in the face of impending drought. Such changes were more prevalent in the Ada-Canyon County region where farmers have a much wider range of alternative crops to choose from. In hard hit Blaine and Lincoln Counties the greater frequency of drought means that the normal cropping pattern has been selected for good response in spite of drought, so that leaving land idle is often the only other feasible response in extremely water short years.

The yield evidence from 1977 does suggest that some water shortage can be accommodated if farmers intensify their water management, resulting in little yield reduction and few unharvested acres. The inefficiency of water use in normal years, tolerable because of the abundance of water, makes this possible. However a severe water shortage such as that experienced by many Blaine and Lincoln County farmers goes well beyond what improvements in efficiency can handle, reducing yields and causing non-harvest. Overall, the slack in the system means that agricultural output would be expected to fall by much less than the percentage shortfall of water.

In the event of future drought, farmers can be expected to adapt a range of water management strategies. They will irrigate some crops less frequently and/or apply less water per irrigation. However this will depend on such things as soil type, the crop being grown, and the degree to which excess water is normally applied. When one crop is actually sacfificed to provide water for another the recipient crops will tend to be high valued crops such as the perennial crops in Ada and Canyon Counties and the potato crop in Bingham and Bannock Counties or a crop vital to overall farm operation such as the forage crops in Blaine and Lincoln Counties.

Use of carry-over storage water in combatting drought, while important for many farmers, is rarely a variable that the farmer has much control over. Either he has carry-over water or he doesn't, depending on the moisture conditions in previous years and on the existence of a storage reservoir. Rarely is drought predicted far enough in advance so that a farmer can decide to save water this year because he knows he will need it next year. It is possible that some farmers may as a matter of insurance try always to save some carry-over. It is possible that a farmer might try to save some carry-over in one drought year in anticipation that the drought would continue for another year. However the fact that the drought being studied was limited in Idaho mainly to the year 1977, and the limited number of questions asked in the interviews mean that this study sheds no light on such behavior. What is certain is that carry-over storage, for those farmers and regions with access to it, can be very useful in a period of drought.

Farmers with access to irrigation wells can be expected to make

increased use of groundwater during periods of drought. However wells are reasonable alternatives only in some groundwater areas, and not in others. Water law and inflexibility of the physical delivery and application systems can limit the use of groundwater. Shortages of hydroelectricity during drought looms as an even more rigid constraint. In 1977 it was Ada and Canyon County farmers who had access to wells and most increased their use of groundwater. The same would probably be true in a future water shortage.

Water transfer is the most unknown factor. Except for Bureau storage water which went to water delivery organizations as intermediaries, water transfer had a very low profile in the 1977 drought. Whether the Water Bank legislation will change things in a future drought is an open question. It may be that a more formal market for water can facilitate movement of water from low value into high value uses in an area such as the Boise Valley with a wide range of crops and a well developed water delivery system. However water transfer is less likely to be widely practiced in an area such as Blaine and Lincoln County where few high valued perennial crops are grown, and where there is little unallocated storage water available for sale.

In a future drought farmers can be expected to again make irrigation system changes and improvements that enable them to better monitor and control water use. This will include conversion to sprinklers, lining of canals, and drilling of wells in regions where such changes are possible. The pace of such improvements will depend on federal and state policies that encourage or subsidize such changes.

However, 1977 was also a learning experience for many farmers. Many

have made system changes and management adjustments since 1977 that will affect their responses to future drought, and the degree to which they will be hurt by that drought. Presumably the experience of the 1977 irrigation season was a major factor causing farmers to make these changes. Many farmers saw their neighbors adopt strategies that helped mitigate the impacts of drought--strategies that they may want to copy in any future drought. Other farmers feel they learned lessons about overreacting--making changes because of predicted drought, when in fact the water shortage didn't turn out to be that bad.

Several interview questions dealt directly with farmers future plans. Over half of the 151 interviewed farmers (56.3 percent) said they had made changes since the 1977 irrigation season that would lesson the effect of any subsequent drought. Table 3.41 shows that a greater portion (72.1 percent) of Blaine and Lincoln County farmers had made improvements since 1977 than was true of the other two areas. The 107 changes made by 85 farmers include 15 new wells, 22 sprinkler systems, 10 gated pipe systems, 15 ditch lining projects and miscellaneous land leveling/field arrangement changes. Presumably these changes will reduce the impact of any future drought on these farmers. Of course these post 1977 changes, along with the changes made in 1977, mean that a future drought may cause less change--many of the feasible changes have already been made. And, to the extent that many of these measures improve irrigation efficiency by reducing runoff and cutting aquifer recharge from deep percolation and seepage, any future drought may see more severe problems for downstream users and groundwater pumpers.

Farmers were asked two questions regarding their probable response

Table 3.41. Have You Done Anything since 1977 that Would Help Deal with Future Droughts?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
No Changes	37	52.9	12	27.9	17	44.7	66	43.7
Put In Wells	7	10.0	5	11.6	3	7.9	15	9.9
Put In Sprinklers	4	5.7	11	25.6	7	18.4	22	14.6
Added Gated Pipe	6	8.6	4	9.3	0	-	10	6.6
Lined Ditches	7	10.0	6	14.0	2	5.3	15	9.9
Land/Layout Improvements	5	7.1	3	7.0	8	21.1	16	10.6
Other	17	24.3	8	18.6	10	26.3	35	23.2
Total Reported Changes	83	-	50	-	40	-	173	-
Farmers Reporting Changes	33	47.1	31	72.1	21	55.3	85	56.3

[1/] Percent of questionnaires.

to any future drought:

- If you were convinced of an impending drought next year what would you do?
- Would you do some things differently as a result of your 1977 experience?

Because farmers were asked the questions in the order given above, there is some ambiguity in their responses. A few answers to the first question were stated as changes from what was done in 1977, negating the intent of the second question. Because of this, responses to both questions must be considered together.

When farmers were asked what they would do if next year was dry, only 20.6 percent of them said they would do nothing (table 3.42). Another 5.8 percent said they would wait and see how severe it was before taking action or would simply proceed as usual and hope it wasn't too bad. The other three-quarters of the sample farmers adopted a more activist stance--although some refer to changes from normal and others to changes from 1977. Ada and Canyon County and Bingham and Bannock County farmers said they would rely heavily on changes in crop mix and variety--which is just what they did in 1977. Farmers in Blaine and Lincoln County would rely much more heavily on reduction of planted acreage--again agreeing with their actual behavior in 1977. Since Blaine and Lincoln County farmers are limited by climate and economics to only a few crops, and the crops they usually grow are those that do relatively well when water is restricted, their only alternative in the face of severe water shortage is to reduce acreage. Reliance on groundwater to mitigate the impacts of a future drought is mainly a phenomenon of Ada and Canyon County. In

Table 3.42. If You Were Convinced of an Impending Drought Next Year, What Would You Do?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
Nothing	17	24.3	6	14.0	9	23.7	32	20.6
Change Crop Mix/Variety	19	27.1	6	14.0	13	34.2	38	24.5
Plant Less Acres	12	17.1	14	32.6	6	15.8	32	20.6
Dig Well	14	20.0	1	2.3	5	13.2	20	12.9
Activate Existing Well/Pump	12	17.1	2	4.7	2	5.3	16	10.3
Other System Changes	4	5.7	3	7.0	6	15.8	13	8.4
Change Water Management	5	7.1	1	2.3	10	26.3	16	10.3
Buy Water	2	2.9	0	-	0	-	2	1.3
Reduce Livestock	0	-	11	25.6	0	-	11	7.1
Buy/Hold Feed	1	1.4	5	11.6	0	-	6	3.9
Seek Aid	1	1.4	1	2.3	1	2.6	3	1.9
Quit/Sell/Retire	3	4.3	1	2.3	0	-	4	2.6
Wait and See/Hope	4	5.7	2	4.7	3	7.9	9	5.8
Other	4	5.7	3	7.0	1	2.6	8	5.2
Total Activities	98	-	56	-	56	-	210	-

[1/] Percent of questionnaires.

Ada and Canyon County, 37.1 percent of the farmers stated that they would either dig a well or activate an existing groundwater system. This percentage fell to 18.4 percent in Bingham and Bannock Counties and to only 7.0 percent for Blaine and Lincoln Counties. Bingham and Bannock County farmers seem ready to place major reliance on changes in water management. For instance:

- 4 farmers said they would watch carryover storage from the previous year more closely,
- 3 farmers said they would water more in the fall,
- 2 farmers said they would water earlier in the spring, and
- 1 farmer said he would attempt to set up a rotating system with his neighbors.

The importance of the livestock enterprise to Blaine and Lincoln County farmers is again shown by the 25.6 percent who indicated they would reduce livestock numbers in response to drought, and by the 11.6 percent who would adjust their feed buying/selling practices.

Because of the problems alluded to above, the question about what farmers would do differently from 1977 does not give definitive results. Some farmers who were dissatisfied with their 1977 actions had that fact recorded by the previous question rather than this one. Thus the responses to this question are incomplete. Still, over half of the 151 respondents replied no, they would do everything as they had done in 1977 (table 3.43). This response was strongest in Blaine and Lincoln Counties where 62.7 percent would repeat their 1977 behavior should drought recur. However, only 42.1 percent of Bingham and Bannock County farmers endorsed their 1977 behavior. This difference is due in part to the regional differences

Table 3.43. Would You Do Some Things Differently as a Result of Your 1977 Experience?

	Ada-Canyon Counties		Blaine-Lincoln Counties		Bingham-Bannock Counties		All Three Areas	
	#	%[1/]	#	%	#	%	#	%
No, Everything as Before	38	54.3	27	62.7	16	42.1	81	53.6
Change Crop Mix/Variety	9	12.8	0	-	3	7.8	12	7.9
Plant Less Acres	4	5.7	3	6.9	0	-	7	4.6
Make System Changes	5	7.1	3	6.9	3	7.8	11	7.2
Not Make System Changes	3	4.2	0	-	2	5.2	5	3.3
Change Water Management	11	15.7	0	-	4	10.5	15	9.9
Buy/Sell Water	5	7.1	0	-	0	-	5	3.3
Not Buy/Sell Water	1	1.4	0	-	0	-	1	0.6
Alter Crop Cultural Practices	3	4.2	2	4.6	3	7.8	8	5.2
Alter Livestock Enterprise	0	-	5	11.6	0	-	5	3.3
Not Alter Livestock Enterprise	1	1.4	1	2.3	0	-	2	1.3
Seek Aid	0	-	4	9.3	0	-	4	2.6
Not Seek Aid	0	-	0	-	1	2.6	1	0.6
Other	2	2.8	0	-	2	5.2	4	2.6
Total Different Activities	82	-	45	-	34	-	161	-

[1/] Percent of questionnaires.

in the severity of the drought. In hard hit Blaine and Lincoln County, farmers were responding as best they could to a serious drought. In mildly hit Bingham and Bannock Counties many farmers felt hardly any impact of drought through their insulation of senior water rights and well developed storage, so they would hardly endorse their 1977 behavior as a valid response to a severe drought. Presumably one would find much more radical adjustments away from 1977 behavior patterns if Bingham and Bannock Counties should ever encounter a drought severe enough to pierce that insulating layer.

Out of the range of reported intentions to do something different from 1977, there are both farmers who propose to take some action and other farmers who tried such action in 1977 and propose not to repeat the action. The interviewers who administered the questionnaire to farmers perceived that this sentiment was even stronger than what shows up in the table. Many farmers felt they had been misled about the severity of the drought by the media and by state and federal agencies. They may have adopted system modifications or acreage shifts in anticipation of water shortage--and then the water shortage never proved critically severe. What is missing, of course, is a clear understanding of how bad the water shortage might have been if many farmers had not adopted such practices. Better water management by many farmers may well have averted critical water shortage in some instances. As a result, the individual farmer may perceive that he, individually, could have gotten by without adjustment. Understanding this micro/macro dichotomy (fallacy of composition) is essential. It is possible that the lesson learned by farmers from the 1977 drought is a false one. Some farmers may now feel it is possible

to weather a dry year like 1977 with few adjustments--when in fact this is valid only on the unlikely premise that everyone adjusts but them. For some, this false lesson of 1977 may have been reinforced by the arrival of timely rains in their locale. These farmers perceptions that the water shortage predictions of federal and state agencies were alarmist are only valid if one accepts the unlikely premise that they will always be rescued by a timely change in the weather. The fact that some farmers appear to perceive the 1977 drought as less severe than it had the potential for being could cause real problems in getting farmers to respond properly to any subsequent drought.

One other observation should be made about table 3.42 and 3.43. This is to note the infrequency with which water transfer was mentioned. This is in spite of the new Water Bank Act and a well documented history of an informal water market. Of course, many water transfers involve a water delivery organization as an intermediary rather than being simply transactions among individuals. It does appear, however, that water transfer has a very low profile and is certainly not in the forefront of farmers' preferred responses to drought. If the Water Bank Act is to achieve effectiveness during future water shortages, it must achieve more visibility and it must demonstrate that there is water available for transfer.

CHAPTER 4

IMPACTS OF THE 1977 DROUGHT ON FARM INCOME

The impacts of, and adjustments to the 1977 drought were presented in physical terms in chapter 3. This chapter will interpret these impacts and adjustments from an economic viewpoint, placing a dollar value on the drought effects on farm income.

The economic effects of drought can be subdivided into two parts; the direct consequences of drought due to factors over which farmers have no control, and the voluntary adjustments made by farmers to the drought or predicted drought. While it is often hard to sort out these two components, the directly drought caused and the adjustment caused income effects, they were both important economic consequences of the 1977 drought.

Farmer adjustment impacts include such things as crop acreage changes, variety changes, and idled cropland. Unharvested cropland and reduced crop yields could have been directly caused by the drought, or might have been the result of farmers' decisions regarding allocation of scarce water. This chapter will present first the impacts of drought caused yield reductions, and in later sections will detail the economic consequences of crop and variety changes, idled land, and land not harvested.

A. Economic Impact from Reduced Crop Yields

The yield reductions caused by drought were shown in table 3.21. This section will interpret these yield reductions in terms of lost farm income. In cases where the yield was so reduced that it was not worthwhile

to harvest the crop, those impacts will be covered in the section for crops not harvested. To calculate the impact of drought caused yield reductions, the following computation was made for each crop harvested:

$$\text{Change in Net Income} = \text{Price} \times \left(\text{1977 Yield} - \text{Adjusted Normal Yield} \right) \times \text{Acres.}$$

The adjusted normal yields indicate an estimate of what the yield would have been in 1977 without the drought, but adjusting for other identifiable factors that were not drought related but would have affected yields. The price used in the calculation was in most cases the price given by the farmer. When no price was obtained in the interview, then an average price based on other farmer responses for the area was used. In several cases where no average price could be determined, a price reported in USDA publications was used.

The total loss from reduced crop yields for the surveyed study area farms was $2,541,929 in 1977, as shown in table 4.1. This includes both dryland and irrigated acreage on the surveyed farms. These losses were broken down by crop and study area in table 4.2, by water application system in table 4.3, and by water source in table 4.4.

A measure of the relative severity of the drought impact is the average loss per acre for the three areas from table 4.1. Ada and Canyon Counties had the highest average loss at $49.50 per acre, followed by Blaine and Lincoln Counties at $26.20 and Bingham and Bannock Counties at $17.70 per acre. These figures reflect both the value of the crops grown in the various areas, as well as the severity of the water shortage. When only the irrigated cropland is considered (see table 4.2), the loss

Table 4.1. Loss from Reduced Crop Yields in 1977, By Area

Area	Total Harvested Acres	# of Farms	# of Farms Reporting A Loss	Total Loss	$\bar{X}$ Loss per Acre	$\bar{X}$ Loss per All Farms	$\bar{X}$ Loss per Farm Reporting Loss
Ada-Canyon	24,259	70	43	$1,201,792	$49.50	$17,168	$27,949
Blaine-Lincoln	32,851	43	41	$860,922	$26.20	$20,021	$20,998
Bingham-Bannock	27,068	38	28	$479,215	$17.70	$12,611	$17,115
Total	84,178	151	112	$2,541,929	$30.20	$16,834	$22,696

Table 4.2. Loss from Reduced Crop Yields in 1977, by Crop

Crop	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Areas		
	Acres	Loss	Loss Per Acre	Acres	Loss	Loss Per Acre	Acres	Loss	Loss Per Acre	Acres	Loss	Loss Per Acre
Alfalfa/Grass Hay	2338	109127	46.70	7003	449228	64.20	4717	128463	27.20	14058	686878	48.90
Grain Hay	98	0	-	165	3600	21.80	112	2700	24.10	375	6300	16.80
Irrigated Pasture	1412	16492	11.70	6033	194190	32.20	1057	13500	12.80	8502	224182	26.40
Green Chop	18	576	32.00	91	4140	45.50	-	-	-	109	4716	43.30
Wheat	600	17943	29.90	326	22205	68.10	4541	84990	18.70	5467	125138	22.90
Wheat-Dryland Variety	-	-	-	63	317	5.00	-	-	-	63	317	5.00
Barley, Feed	3469	86443	24.90	1258	75813	60.30	1151	24283	21.10	5878	186539	31.70
Barley, Malting	136	2069	15.20	-	-	-	650	11880	18.30	786	13949	17.70
Barley, Feed Dry. Var.	50	540	10.80	605	40157	66.40	-	-	-	655	40697	62.10
Oats	233	1566	6.70	399	16860	42.30	168	1080	6.40	800	19506	24.40
Rye	44	0	-	-	-	-	-	-	-	18	0	-
Mixed Grain	115	1170	10.20	169	4871	28.80	68	265	3.90	352	6306	17.90
Mixed Grain, Dry. Var.	-	-	-	60	5148	85.80	-	-	-	60	5148	85.80
Corn, Grain	201	5670	28.20	-	-	-	-	-	-	201	5670	28.20
Corn, Grain Early Mat.	35	394	11.30	15	0	-	-	-	-	50	394	7.90
Corn, Silage	941	44655	46.00	12	984	82.00	105	1405	13.40	1088	47044	43.20
Corn, Silage Early Mat.	859	17769	20.70	60	2810	46.80	-	-	-	919	20579	22.40
Seed: Barley	83	-	-	-	-	-	17	0	-	100	0	-
Wheat	42	1208	28.80	11	725	65.90	-	-	-	53	1933	36.50
Oats	18	0	-	-	-	-	-	-	-	18	0	-
Alfalfa	1113	211500	190.00	-	-	-	-	-	-	1113	211500	190.00
Clover	8	0	-	-	-	-	-	-	-	8	0	-
Corn	351	16517	47.10	-	-	-	-	-	-	351	16517	47.10
Lettuce	46	0	-	-	-	-	-	-	-	46	0	-
Onion	84	0	-	-	-	-	-	-	-	84	0	-
Pea	18	0	-	-	-	-	-	-	-	18	0	-
Lima Bean	66	5600	84.80	-	-	-	-	-	-	66	5600	84.80
Pinto Beans	22	2310	105.00	-	-	-	-	-	-	22	2310	105.00
Garden Variety Bean	126	0	-	-	-	-	-	-	-	126	0	-
Green Beans	48	490	10.20	-	-	-	-	-	-	48	490	10.20
Kidney Beans	45	0	-	-	-	-	-	-	-	45	0	-
Lima Beans	100	6500	65.00	-	-	-	-	-	-	100	6500	65.00
Dry Commerical Beans	700	45130	64.50	80	0	-	30	4920	164.00	810	50050	61.80
Greens/Spinach	64	0	-	-	-	-	-	-	-	64	0	-
Sweet Corn	327	11070	33.90	-	-	-	-	-	-	327	11070	33.90
Dry Peas	140	9520	68.00	-	-	-	-	-	-	140	9520	68.00
Onions	130	2500	19.20	-	-	-	-	-	-	130	2500	19.20
Potatoes	941	38625	41.00	95	3200	33.70	3657	159390	43.60	4693	201215	42.90
Sugar Beets	1221	44299	36.30	-	-	-	535	44119	82.50	1756	88418	50.40
Tree Fruits	1944	25000	12.90	-	-	-	-	-	-	1944	25000	12.90
Strawberries	25	0	-	-	-	-	-	-	-	25	0	-
Hops	1963	44320	22.60	-	-	-	-	-	-	1963	44320	22.60
Mint	3988	432699	108.50	-	-	-	-	-	-	3988	432699	108.50
Total Irrigated Harvested Land	24192	1201702	49.70	16445	824308	50.10	16808	476995	28.40	57445	2503005	43.60
Dryland Barley	-	-	-	495	3593	7.30	-	-	-	495	3593	7.30
Dryland Pasture	67	90	1.30	32356	33021	1.00	10266	2220	.20	42683	35331	.50
Total Dryland	67	90	1.30	32851	36614	1.10	10260	2220	.20	43178	38924	.90
Unharvested	50	-	-	1392	-	-	133	-	-	1575	-	-
Idled	425	-	-	1109	-	-	10	-	-	1544	-	-
Set Aside	-	-	-	-	-	-	10	-	-	10		
Waste	431	-	-	3920	-	-	522	-	-	4873	-	-
Total All Land	25165	1201792	49.50	55717	860922	26.20	27743	479215	17.70	108625	2541929	30.20

per acre changes considerably for Blaine and Lincoln Counties and to a lesser degree for Bingham and Bannock Counties, reflecting the importance of dryland crop acreage in those areas and the lower per acre value of dryland crops. The per acre loss for irrigated cropland only was $50.10 for Blaine and Lincoln Counties, $49.70 for Ada and Canyon Counties and for Bingham and Bannock Counties it was $28.40. In spite of the high yielding and high valued crops grown in the Boise Valley, the Ada-Canyon County losses were less than the per acre loss in Blaine and Lincoln Counties, reflecting the severity of the water shortage in the latter.

An indicator of the pervasiveness of drought impacts in each area is the number of farms reporting yield related losses. In table 4.1, the 41 Blaine and Lincoln County farmers with yield losses represent 95 percent of the farmers interviewed in that area. The corresponding percentages were 61 percent for Ada and Canyon Counties and 74 percent for Bingham and Bannock Counties. While the dollar per acre yield losses were higher in the Boise Valley, the yield impacts were more pervasive in the other two study areas.

1. Loss by crop

Table 4.2 shows the loss due to reduced crop yields in 1977, identified by crop. The type of crop, the number of harvested acres, the total loss, and the loss per acre for each of the study areas, and for the combined area are given. Irrigated cropland and dryland are separated to prevent the normally lower returns from dryland from masking the impacts for the higher value crops on irrigated ground. This is especially important for Blaine and Lincoln Counties where only 30 percent of the total cropland

on surveyed farms is irrigated. While the interviews excluded farms which relied principally on dryland, dryland grazing and grain are very prevalent even on Blaine-Lincoln area farms with substantial irrigated acreage. (Remember that the dryland varieties shown toward the top of table 4.2 refer to varieties that are normally grown under dryland conditions, but were grown on irrigated land in 1977 in anticipation of water shortage.)

The relative importance of yield losses by various crops depends on the number of acres and the value of the crop. For example, the 2988 acres of mint comprised 16.5 percent of the irrigated cropland in the Ada-Canyon survey area, but the yield loss on mint of $432,699 accounted for 36 percent of the total crop yield loss in that area. For the same study area, irrigated pasture with 1412 acres occupied 5.8 percent of the irrigated cropland, but accounted for only 1.4 percent of the yield related farm income losses.

2. Loss by application system and water source

The farm income losses due to reduced yields are broken down by type of water application system in table 4.3 and by source of water in table 4.4. (It should be pointed out again that farmers using only groundwater were excluded from the sample of farmers interviewed.) The per acre loss for the three gravity application systems averaged $48.50 while the loss for the four sprinkler systems averaged $37.30 per acre. Before concluding that this difference is meaningful, it is important to note the differences in crops grown under the two application systems, and also differences in source of water. Many of the high valued crops grown in the Ada-Canyon

Table 4.3. Loss from Reduced Crop Yields in 1977, By Water Application System

Water Application System	Acres	Loss	Loss per Acre
Gravity: open-headgate	15,819	$744,894	$47.10
Gravity: gated pipe	1,501	69,002	46.00
Gravity: siphon tube	16,831	842,846	50.10
Sprinkler: handline	14,176	480,425	33.90
Sprinkler: solid set	853	22,125	25.90
Sprinkler: center pivot	573	42,642	74.40
Sprinkler: side roll	6,617	283,332	42.80
Sprinkler/Gravity Combination	40	0	0
Sub-irrigated	1,035	17,740	17.10
Dryland	43,178	38,924	.90
Total Harvested	100,623	$2,541,930	$25.30
Set-aside, Idled, Unharvested, Waste, Unspecified	8,002	-	-
Total Acreage	108,625	-	-

Table 4.4. Loss from Reduced Crop Yields in 1977, By Water Source

Water Source	Acres	Loss	Loss per Acre
Surface	37,318	$1,533,884	$41.10
Groundwater	3,585	80,463	22.40
Mix	15,507	870,919	56.20
Sub-irrigated	1,035	17,740	17.10
Dryland	43,178	38,924	.90
Total Harvested	100,623	2,541,930	25.30
Set Aside, Idle, Unharvested, Waste, Unspecified	8,002	-	-
Total Acreage	108,625	-	-

area are watered by gravity systems. Many of the sprinkler systems are based on groundwater, which is probably a more reliable water source during periods of drought. These differences may overshadow the efficiency differences between gravity and sprinkler application.

The figures on yield related income losses classed by source of water also require some explanation. The loss was $22.40 per acre for land being irrigated with groundwater, and $41.10 per acre for land irrigated with surface water. However lands getting water from both sources had the highest per acre loss, $56.20. Clearly reliance on groundwater does not entirely remove the risk of yield losses during drought. This agrees with the results noted in chapter 3, where 21 percent of the wells in the survey area were reportedly impacted to some degree by the drought, half of these mildly impacted, and half severely. Whether the high per acre loss for mixed water source land was due to well problems, or to the crops being grown on this land is unclear. Perhaps use of supplemental wells indicates tenuous surface rights, highly vulnerable to drought.

B. Economic Impact from Acreage Changes

The four types of changes to be evaluated in this section include: 1) crop changes; 2) variety changes; 3) idled acreage; and 4) unharvested acreage. All four are changes over which the farmer exercises some control. The first three are clearly decision variables available to the farmer trying to optimize his use of water. The decision not to harvest a crop is different, in that it occurs at the end of the growing season, but in many cases the farmer still must decide whether the severely

damaged crop will repay the variable cost of harvest. Of course the reason why the crop was so severely damaged may have been under his control (he allocated the water to a higher MVP crop) or may not have been controllable (his water was shut off).

The kinds of voluntary changes such as those discussed in this section reflect how the farmer perceives the risks associated with a drought, and the drought's possible impacts on his operation. Variety change, crop change, and idled land represent progressively stronger responses to the risks of prospective drought. The cases of crops left unharvested are less clear. They could result from farmers thinking there was a low risk of drought problems, and being caught by surprise. Non harvest could also result when farmers persist with normal cropping patterns, voluntarily gambling that water would be adequate, but knowing that the risks were high. Table 4.5 shows the number of acres involved in these four kinds of acreage changes, by area.

1. Variety changes

The only major crops grown in the study area, for which variety changes are available to reduce water consumption, or better withstand a water shortage, are corn and grain. Some farmers switched to dryland grain varieties, which perform better than regular varieties when irrigation water is restricted, although under normal conditions their yield would be lower. For both corn for grain and for silage some growers switched to earlier varieties. They grew 90 or 100 day varieties rather than 110 or 120 day varieties. The lower yielding short season varieties would use less water in total, and the lower late season water requirements would

Table 4.5 Drought Related Acreage Changes in 1977 By Area

	Ada-Canyon		Blaine-Lincoln		Bingham-Bannock		All Three Areas	
	Acres	% of Total Acres	Acres	% of Total Acres	Acres	% of Total Acres	Acres	% of Total Acres
Variety Change	652	2.6	890	4.6	0	0	1,542	2.5
Crop Change	1,111	4.5	465	2.4	287	1.7	1,863	3.1
Idled Acreage	390[1/]	1.6	1,109	5.7	10	.06	1,509	2.5
Unharvested Acreage	50	0.2	1,392	7.2	133	.8	1,575	2.6
Total	2,203	8.9	3,856	19.9	430	2.6	6,489	10.7

[1/] excludes 35 ac. that was idled, but not drought related

allow the crop to mature before the water shortage became critical.

Both grain and corn variety changes reflect farmers attempts to avoid complete crop failure. The cost of this risk averting behavior is the lower expected yield from the drought resistant or early maturing variety. The lost revenue from such variety changes was computed using the following formula:

$$\text{Change in Net Revenue} = \text{Acres} \times \left(\begin{array}{c}\text{Adjusted Normal Yield for New Variety} \\ - \\ \text{Adjusted Normal Yield for Old Variety}\end{array} \right) \times \text{Price}$$

This computation assumed that the operating costs were the same for both old and new varieties. If farmers noted any input savings associated with the variety changes, the revenue was adjusted accordingly. Note that in cases where drought lowered actual yields below the adjusted normal yield for the new variety, this income impact has already been included in the tabulation of the income effects of reduced yields.

Table 4.6 shows the losses that resulted from these crop variety changes. The table presents the total loss by area, the loss per affected acre, the loss per affected farm, and the loss per reported change. Each acre of changed variety resulted in an average $50.90 loss in Ada and Canyon Counties, but only $25.00 loss in Blaine and Lincoln County. This reflects both the higher yield potential, and the greater frequency of corn variety changes, in the Boise Valley. The interviews did not uncover any variety changes in the Bingham-Bannock County area, reflecting lower perceived drought risks resulting from more secure water rights. The lower loss per affected Ada-Canyon County farm results because farmers in that area who made variety changes, did so on fewer acres than was true for Blaine and Lincoln County farmers. The average variety change on Boise area farms making such changes

Table 4.6 Loss from Crop Variety Changes in 1977, By Area

Area	Total Loss	# of Acres	Average Loss Per Affected Acre	# of Farms Reporting Variety Change	Average Loss Per Affected Farm	# of Reported Changes	Average Loss Per Change
Ada-Canyon	$33,200	652	$50.90	12	$2,767	14	$2,371
Blaine-Lincoln	22,280	890	25.00	8	$2,785	13	$1,714
Bingham-Bannock	0	0	-	0	-	0	-
Total	55,480	1,542	$36.00	20	$2,774	27	$2,055

involved 54 acres, but on affected Blaine-Lincoln area farms such an average change involved 111 acres.

Table 4.7 shows the lost revenue from variety changes broken down by the crop variety that would otherwise have been grown. Barley involved the most acres of variety changes, 750, and the second largest total loss, $16,846. Corn silage was second in acreage, 672, but first in total loss, $34,070. Note again that the corn silage losses are concentrated in Ada and Canyon Counties, while the barley losses dominate in Blaine and Lincoln Counties.

2. Crop changes

A second option open to farmers for reducing water use and the risk of crop failure was to switch to crops that need less water or to crops which exhibit greater tolerance for moisture stress. The crop changes observed in 1977 were listed in table 3.1. These changes are summarized in table 4.5. A total of 1863 acres on study area farms was involved in crop changes: 1111 acres in Ada and Canyon Counties; 465 acres in Blaine and Lincoln Counties and 287 acres in Bingham and Bannock Counties. The table also presents this as a percent of total irrigated cropland on surveyed farms.

The switch to crops using less water usually meant a change to a lower value crop as well. Corn, onions, and other high value row crops were replaced by grain or green chop (grain that was harvested as silage because it would not have matured). The loss from such a change was the difference in gross revenue between the crop grown and the crop forgone. This was adjusted for differences in variable production costs between

Table 4.7 Loss From Crop Variety Changes in 1977, By Crop

Crop	Ada-Canyon Acres	Ada-Canyon Loss	Ada-Canyon Loss Per Affected Acre	Blaine-Lincoln Acres	Blaine-Lincoln Loss	Blaine-Lincoln Loss Per Affected Acre	Total Acres	Total Loss	Total Loss Per Affected Acre
Wheat	0	-	-	55	$2,170	$39.50	55	$2,170	$39.50
Barley, Feed	50	$716	$14.32	700	$16,130	$23.40	750	16,846	$22.50
Mixed Grain	0	-	-	60	$819	$13.70	60	$819	$13.70
Corn, Grain	35	$1,575	$45.00	15	0	$0	50	$1,575	31.50
Corn, Silage	567	$30,908	$54.50	60	3,162	$52.70	627	34,070	$54.30
Total	652	$33,199	$50.90	890	$22,281	$25.00	1,542	55,480	$36.00

the two crops. The loss calculation used the formula:

$$\begin{aligned}\text{Change in Net Revenue} = \text{Acres} \times \Big[&\left(\text{Normal Adjusted Yield, 1977 Crop} \times \text{Price 1977 Crop}\right) \\ &- \left(\text{Normal Adjusted Yield, Normal Crop} \times \text{Price Normal Crop}\right) \\ &+ \left(\text{Normal Crop Variable Production Cost} - \text{1977 Crop Variable Production Cost}\right)\Big]\end{aligned}$$

The variable production costs used in this calculation accounted for any costs that would have changed when the crop grown was changed. These might include fuel, seed, fertilizer, labor, etc. Fixed costs, such as water charges, depreciation, and insurance, did not have to be tabulated since they remain constant in the face of short term crop changes. This cost data was based on budgets developed by the Department of Agricultural Economics for most major southern Idaho crops. These budgets were adjusted to a 1977 base using price indices from USDA sources. Any yield loss below adjusted normal yields for the new crop has already been counted in the income effects of drought caused yield reductions.

The farm income loss resulting from crop changes is shown in table 4.8. Thirty-eight of the interviewed farmers from the three study areas made a total of 58 crop changes, and incurred a loss of $336,635. Although Blaine and Lincoln Counties were the most severely impacted by the drought, they had the lowest average loss per changed acre and the lowest average loss per affected farm, $110 per acre and $4640 per farm. This reflects the lower value of the forage crops grown in the area and the lack of alternative crops the farmers could switch to. The lack of alternative crops is further illustrated by the crop change row in table 4.5. Crop change was a relatively

Table 4.8 Loss From Crop Changes in 1977, By Area

Area	Total Loss	# of Acres	Average Loss Per Affected Acre	# of Farms Reporting Crop Changes	Average Loss Per Affected Acre	# of Reporting Changes	Average Loss Per Change
Ada-Canyon	$235,507	1,111	$212.00	24	$9,813	39	$6,039
Blaine-Lincoln	$51,043	465	$109.80	11	4,640	15	$3,403
Bingham-Bannock	$50,085	287	$174.50	3	16,695	4	$12,521
Total	$336,635	1,863	$180.70	38	$8,859	58	$5,804

unpopular option among Blaine and Lincoln County farmers. In contrast the crop change option involved a greater percentage of total irrigated land in both of the other study areas. While switching crops appeared to be the most reasonable adjustment in these two areas, it was an expensive option in terms of lost income. The average Ada-Canyon County farm making crop changes lost $9,813, twice the figure for Blaine and Lincoln county affected farms, due mainly to the high value crops affected in the former. The high loss ($16,695) on affected Bingham-Bannock County farms resulted because three out of the four crop changes reported were changes away from potatoes.

Table 4.9 breaks down this crop change loss according to the crop which would normally have been grown. Almost 80 percent of this loss was due to changes away from four crops: potatoes, dry beans, mint, and onions. The relative importance of crop changes as a drought response in the three areas is indicated by the relative frequency of occurrence and number of crops involved in each area.

3. Idled cropland

A third option available to farmers who want to reduce water consumption was to idle some cropland. Of the three options examined so far, this one is the most effective in saving water, but it is also the most costly to the farmer in terms of reduced income. The acreage idled in 1977, broken down by area and by crop not grown are shown in table 3.1. Table 4.5 summarized these figures, giving the total acreage idled, 1509 acres, and a breakdown by area: 390 acres in Ada and Canyon Counties, 1109 acres in Blaine and Lincoln Counties, and only 10 acres in Bingham and Bannock Counties. Less than one tenth of one percent of the irrigated

Table 4.9. Loss from Crop Changes in 1977, by Crop Forgone

Crop	Ada-Canyon			Blaine-Lincoln			Bingham-Bannock			Total		
	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre
Alfalfa	12	$498	$41.50	50	$4,933	$98.70	-	-	-	62	$5,431	$87.60
Wheat	38	3,025	79.60	105	9,443	89.90	127	6,255	49.25	270	18,723	69.30
Barley	175	9,471	54.10	60	2,186	36.40	-			235	11,657	49.60
Mixed Grain	-			115	1,736	15.10	-			115	1,736	15.10
Corn, Grain	28	0	0	-	-	-	-	-	-	28	0	0
Corn, Silage	257	129	.50	55	0	0	-			312	129	.40
Alfalfa Seed	29	19,725	680.20	-	0	0	-	-	-	29	19,725	680.20
Lima Bean Seed	30	756	25.20	-			-			30	756	25.20
Pinto Bean Seed	31	725	23.40	-	-	-	-	-	-	31	725	23.40
Garden Variety Bean Seed	20	0	0	-			-			20	0	0
Lima Beans	75	6,394	85.25	-			-			75	6,394	85.25
Dry Beans	214	73,753	344.65	40	9,173	229.30	-			254	82,926	326.50
Sweet Corn	44	1,191	27.10	-			-			44	1,191	27.10
Onions	25	53,509	2140.40	-			-			25	53,509	2140.40
Potatoes	10	3,263	326.30	40	23,572	380.20	160	43,830	273.90	210	70,665	336.50
Sugar Beets	46	6,261	136.10	-			-			46	6,261	136.10
Mint	77	56,807	737.75	-			-			77	56,807	737.75
Total	1,111	235,507	212.00	465	51,043	109.75	287	50,085	174.50	1,863	336,635	4740.40

ground in mildly impacted Bingham and Bannock Counties was idled, compared to 1.6 percent in moderately impacted Ada and Canyon Counties and 6.2 percent in severely impacted Blaine and Lincoln Counties. Farmers in the areas where serious drought prospects were perceived at planting time, were more willing to take the drastic step of idling irrigated cropland. In Blaine and Lincoln Counties where water shortage is a chronic problem, water conserving crops and varieties are the norm. With acute shortage as during the summer of 1977, idling some land is one of the few available options.

The income impact of idling land was the lost revenue from the crop not grown, less the variable production costs saved:

$$\text{Change in Net Revenue} = \text{Acres} \times \left[\begin{array}{c} \text{Variable Costs} \\ \text{per Acre for} \\ \text{Crop Forgone} \end{array} - \left(\begin{array}{c} \text{Adjusted} \\ \text{Normal Yield} \\ \text{per Acre} \end{array} \times \text{Price} \right) \right]$$

The resulting income losses from idled cropland are shown in table 4.10. Thirty-five of the interviewed farmers from the combined study areas made 44 changes involving idled cropland, resulting in a net less of $197,718. In Ada and Canyon Counties, 13 farmers idled 16 parcels for a loss of $105,175, and in Bingham and Bannock Counties, only one farmer reported idling one parcel, for a loss of only $754. The 21 farmers in Blaine and Lincoln Counties who took the drastic step of idling land represented almost half of the region's surveyed farmers. These 21 operators idled 27 plots for a loss of $91,789.

Table 4.11 lists these idled cropland losses according to the crop that would otherwise have been grown. Most of the idled land involved lower value crops such as alfalfa, grain, or corn silage. (Of course

Table 4.10 Loss from Idled Cropland in 1977, By Area

Area	Total Loss	# of Acres	Average Loss Per Affected Acre	# of Farms Reporting Idled Cropland	Average Loss Per Affected Farm	# of Reporting Changes	Average Loss Per Change
Ada-Canyon	$105,175	390	$270.00	13	$8,090	16	$6,573
Blaine-Lincoln	$91,788	1,109	$82.80	21	$4,371	17	$5,399
Bingham-Bannock	$754	10	$75.40	1	$754	1	$754
Total	$197,718	1,509	$131.00	35	$5,649	44	$4,494

Table 4.11 Loss From Idled Cropland in 1977, By Cropland Foregone

Crop	Ada-Canyon			Blaine-Lincoln			Bingham-Bannock			Total		
	Acres	Loss	Loss Per Affected Acre	Acres	Loss	Loss Per Affected Acre	Acres	Loss	Loss Per Affected Acre	Acres	Loss	Loss Per Affected Acre
Alfalfa	-	-	-	43	$5,248	$122.00	-	-	-	43	$5,248	$122.00
Barley, Feed	140	$14,005	$100.00	235	17,768	$75.60	-	-	-	375	$31,773	$84.70
Oats	10	$675	$67.50	43	3,381	$78.60	10	$754	75.40	63	4,810	$76.40
Mixed Grain	-	-	-	317	$33,205	$104.70	-	-	-	317	$33,205	$104.70
Corn, Silage	97	9,122	$94.00	186	$7,316	$39.30	-	-	-	283	16,438	$58.20
Wheat	14	2,946	$210.40	180	$18,486	$102.70	-	-	-	194	21,432	$110.50
Barley, Dryland	-	-	-	105	$6,384	$60.80	-	-	-	105	$6,384	$60.80
Seed Corn	17	$6,788	$399.30	-		-	-	-	-	17	$6,788	$399.30
Potatoes	40	$19,792	$494.80	-		-	-	-	-	40	$19,792	$474.80
Mint	72	$51,847	$720.10	-		-	-	-	-	72	$51,847	$720.10
Total	390	105,175	$269.70	1,109	91,788	$82.80	10	754	75.40	1509	$197,717	$131.00

these are the crops grown in Blaine and Lincoln Counties where the drought was severe enough to cause people to take such drastic action.) Some land that would have grown high valued crops such as seed corn, potatoes, and mint was also idled. While representing only 8.6 percent of the idle acreage, these higher value crops accounted for 39.7 percent of the total loss. Most of this high value crop loss occurred in Ada and Canyon Counties, boosting that area's per acre loss from idled land.

4. Unharvested cropland

The option of not harvesting a crop was usually the consequence of other actions taken by the farmer (reducing water application so severely that the crop was ruined), or the consequence of some factor over which the farmer had no direct control (a watering schedule imposed which prevented adequate irrigation of the crop). In cases where the farmer diverted water from one crop to another, the water saved by sacrificing one crop presumably allowed better yields for the other.

Most of the costs of production will have already been committed by the time a decision is made to abandon a crop, and so remain a constant whether or not the crop is harvested. For crops not harvested, the income loss is the lost gross revenue from the crop, less any harvesting costs saved:

$$\begin{matrix}\text{Change in} \\ \text{Net Revenue}\end{matrix} = \text{Acres} \times \left[\begin{matrix}\text{Harvest Cost} \\ \text{per Acre}\end{matrix} - \left(\begin{matrix}\text{Adjusted} \\ \text{Normal Yield}\end{matrix} \times \text{Price}\right)\right]$$

The income loss from these unharvested crops is shown in table 4.12. The Bingham-Bannock County sample had only two farmers not harvesting four crops for a loss of $10,679, or $5,339 per affected farm. In Ada

Table 4.12 Loss from Unharvested Cropland in 1977, By Area

Area	Total Loss	# of Acres	Average Loss Per Affected Acre	# of Farms Reporting Unharvested Cropland	Average Loss Per Affected Farm	# of Reported Changes	Average Loss Per Change
Ada-Canyon	$14,897	50	$297.90	4	$3,724	5	$2,979
Blaine-Lincoln	$232,344	1,392	$166.90	14	$16,596	18	$12,908
Bingham-Bannock	$10,679	133	$80.30	2	$5,339	4	$2,670
Total	$257,920	1,575	$163.80	20	$12,896	27	$9,552

and Canyon Counties four farmers didn't harvest five crops for a loss of $14,897, or $3,724 per affected farm. In severely impacted Blaine and Lincoln Counties, 14 farmers left 18 parcels unharvested, losing $232,344, or $16,596 for each affected farm. These 14 farmers represented 32 percent of those interviewed in Blaine and Lincoln Counties, compared to only 5 or 6 percent of the farmers in the other areas who left crops unharvested.

Table 4.13 shows that most of the unharvested crops were hay or grain (98 percent of the acreage) although 20 acres of sweet corn and 3 acres of mint were also left unharvested. The 752 acres of alfalfa and grass hay not harvested represented 47 percent of the unharvested acreage, and 52 percent of the income loss. Feed barley was the second most frequently unharvested crop with 485 acres (31 percent of the acreage) and an income loss of $80,093 (31 percent of the income loss). The higher value crops and higher yields on Ada and Canyon County farms produced a higher average loss of $297.90 per unharvested acre. This compares to $166.90 per unharvested acre on Blaine and Lincoln County farms and $80.30 on Bingham and Bannock County farms. The low per acre losses for the latter area resulted because three of the four unharvested plots were located on one farm with marginal sandy soil and a low yield potential (and a susceptibility to drought).

5. Incidence of these losses, by application system and water source

A summary of the income losses from these crop acreage changes, broken down by type of water application system used, and by water source, is given in tables 4.14 and 4.15. Because in the sample there was a close association between the study areas and variables such as the crops grown,

Table 4.13. Loss from Unharvested Cropland in 1977, By Crop Not Harvested

Crop	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			Total		
	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre
Alfalfa/Grass Hay	9	$1,346	$149.60	743	$131,803	$177.40	-	-	-	752	$133,149	$177.10
Barley Feed	-			455	76,262	167.60	30	3,831	127.70	485	80,093	165.10
Oats	-			40	6,468	161.70	20	960	48.00	60	7,428	123.80
Mixed Grain	-	-	-	25	3,334	133.40	-	-	-	25	3,334	133.40
Green Chop	-	-	-	50	5,343	106.90	-	-	-	50	5,343	106.90
Wheat	18	3,936	218.70				13	2,496	192.00	31	6,432	207.50
Barley, Dry. Var.	-			55	6,965	126.60	-			55	6,965	126.60
Sweet Corn	20	7,792	389.60	-	-	-	-	-	-	20	7,792	389.60
Mint	3	1,823	607.70	-	-	-	-	-	-	3	1,823	607.70
Dryland Barley	-	-	-	24	2,169	90.40	-	-	-	24	2,169	90.40
Dryland Rye	-	-	-	-	-	-	70	3,392	48.50	70	3,392	48.50
Total	50	$14,897	$297.90	1392	$232,344	$166.90	133	$10,679	$80.30	1575	$257,920	$163.80

Table 4.14. Loss Due to Acreage Changes in 1977, By Water Source

	Crop Variety Change			Crop Change			Idled Cropland			Unharvested Cropland			Total All Acreage Changes		
Water Source	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Affected Acre
Surface	1,096	$40,601	$37.00	1,555	$221,375	$142.40	1,064	$139,430	$131.00	709	$108,832	$153.50	4,424	$510,238	$115.30
Groundwater	55	2,170	39.50	40	12,393	309.80	-	-	-	40	6,468	161.70	135	21,031	155.80
Mix	391	12,709	32.50	268	102,867	333.80	340	51,903	152.65	732	137,058	187.20	1,731	304,537	175.90
Dryland							105	6,384	60.80	94	5,561	59.20	199	11,945	60.00
Total	1,542	$55,480		1,863	$336,635		1,509	$197,717		1,575	$257,919		6,489	$847,751	

Table 4.15. Loss Due to Acreage Changes for 1977, By Water Application System

Water Source	Crop Variety Change			Crop Change			Idled Cropland			Unharvested Cropland			Total All Acreage Changes		
	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre	Acres	Loss	Loss per Affected Acre
Gravity: Open Headgate	667	$17,057	$25.60	509	$53,999	$106.10	822	$69,956	$85.10	1,077	$178,387	$165.60	3,075	$319,399	$103.90
Gravity: Gated Pipe	48	942	19.60	35	0	0	-	-	-	3	1,823	607.70	86	2,765	32.20
Gravity: Siphon Tube	622	31,109	50.00	838	177,701	212.00	379	86,580	228.75	38	11,727	308.60	1,877	307,117	163.60
Sprinkler: Hand Line	155	5,990	38.60	331	70,660	213.50	115	26,321	228.90	159	23,011	144.70	760	125,982	165.80
Sprinkler: Side Roll	50	382	7.60	150	34,775	228.50	88	8,477	96.30	204	37,410	183.40	492	80,544	163.70
Dryland	-	-	-	-	-	-	105	6,384	60.80	94	5,561	59.20	199	11,945	60.00
Total	1,542	$55,480		1,863	$336,635		1,509	$197,718		1,575	$257,919		6,489	$847,752	

the application system used, and the water source, extreme care should be exercised in drawing conclusions from these tables regarding the importance of water source and application system as determinants of drought losses.

C. Total Crop Income Loss in 1977

A summary of the five types of crop losses evaluated in this chapter is presented as table 4.16. The most important conclusion is that reduced crop yields was the dominant loss in all three study areas. This ranged from a low of 68.4 percent of the total crop income loss in Blaine and Lincoln Counties to a high of 88.6 percent in Bingham and Bannock Counties. For the three study areas, 75 percent of the income loss was due to yield declines. This amounted to a total loss of $2,541,929. By comparison, losses due to acreage changes played a more minor role. The income losses due to acreage changes totalled only $847,753.

The total crop income loss identified by this study for the three areas was just under 3.4 million dollars. While Ada and Canyon County farms accounted for only 23 percent of the cropland on all surveyed farms, these farms accounted for almost 47 percent of the total income loss, 1.6 million dollars. Blaine and Lincoln County farms with 51 percent of the land had 37 percent of the loss, 1.26 million dollars. The remaining 26 percent of the land and 16 percent of the loss was on Bingham and Bannock County study farms.

Among the acreage change options, both Ada and Canyon Counties and Bingham and Bannock Counties suffered their greatest income losses from crop changes. One should carefully avoid the conclusion that crop changes

Table 4.16. Summary of Crop Income Loss in 1977

Factor	Ada-Canyon Counties			Blaine-Lincoln Counties			Bingham-Bannock Counties			All Three Areas		
	Loss	% of Total Loss	Loss per Acre of Cropland	Loss	% of Total Loss	Loss per Acre of Cropland	Loss	% of Total Loss	Loss per Acre of Cropland	Loss	% of Total Loss	Loss per Acre of Cropland
Reduced Crop Yields	$1,201,792	75.6	48.72	$860,922	68.4	44.03	$479,215	88.6	28.14	$2,541,929	75.0	42.77
Variety Changes	33,200	2.1	1.35	22,280	1.8	1.19	0	0	0	55,480	1.6	0.92
Crop Changes	235,507	14.8	9.55	51,043	4.1	2.73	50,085	9.3	2.95	336,635	10.0	5.58
Idled Cropland	105,175	6.6	4.26	91,789	7.3	4.90	754	0.1	0.04	197,718	5.8	3.17
Unharvested Cropland	14,897	0.9	0.60	232,344	18.4	12.41	10,679	2.0	0.63	257,920	7.6	4.18
Total	$1,590,571	100	64.48	$1,258,378	100	64.80	$540,733	100	31.57	$3,389,682	100	55.33

were an undesirable strategy. These farmers might have suffered even greater losses from yield declines and nonharvest if they had persisted in their normal cropping pattern. Note that Blaine and Lincoln Counties with few options to change crops or varieties did suffer severe losses due to nonharvest.

The picture that emerges is one of passivity. In the preponderance of cases, farmers proceeded with a nearly normal cropping pattern, and hoped for enough rain to grow a crop. In all areas the result was some degree of yield decline and income loss. In Blaine and Lincoln Counties the water shortage was so severe that many of these planted crops weren't worth harvesting, so the income penalty was greater. Except in limited cases, farmers did not have, or extensively use their options to change crops or varieties or idle land in anticipation of water shortage.

Table 4.17 summarizes these losses by crop. The impacts ranged from highs of $830,706 for alfalfa and grass hay and $543,176 for mint, to no reported impact on several specialty and seed crops. The total income loss due to the drought on farms in the study was $3,338,813 for irrigated crops and $50,869 for the dryland crops grown on the study farms.

It is easier to grasp the composite income impacts when they are stated on a per acre basis. Table 4.16 shows the lost income from irrigated crops divided by the irrigated acreage in each study area. This loss was $64.48 for Ada and Canyon County irrigated land, $64.80 in Blaine and Lincoln Counties, $31.57 for irrigated land in Bingham and Bannock Counties and $55.33 for all three regions.

Clearly the drought of 1977 had a large and pervasive impact on farm income in all three areas where interviews were conducted, and presumably

Table 4.17. Summary of Crop Income Losses in 1977, by Crop

Crop	Reduced Yields	Variety Changes	Crop Changes	Idled Cropland	Unharvested Cropland	Total
Alfalfa/Grass Hay	$686,878		$5,431	$5,248	$133,149	$830,706
Grain Hay	6,300					6,300
Irrigated Pasture	224,182					224,182
Green Chop	4,716				5,343	10,059
Wheat	125,138	$2,170	18,723	21,432	6,431	173,894
Wheat-Dryland Variety	317					317
Barley, Feed	186,539	16,846	11,657	31,773	80,094	326,909
Barley, Malting	13,949					13,949
Barley, Feed Dry. Var.	40,697				6,965	47,662
Oats	19,506			4,810	7,428	31,745
Rye	0					0
Mixed Grain	6,306	819	1,736	33,205	3,334	45,400
Mixed Grain, Dryland Variety	5,148					5,148
Corn, Grain	5,670	1,575	0			7,245
Corn, Grain, Early Maturing	394					394
Corn, Silage	47,044	34,070	129	16,438		97,681
Corn, Silage Early Maturing	20,579					20,579
Seed: Barley	0					0
Wheat	1,933					1,933
Oats	0					0
Alfalfa	211,500		19,725			231,225
Clover	0					0
Corn	16,517			6,788		23,305
Lettuce	0					0
Onion	0					0
Pea	0					0
Lima Bean	5,600		756			6,356
Pinto Bean	2,310		725			3,035
Garden Variety Bean	0		0			0
Green Beans	490					490
Kidney Beans	0					0
Lima Beans	6,500		6,394			12,894
Dry Commerical Beans	50,050		82,926			132,976
Greens/Spinach	0					0
Sweet Corn	11,070		1,191		7,792	20,053
Dry Peas	9,520					9,520
Onions	2,500		53,509			56,009
Potatoes	201,215		70,665	19,792		291,672
Sugar Beets	88,418		6,261			94,679
Tree Fruits	25,000					25,000
Strawberries	0					0
Hops	44,320					44,320
Mint	432,699		56,807	51,847	1,823	543,176
Total Irrigated Cropland	$2,503,005	$55,480	$336,635	$191,333	$252,359	3,338,813
Dryland Barley	3,593			6,384	2,169	12,146
Dryland Pasture	35,331					35,331
Dryland Rye					3,392	3,392
Total Dryland	38,924	0	0	6,384	5,561	50,869

on most other parts of southern Idaho as well. The damage was greatest in Blaine and Lincoln Counties where water supply was insecure because of lack of storage, but the loss was nearly as large in the Boise Valley where water was more secure and more rigidly managed, but where higher valued crops were grown. Even in Bingham and Bannock Counties, an area included in this study because the 1977 drought impacts were expected to be minor because of well developed storage and senior water rights, still showed an income loss of $31.57 per irrigated acre from the drought.

D. Carryover of Drought Income Impacts into 1978

Chapter three noted that there was some carryover of the drought impacts into the following year. In spite of the return of normal precipitation patterns during the fall and winter of 1977-78, there were instances of drought caused yield reductions and acreage changes in the 1978 crop year.

Table 4.18 shows the income losses estimated for 1978. The recovery from a $3.4 million loss in 1977 to only a $200,000 loss in 1978 is striking. The income losses which exceeded $55 in the drought year diminished to only $3.32 in the succeeding year. Nearly three quarters of this persistant loss can be traced to Blaine and Lincoln County, where hay and irrigated pasture crops persisted with low yields, causing a loss of over $70,000. Only in Blaine and Lincoln County were acreage changes of much significance--a $32,000 loss to crop changes and a $2,000 loss to idled and unharvested cropland. The $48,000 loss to Ada and Canyon County farmers was almost entirely due to persistent yield declines for hay crops, corn silage, and mint. Only in Blaine and Lincoln County was the

Table 4.18 Summary of Crop Income Losses for 1978

Factor	Ada-Canyon			Blaine-Lincoln			Bingham-Bannock			All Three Areas		
	Loss	% of Total Loss	Loss Per Irrigated Acre	Loss	% of Total Loss	Loss Per Irrigated Acre	Loss	% of Total Loss	Loss Per Irrigated Acre	Loss	% of Total Loss	Loss Per Irrigated Acre
Reduced Crop Yields	47,724	96.9	1.95	110,615	76.4	6.02	5,140	86.5	0.29	163,479	81.7	2.71
Variety Changes	0	0	0	0	0	0	0	0		0	0	0
Crop Changes	0	0	0	32,208	22.2	1.75	0	0		32,208	16.1	0.53
Idled Cropland	0	0	0	845	0.5	0.05	0	0		845	0.4	0.01
Unharvested Cropland	1,504	3.1	0.06	1,140	0.7	0.06	804	13.5	0.05	3,448	1.7	0.06
Total	49,228	100	2.02	144,808	100	7.88	5,944	100	0.34	199,980	100	3.32

average per acre damage ($7.88) high enough to cause much concern.

The obvious conclusion from the 1978 figures is the remarkable resiliency of southern Idaho irrigated farming. Those effects that did persist into 1978 involved mostly perennial crops such as hay and mint. For most annual crops there was sufficient water available to replenish soil moisture and produce normal yields.

E. Summary of the Economic Impacts of the 1977 Drought

This chapter has focused on crop income losses resulting from drought caused yield declines and cropping pattern changes. These losses have been shown to be both large and pervasive, ranging from $32 to $65 per irrigated acre in 1977 for the three areas studied. The losses were dominated by the effects of yield loss and by unharvested cropland in the most severely impacted areas. This suggests that farmers respond passively to drought, tending to persist in their normal cropping patterns, and then suffering yield reductions and unharvestable crops when the water runs short.

There are several other aspects of the economic impacts of drought which this study has not evaluated because sufficient information for a complete analysis was not available. These include labor cost impacts, costs for irrigation system changes and improvements, livestock impacts, and the impacts on the wider economy.

This chapter has attempted to account for savings of imputs not used in crop production by using crop budget data when evaluating the impacts of crop and variety changes and idled land. Among the inputs treated in this manner was labor. However much of this saved labor was

in fact unpaid family labor. Unless this released family labor was alternately employed elsewhere, the result was not a cost savings, but underemployment for some family members. As noted in chapter 3, some farmers reported hiring more labor to handle the problems caused by water shortage. The 151 interviewed farmers reported spending $62,000 to hire 16,800 hours of extra irrigation labor. They also reported using an additional 17,700 hours of family labor. Thus the labor impact was diverse, some farmers hiring more and others less labor than usual, and some using more and others less family labor. Since precise data on all these shifts was not available the full economic impact of drought on the labor factor could not be computed. The offsetting nature of the changes suggest that the net income impact might not be large.

Farmers made a range of capital improvements such as new wells, sprinkler systems, lining canals, etc., motivated at least partly by the 1977 drought. Spending on such improvements was reported to exceed $1.5 million (table 3.12). The economic impact of these improvements and the portion of that impact which must be attributed to drought is difficult to sort out. Many of these improvements will increase water use efficiency, improve farmers ability to manage water, save labor, and improve yields. Where this is true the improvements will increase future returns rather than be counted as a cost of drought. Even those capital items which are truly costs will serve again to mitigate future droughts, so that only depreciation, operating costs, and maintenance can be counted as costs of the 1977 drought.

Farmers impacted by drought received aid from a wide variety of sources. Many of the capital improvements were subsidized by some kind

of aid program which reduced their cost. This assistance, mostly in the form of loans, totaled over $340,000 in the sample. There were other forms of assistance and disaster aid, also mostly in the form of loans that helped to defray some of the other impacts of drought. While loans must of course be repaid, the low interest rates are a subsidy to the injured farmer.

While the sample of farmers selected for this study was chosen to emphasize irrigated crop farming, the surveyed farms also had large numbers of livestock. Table 3.27 has shown that drought caused large income losses in the livestock sector. In fact these losses may exceed the losses to irrigated crops on the sampled farms.

A complete view of the economic impacts of drought on irrigated agriculture would have to encompass the consequence for the larger economy. Farmers sell their output to agricultural processing industries and buy inputs from farm supply firms. Farmers also spend their income to buy consumer items. Thus farm income has a substantial multiplier impact on the wider economy of the community, the state, and the nation. A dollar of lost farm income may mean loss of a dollar or two of income elsewhere in the economy. However drought related capital spending by farmers will generate some offsetting income somewhere else in the economic system.

In summary, there are a number of other factors that may boost the $3.4 million estimated impact of drought on irrigated crop agriculture in the study area. However these adjustments are probably not large. The impacts of drought on the livestock sector may exceed the impact on crops, and the multiplier impact of these income losses will further magnify the consequences of water shortage.

CHAPTER 5

RESPONSE OF WATER DELIVERY ORGANIZATIONS DURING THE 1977 DROUGHT

The basic purpose of the water organization is to deliver water to users within their organization. A system of canals maintained by the organization provides the primary means of water conveyance in most cases, although some organizations use a closed system (pipe) to deliver either pressurized or unpressurized water to their users. Being responsible for water delivery, the water organization plays the central role in allocating water within the system among the irrigators. During water shortage, the important task of allocating water to individual farms in southern Idaho is principally in the hands of the delivery organizations because a great majority of irrigators are served by these organizations. According to one study 93% of Idaho irrigators obtain water through these delivery organizations.[114/] The way these organizations allocate water during a shortage is a major element in shaping water management strategy during drought. Before discussing the strategies employed by delivery organizations, the types of organizations delivering water are identified.

A. Water Delivery Organizations

Water delivery organizations in Idaho fall into two basic categories: 1) irrigation districts; and 2) canal or ditch companies. Whether organizations in the second category are called canal companies, ditch companies, associations or any other names; they will be treated under the heading of "canal company" for the purpose of examining their characteristics and their role as a water delivery organization.

1. Irrigation districts.

Irrigation districts were created to provide for the construction, operation, and maintenance of reservoirs, canals and other facilities to bring water to the lands within the district. Many irrigation districts came into being in conjunction with Bureau of Reclamation projects under the Reclamation Act of 1902. Establishment of a district required a two-thirds majority of the ballots cast by those voting within the proposed district. There was an element of compulsion in that once the district was established by vote, everyone within the geographic boundaries of the district had to belong and pay assessments unless petition for special exclusion was granted.

The district functions as a nonprofit legal entity for the purpose of contracting and debt acquisition on behalf of the district members. A board of directors, elected by members of the district, sets policy and serves as a grievance committee for members' complaints. The day-to-day operations are generally handled by a manager and his assistant ditch riders, hired by the board of directors. The size of the irrigation district dictates the degree of personnel specialization. A formalized policy of the district is normally contained within the bylaws of the organization which may outline the duties, responsibilities, and legal obligations of the management and of the members of the district.

2. Canal companies.

Canal companies are legally incorporated mutual companies, created for the purposes of operating and maintaining canals and other facilities necessary to provide water to land developed for irrigation. The land was either developed privately, or in some cases the land was developed by an associated land company under the Carey Act of 1894. The land

company constructed canals and laterals to bring water to the land. Upon acquiring land in the tract, farmers purchased shares in the canal company entitling them to receive water. Ultimately the land company turned over the operation and maintenance of the delivery system to the canal company. Membership in the canal company is voluntary in that it is a nonprofit mutual company in which irrigators agree to purchase shares. In a legal sense members voluntarily subscribe to the bylaws of the company when they purchase shares.

Governance of canal companies is similar to irrigation districts. A board of directors elected by shareholders makes budgetary decisions, decisions about system improvements, and exercises supervisory authority over the water manager and other staff. The water manager is responsible for daily operating decisions regarding water allocation and maintenance.

Most canal companies predate irrigation districts within the same area and serve land in closer proximity to the stream from which the diversion is being made, requiring a less extensive system of canals. The earlier development usually allowed the canal companies to acquire the older (and therefore better) water rights. Canal companies were usually given the opportunity to buy storage space as reservoirs were constructed, giving them added security for the late season irrigations when the natural stream flow is likely to be at its lowest.

Some companies function only to transmit water and are not recognized as the appropriator of water. These organizations may deliver water along a lateral from a larger canal company or irrigation district, or for a small group of individuals with their own water rights. Individuals served by these organizations buy shares or carrying rights in the company to have water appropriated by themselves or by another organization delivered to their land. The maintenance and other charges are assessed on the number

of shares owned or the amount of water an individual transmits through the canal. The company may be an informal organization of several farmers or a formally chartered corporation, similar to the "canal companies" described above. Because they have no direct control over water rights, and only follow the policies of the Idaho water law, the canal company, or the irrigation district, they will not be treated as a separate type of organization.

B. Water Allocation Role of Delivery Organizations

The ownership of water rights becomes obscured somewhat in the case of both irrigation districts and canal companies. It is not very useful to talk about who owns the water rights but rather to discuss the issue in terms of who enjoys what rights in the use of water in the event of conflicts. The law recognizes the delivery organization as the water appropriator for purposes of resolving a water right conflict originating from outside the delivery organization. The outside party would not have to deal with each of the irrigators served by the water organization to settle the dispute. The conflict would be resolved between the other party and the delivery organization as the appropriator for the irrigators.

The irrigator does not technically hold the water right since the delivery organization is officially the appropriator. However, in the event of an internal conflict between the irrigator and the delivery organization, the irrigator has the right to receive his share of water into perpetuity so long as he pays the assessed water fees to the delivery organization and abides by the rules or bylaws of the organization.

Any internal conflict between users served by a canal company, as might occur during a period of water shortage is usually resolved by sharing available water on a pro rata basis apportioned according to the number of shares held. Generally irrigators served by a canal company,

who settled in a tract at about the same time, are considered to have water rights of equal priority. A provision for the pro rata sharing of water from a canal company is usually included in the bylaws of the organization. The irrigator's consent to pro rata sharing is implied when he joins the organization.

In the case of a similar conflict between users served by an irrigation district, Idaho Code (Statute 42-904) allows for internal adjudication of rights to water. In fact, this code has seldom been used and water is usually shared on a pro rata basis within irrigation districts as well.

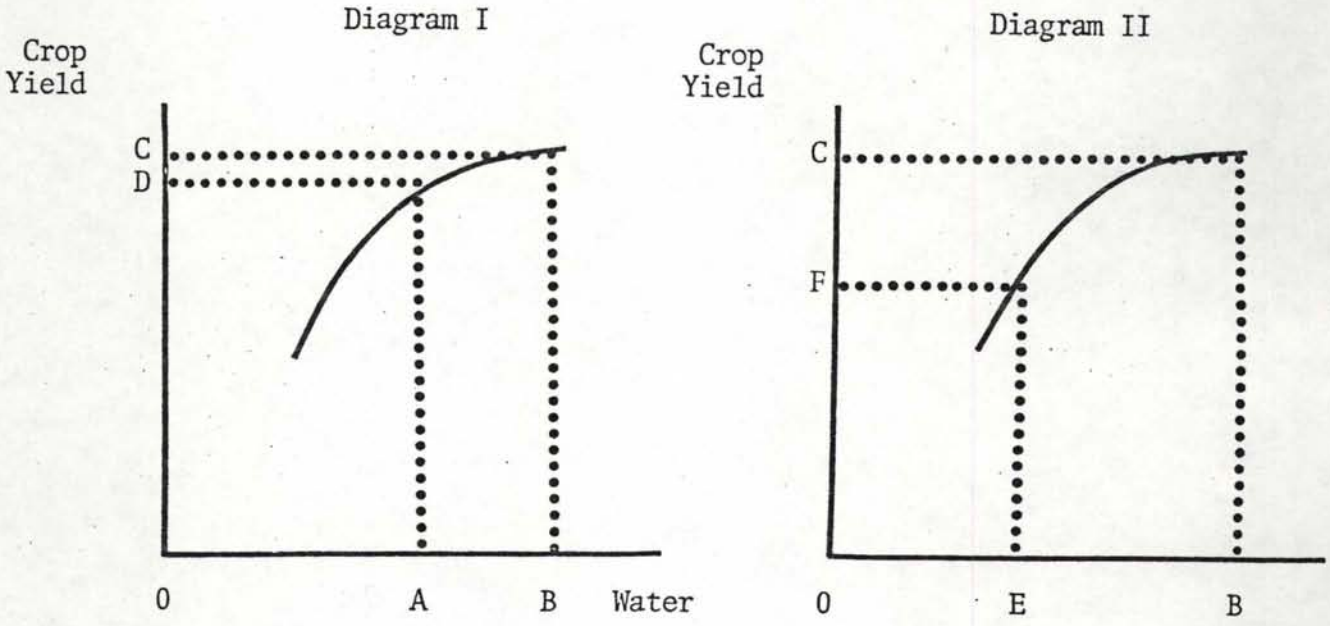
An exception to pro rata sharing of water within an organization occurs when a project has been expanded at some point in time upon the appropriation of more water. Irrigators served by the expansion comprise a separate class with a lower priority for water than the earlier class. However, within each class of users pro rata sharing is still typical.

Whether it was intentional or not, there is a sound economic argument for allocating available water on a pro rata basis to irrigators similarly situated as you might find them to be on an irrigated tract. This argument is valid as long as the crop yield response function exhibits diminishing marginal returns to water. In such cases, the combined yield penalty from cutting equally the water for two similar irrigators will always be less than the yield decline from cutting one irrigator's water the full amount of the shortfall and not cutting the other irrigator at all.

In Figure 5.1 Diagram I both irrigators have their water cut equally by the amount $\overline{AB}$. Total yield loss is 2 $\overline{CD}$. In diagram II, one irrigator sustains the full water shortfall ($\overline{EB} = 2\overline{AB}$) and the yield decline is $\overline{CF} > 2\overline{CD}$. Sharing water equally between similarly situated irrigators is efficient because the marginal value product of water is equalized between uses.

"Economic Aspects of Water Resource Policy," American Journal of Economics and Sociology, V. 28, p. 131.

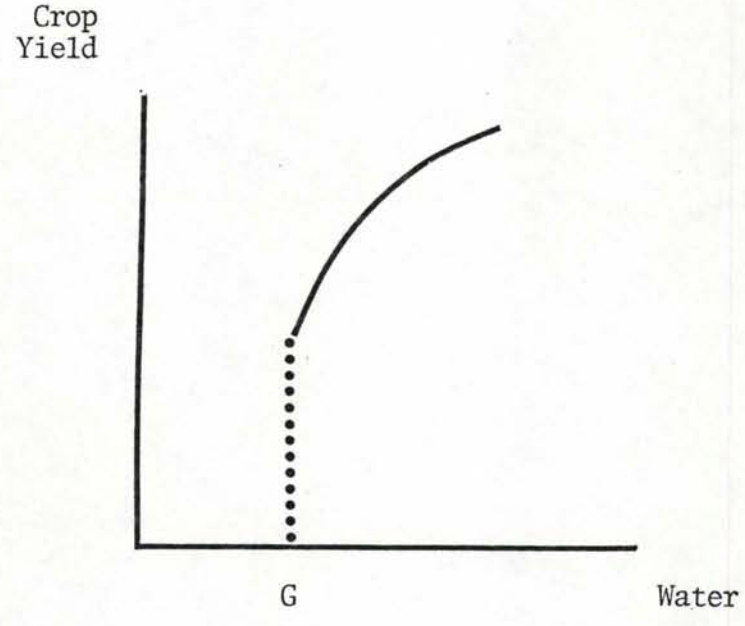
Figure 5.1



If the yield response curve to water exhibits a discontinuous segment associated with a threshold for crop yield, an attempt to allocate water equally across all land under a severe water shortage may result in loss of much of the crop. As shown in Figure 5.2, reducing water applied during the irrigation season below G would stress the plant excessively, eliminating yield. In this case each irrigator should allocate his pro rata share of water across his land so that some of his crop acreage is left unwatered, sacrified in order to have sufficient water to sustain the rest of the crop above the threshold. During drought, the pro rata sharing of available water on an irrigation tract is efficient because it minimizes the yield penalty.

The degree of control over the delivery of water varies from organization to organization. Some water delivery organizations retain direct control over the water from the point of water diversion into the delivery system, to the farmers headgate where a water metering device is used to

Figure 5.2



allocate the proper quantity of water. Ditch riders are commonly employed to control headgates and adjust the flow of water through the system in allocating water among users. At the opposite extreme are water organizations where the only water metering device is at the point of diversion from the source. The water may be managed directly by the company only until it reaches a main lateral serving several farmers. It then becomes the responsibility of the farmers on the lateral to allocate the water properly. This may be done on either a formal or informal basis.

While there are differences in the legal organization and structure of irrigation districts and canal companies, in practice they function essentially the same in allocating water. In general, storage and flow sources of water are comingled. Usually water is allocated on a pro rata basis to all irrigators of the same class served by the organization. The irrigator's entitlement to water is usually specified in terms of acre feet per acre, or a flow rate per share or per acre in miner's inches. Water organizations

collect fees from water users to pay for operating and maintenance expenses, as well as to retire the bonds which financed construction costs. Water assessments are levied on a per acre basis, per acre foot, or per share where a share is equivalent to a flow of so many miner's inches. The total assessment is determined by the irrigators entitlement to water not on the water actually used during the season. The pricing of water thus does not provide an incentive for conservation even during a water shortage.

C. Delivery Organization Drought Response

1. Water manager survey.

A water manager survey was conducted to determine the strategies followed by delivery organizations during the 1977 drought, opinions regarding drought management, and likely response patterns during future drought. The survey instrument, Appendix F, was personally administered to the water manager, ditch rider, or administrative officer of the Board of Directors from 24 water delivery organizations in southern Idaho during the fall of 1980. There were questions eliciting specific responses regarding the characteristics of the delivery organization and strategies for dealing with the 1977 drought. Open ended opinion questions dealing with drought management and future drought were also included. The survey interview required approximately one hour. Delivery organizations which served irrigators interviewed in the farmer survey were selected to participate in the water manager survey. Eleven organizations were from Ada and Canyon counties, three from Blaine and Lincoln, and ten from Bingham and Bannock. Eleven of the organizations were irrigation districts and thirteen were canal companies or ditch companies.

2. Drought impact.

Four delivery organizations indicated that water shortages were common in their systems, occurring at least as frequently as one year in five. During the drought of 1977 only one delivery organization reported no shortage of water. Fifty-eight percent of the organizations surveyed reported a shortage of flow water (14) and thirty-eight percent reported a shortage of both storage and flow water (9). For the organizations surveyed it appears that flow sources were impacted more severely by the 1977 drought than storage supplies. This conclusion is supported by the observation that all organizations which indicated only a flow shortage also had storage water but this was not reported to be short, and because no organization claimed a shortage of storage water only.

3. Water measuring devices.

Allocating water carefully between irrigators in a water-short year, requires accurate water measuring devices at the farm turnouts. Suitable devices for this purpose include weirs, submerged orifice, flumes and vane deflection meters for open flow delivery systems; propeller meter, pitot tube, and pipe orifice for closed delivery systems. Lack of these devices at the farm turnout detracts from the delivery organization's ability to allocate water accurately during drought. Of the organizations surveyed, 33% reported that they did not measure water at each farm turnout even in water-short years. Either there were no water measuring devices installed in the system (3 responses), the devices were mainly installed at laterals and not at each farm turnout (4 responses), or the only devices installed at the turnouts were steel headgates and they were not used to measure water (1 response).

Even without a measuring device at each turnout, a delivery organization could still do a creditable job of allocating scarce water by a rotation or

or schedule system if water measuring devices were installed at all laterals and there were relatively few irrigators on each lateral. This observation, combined with the need to generate sufficient flow of water to irrigate the full length of furrows quickly, probably explains why so many organizations adopted a schedule or rotation delivery pattern during the drought. Of the eight organizations above, which reported they did not measure water at each farm turnout, seven delivered water during the drought on a schedule or rotation basis. If greater flexibility in water delivery were desired during a water shortage more water measuring devices would need to be installed at farm turnouts.

4. Delivery pattern.

For the delivery organizations surveyed, the most common delivery pattern in a normal year is delivery on demand. More than 60% of the sample use this pattern. Twenty-five percent of the delivery organizations deliver water on a continuous basis. Only two of the delivery organizations normally deliver water on a schedule or rotation basis. With scheduled delivery, irrigators are programmed to be on water for a few days then off for a few days. With a rotation system, farmers in different sections of the irrigated tract alternate in receiving water. These methods for allocating water are quite similar with time being used to meter the available flow of water. One organization reported that normally sprinklers are supplied water continuously but other irrigators receive their water on rotation.

During the drought, some delivery organizations altered their delivery pattern to accomodate the water shortage. Seven organizations normally delivering on demand switched to scheduled delivery or rotation when flow water diminished. Low flows did not provide sufficient water for meeting the normal simultaneous demand placed on these systems. Of the six organizations normally delivering water on a continuous basis, two reported

switching to a schedule or rotation delivery pattern when water flows dwindled.

The remaining fifteen delivery organizations did not change their mode of delivery during the drought. However, of this group, many reported cutting back on the rate at which they were providing water.

The delivery organization strategy with regard to delivery mode during the drought is summarized in Table 5.1. Of the organizations reporting an impact, those with normal delivery on demand were more likely to switch mode while those with normal continuous delivery were more likely to retain that mode but to reduce flows. When a change in mode did occur, the new pattern chosen was schedule or rotation in every case. While only 12% of the sample is delivered by schedule or rotation in a normal year, 50% used this most common strategy during the drought.

5. Water transfers.

During periods of water shortage, efficiency in water use assumes even greater importance than normally. A necessary condition for efficient water use requires that the marginal value product of water be equal in all uses.*/ This efficiency condition may require the reallocation of water from uses with low marginal value product to uses with higher productivity or return.

During the drought, nine water delivery organizations (38%) reported an increase in intramural water transfers, transfers between users within an irrigated tract. Most of these transfers were informal in that they were arranged through the ditchrider without making formal arrangements with the water manager of the delivery organization. Because of the

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*/Assuming a gravity delivery system where the marginal cost of water is zero.

Table 5.1. Water Delivery Strategy.

	Normal Year [1]	Switched Mode [2]	1977 Drought [3]
Continuous	6	2	4
On Demand	15	7	8
Schedule	2	0	11
Combination [4]	1	0	1

[4] Continuous delivery for sprinklers, other application systems receive water by schedule or rotation.

[1] The number of delivery organizations using each delivery pattern in a normal year; [2] The number in each group switching delivery mode during the 1977 drought; [3] The number of delivery organizations using each delivery pattern during the year of the drought.

informality of transfers, more intramural transfers than reported in the survey may have occurred without the knowledge of the delivery organization.

The nature of the transfers was varied. Some irrigators purchased water from owners of developed residential lots within the irrigated tract whose water share exceeded their needs for lawn and garden. Some farmers with wells sold water to supplement the surface flows of their neighbors. In some cases two or more farmers pooled their water and applied it all on a reduced parcel of their total irrigated acreage. Some farmers reduced their planted acreage and sold their unused water.

Several delivery organizations reported selling supplemental water to irrigators. The source of water for these sales was either excess water in the delivery system resulting from non-use of water shares on residential tracts developed from irrigated cropland or the purchase of additional water from outside the system, usually storage water. Twenty-one percent of the delivery organizations reported additional extramural purchases or sales of water during the drought. Four organizations purchased storage water, either uncommitted or power company water, to supplement their users during the drought. One delivery organization sold the water from a small supplemental storage right during 1977.

6. Special problems.

The water organizations were asked to identify special problems encountered during the drought. Thirty-three percent (8) indicated there were no unusual problems beyond those occurring in a normal year. In fact, 12% (3) reported fewer problems with and among users than normal because of better cooperation or communication. Five delivery organizations reported more complaints or farmer resentment because of the

water shortage in their system. Four delivery organizations had difficulty serving irrigators at ditch ends or on high ground because of low flows. If high checking was used to compensate for low flows excessive seepage loss relative to flow reduced the delivery system efficiency. Other delivery organizations reported various problems related to water loss, water measurement, or equitable allocation. The most common response by delivery organizations for dealing with these problems was to expend extra labor to set headgates and otherwise manage the water more closely. Thirty-eight percent indicated this response.

7. Delivery system efficiency.

Inevitably transmission losses will occur as water is conveyed through the delivery system. Evaporation, seepage, spillage, moss and weeds all take their toll. Of the 20 delivery organizations responding to the system efficiency question, 50% reported delivery efficiencies of 75% or below in a normal year. From the same group of 20 organizations, 35% observed reduced delivery efficiencies during the drought due to dry conditions and higher percentage carriage loss with low flows.

Twenty-one percent of all organizations surveyed felt there was a great need[1/] to improve the efficiency of their delivery system. The most common improvement mentioned by all organizations was to line the canals. Seventy-five percent of the delivery organizations surveyed suggested this improvement. Two-thirds of this group, however, felt that because of the expense of this improvement, it would not be practical at this time. The two additional improvements most often mentioned were improved weed control and better water measuring devices. Twelve percent

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1/ A ranking of 4 or 5 on a scale of need from 1 to 5.

of the organizations mentioned each of these improvements. Other improvements mentioned less often include grading sections of canals or ditches, and installing closed pipe laterals.

8. Preparation for future drought.

Water managers were queried about their preparedness for future drought as a result of any managerial insights gained during the 1977 drought or as a result of system modifications inspired by the drought. Three managers responded that they wouldn't do anything differently in the future as a result of their experience in 1977. Eleven responded in indefinite terms that they would be guided in the management of future droughts by the general experience they had gained during 1977. Two managers indicated that they would use a water rotation schedule developed in 1977 during any future drought. Another water manager said he would begin a water rotation schedule earlier in the growing season during future drought. Other management options mentioned were using a bigger head of water initially to wet the canal and meeting early crop water needs more fully even at the risk of reduced watering later. Finally one manager said he would not install pumps in return flow drains to re-use water in the future.

Most water managers, 71%, reported that they had not made any system modifications based on their experiences in 1977 to better prepare themselves for dealing with future drought. Four of the organizations surveyed initiated system modifications as a result of the 1977 drought. The modifications included concrete pipe lateral, additional wells, efforts to reduce seepage, and more water measuring devices. Because of the expense involved in system modifications, preparation for future drought is more likely to take the form of managerial options for more efficient allocation or delivery of water.

D. How water managers rated the performance of drought related agencies and institutions.

So far chapter 5 has focused mainly on the actions of water delivery organizations as they attempted to deal with water shortages during the summer of 1977. Water managers were also asked a number of questions about the performance of government agencies and water institutions that presumably had some role to play in dealing with the 1977 drought.

A water manager needs accurate information on which to base any drought management strategy that deviates from normal water management practice. Table 5.2 shows how the water managers appraised a number of potential information sources. As expected, the most important information source was the water master. His role in supervising water allocation to a number of delivery organizations justifies this position. Generally it is the water master who tells the managers of the water delivery organization how much water they can expect to receive. The water master was followed by the Soil Conservation Service (which predicts water availability), the Bureau of Reclamation (which operates much of the storage) and by the Idaho Department of Water Resources as useful information sources. Surprisingly, other water managers were not cited as useful information sources. One might expect that the experiences of other delivery organizations in implementing programs such as scheduling, rotation, installation of measuring devices, etc., would be relevant. However it appears that there is no mechanism to facilitate such communication. Regarding the sources of information they used, the water managers were quite complementary -- 87 percent said the information was timely and only 17 percent thought the information was poorly coordinated.

When asked about the adequacy of communications between themselves and farmers, 92 percent of the water managers rated it average or better.

Table 5.2. Water Managers Rating of Useful Information Sources

Source	Source Used #	Source Used %	Source Was Somewhat/Very Useful #	Source Was Somewhat/Very Useful %	Source Was Not Useful #	Source Was Not Useful %	No Answer on Usefulness #	No Answer on Usefulness %
Water Master	17	73.9	16	69.6	0	0.0	1	4.3
SCS	11	47.8	10	43.5	1	4.3	0	0.0
Bureau of Reclamation	12	52.2	9	39.1	1	4.3	2	8.7
IDWR	13	56.5	7	30.5	2	8.7	4	17.4
Media	9	39.1	5	21.7	2	8.7	2	8.7
Extension Service	5	21.7	4	17.4	0	0.0	1	4.3
Drought Task Force	5	21.7	2	8.7	2	8.7	1	4.3
ASCS	3	13.0	2	8.7	0	0.0	1	4.3
USGS	2	8.7	1	4.3	0	0.0	1	4.3
Other Managers	2	8.7	1	4.3	1	4.3	0	0.0
Ditch Rider	1	4.3	1	4.3	0	0.0	0	0.0
ARS	0	0.0	0	0.0	0	0.0	0	0.0
Farmers	0	0.0	0	0.0	0	0.0	0	0.0

Certainly the drought intensified that communication -- 71 percent reported more communication than in previous years. However several water managers lamented that much of the increase was in the form of complaints. None of the managers reported a need for more communication.

The Idaho Department of Water Resources (IDWR) is the principal state agency that might be expected to have a role in dealing with drought. When water managers were asked what IDWR had done to help their delivery organization in 1977, half said that they were not aware of any help. Six others said that IDWR was a source of information. Other comments about IDWR included:

- helped delivery organization get equipment from federal agency.
- did not support application for aid for installing water measurement devices.
- helped locate additional storage water.
- initiated adjudication proceedings several years ago.

While half of the water managers didn't see anything else that IDWR should do in a future drought. Others suggested that IDWR should:

- encourage sprinkler conversion.
- do better job of distributing information and referring problems to other agencies.
- distribute money more equitably.
- more frequent and timely water reports.
- police wells and drains more effectively, enforce permits.

The water managers were unanimous in their support of the appropriation doctrine, seeing no need for fundamental changes in water law. However there were some suggestions for changes in water and drought policy (several of which seem to be oblique criticisms of the appropriation doctrine):

- make sure reservoirs will fill before starting to spill water in spring. (2 responses)
- reallocate river and storage more equitably.
- disaster payments should go to everyone in disaster area, not just those in set aside program.
- 160 acre limit should be changed.
- critical of efforts to improve water use efficiency because farmers could lose rights to saved water.
- IDWR should have more control over waste water and ground water use.

Only half of the water managers were aware of the Water Bank Act. When the program was explained to them, only 3 said that the program would not be useful, compared to 13 who thought it would be useful and 5 who were not sure. Two others thought it would be a useful program, but not in their delivery organization. When those who thought it would be useful were asked to elaborate, their comments began to sound a bit less enthusiastic:

- no water available during drought in this area. (4 responses)
- idle water should be put to use to promote efficiency. (3 responses)
- extra government read tape not needed. (2 responses)
- water master does this under existing policy. (2 responses)
- would allow greater flexibility.
- good program if IDWR did not control it.
- should be useful, but for stored water only.
- delivery organization doesn't know if there is extra water until season is over.
- doubts that much water would be sold.
- farmers can handle transfers themselves.
- delivery organizations don't want water leaving their system.

- would clear up legal questions about current procedures.
- who would pay administrative costs?

It is clear that water managers (as was true for farmers) have a range of misgivings about the usefulness of the Water Bank Act. It will take another drought approaching the severity of that in 1977 to test the worth of this program.

E. Summary

The predominate strategy of the delivery organizations during the drought was to switch to scheduled delivery of water. This strategy was expendient given the limited distribution of water metering devices at farm turnouts and the need to generate sufficient flow of water to irrigate fields. The sharing of available water on a pro rata basis within a fairly homogeneous delivery organization is an economically efficient way to allocate water during drought. The yield penalty from water shortage will be less than if some irrigators bear all the cuts while others incur none.

CHAPTER 6

SUMMARY AND IMPLICATIONS FOR FUTURE DROUGHT

Previous chapters have noted the responses of Idaho farmers and water delivery organizations to the drought of 1977. The task of this chapter is to draw that information together and to examine the implications for future periods of water shortage.

Chapter 2 gave a basic overview of Idaho water law and the constraints which it places on response to drought. Water law was formulated to protect, as much as possible, the security of water rights, creating a favorable climate for long term investment in water resource development. However the long term security embedded in the appropriation doctrine imposes costs of system inflexibility in times of drought. While water law and delivery organization bylaws restrict water from moving freely into uses with higher marginal value products, strategies such as prorationing, rotation, and participation in Water Bank programs do allow an approach toward optimal allocation. Because the interrelationships among users and uses, where one users waste water becomes another's water source, is not yet well understood, it is prudent to proceed cautiously with on-farm efficiency improvements and reallocation of water as strategies for dealing with water shortage. The strong support for the appropriation doctrine in both the farmer and water manager interviews implies that long term water right security is valued more highly than short term flexibility during drought. The lukewarm reception of the Water Bank program by both the farmers and water managers interviewed in this study

reinforces this impression. It appears that fundamental water law changes to help farmers during drought are not wanted.

Chapter 3 addressed what farmers actually did during the 1977 drought. While crop changes, variety changes, and idled land were observed, their magnitude was quite small as a percentage of irrigated cropland in the study areas. The crop and variety changes that did occur were concentrated in the Ada-Canyon County area, a diversified area with a wide variety of potential crops for farmers to select from. Much of the idled land was in Blaine and Lincoln Counties, which have fewer potential crops and are subject to chronic water shortage. Water conserving crops are the norm in this area, so one of the few options when water is acutely short is to idle cropland.

While some farmers did adopt these cropping pattern strategies, most farmers proceeded with their usual cropping pattern, even when faced with a high probability of water shortage. As a result, the primary effect of drought was to cause yield declines, crop quality problems, and nonharvest, rather than acreage changes.

The decision process of farmers faced by drought is complicated by several levels of uncertainty.* First the severity of drought is unknown at planting time, and most cropping pattern changes to save water would result in a certainty of lowered incomes. Farmers may perceive that proceeding with a normal cropping pattern and hoping that enough water is available is the strategy which will give the highest expected utility

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*The terms risk and uncertainty are treated synonymously here, ignoring the distinction between the terms sometimes made by economists.

from income. The second uncertainty is really a lack of knowledge about crop response to water. Not enough is yet known about how crops respond to reduced water application to allow farmers to make fully informed decisions about which cropping pattern and water allocation strategy is economically optimal. The patterns observed during the 1977 drought seem roughly to agree with our expectations of which uses might have higher marginal value products. However the absense of good information on how the range of crops grown in southern Idaho respond to water prevents a precise evaluation of whether farmers response in 1977 was economically rational.

The implication is that better information would be helpful to farmers faced by drought. This would include continued improvements in the accuracy and timeliness of forecasts produced by agencies charged with predicting the severity and timing of drought. Also helpful would be better advice to farmers regarding which crops to grow and how to allocate a limited quantity of water more effectively. The type of crop response data now being collected in various studies of deficit irrigation should contribute to the optimazation of water use during drought.

The farmer interviews did suggest that water was being managed much more carefully than usual during the summer of 1977. Many crops got less water, but didn't suffer corresponding yield declines. Farmers made many irrigation system changes and improvements in 1977. How many of these were changes that had been needed for some time, but were finally prompted by the dry year and/or the availability of financial aid is uncertain. It is certain that these changes helped farmers to better control their use of water, and thus improve their efficiency. The ability to make such

efficiency improvements means that some water shortage can be endured with not too much impact on crops. However this has a disturbing implication--the long term movement to improve irrigation efficiency by sprinkler conversion, lining canals, irrigation scheduling, etc., means that much of this cushion may be lost. Idaho irrigated agriculture may become more vulnerable to drought. The effect of improvements in water use efficiency on this drought cushion depends very much on how Idaho water law interprets a farmer's rights to the water saved by efficiency improvements. The effects of these system changes and efficiency improvements on return flows and groundwater levels are uncertain--but should be of concern to those farmers who rely on such sources for their irrigation water.

The move to more energy intensive irrigation systems which use even more electricity in low rainfall years will complicate the efforts of electric utilities to provide enough electric power during periods of drought. Use of irrigation wells during drought to supplement short surface water supplies will further accentuate the drought caused irrigation electricity demand peak at a time when the hydroelectric generating capacity is depleted.

The water delivery organizations play a major role in allocating water during drought. The interviews suggest that the tendency to shift to rotation delivery of water during 1977 was based at least in part on the ease of using time to measure water in the absence of devices to physically measure water delivery. The problems of combining rotation delivery with sprinkler application, and the growth of the latter suggest that many water delivery organizations may have to make more use of water

measuring devices in the future.

The close relationship between farmers and water delivery organizations suggest that the water delivery organization may be a good vehicle for reaching farmers with information about drought severity and suggestions about crop pattern changes and water management practices. In fact farmers listed the ditch rider and water manager among their most useful information sources during the 1977 drought. Programs to improve the quality of information which these sources can pass along, would be very useful.

It is clear from the interviews that drought financial aid played an important role in 1977. Some of the aid served primarily to mitigate farmers drought losses and help them survive financially for another year. Other aid programs served as an incentive for farmers to change their ways of doing things--to make application system changes, line canals, drill wells, install measuring devices, etc. Given the potential of these aid programs as incentives to influence farmer behavior, and the possible consequences of these changes for Idaho irrigated agriculture, there is a need to carefully evaluate these aid programs to assure that their results serve society's long term interests.

Society certainly has an interest in helping farmers deal with drought. The costs of the 1977 drought described in chapter 4 were large, and these were only the primary impacts. The secondary and tertiary impacts on agricultural processing firms, farm input suppliers, farm service businesses, local communities, and on state tax revenues must have also been large. Thus society can, in its own self interest, justify drought aid programs, programs to reduce the impact of the drought, and can justify the involvement of state and federal agencies in helping farmers to deal with drought.

FOOTNOTES

1. Yevjevich, V., W.A. Hall, and J.D. Salas (Eds.), Drought Research Needs, Proceedings of a conference held at Fort Collins December 1977, Water Resources Publications, Fort Collins, 1978, p. 235.

2. Yevjevich, op. cit., p. 36.

3. Idaho Const. art. 15, Sec. 3; Idaho Code Sec. 42-103 (1977); Drake v. Earhart, 2 Idaho 750, 23 P. 541 (1890).

4. State of Idaho, Department of Parks v. Idaho Department of Water Administration, 96 Idaho 440, 530 P.2d 924 (1974).

5. Idaho Code Sec. 42-1501 to 1505; 67-4301 to 4312 (1973, 1977 & Supp. 1980).

6. See, e.g., Olson v. Bedke, 97 Idaho 825, 830, 555 P.2d 156, 161 (1976); Parke v. Bell, 97 Idaho 67, 69, 539 P.2d 995, 997 (1975); DeRousse v. Higginson, 95 Idaho 173, 174, 175, 505 P.2d 321, 322, 323 (1973).

7. E.g., Nielson v. Parker, 19 Idaho 727, 115 P. 488 (1911). The constitutional method of appropriation is discussed more fully in Grant, The Idaho Water Plan: Two Threshold Constitutional Problems and Suggested Solutions, 15 Idaho L. Rev. 443, 476-82 (1979).

8. 1971 Idaho Sess. Laws, ch. 177, now codified in Idaho Code Sec. 42-103 and - 201 (1977).

9. Idaho Code Sec. 42-217,-218 (1977 & Supp. 1980).

10. Idaho Code Sec. 42-220 (1977).

11. Idaho Code Sec. 42-1401 to-1414 (1977 & Supp. 1980).

12. Nielson v. Parker, 19 Idaho 727, 115 P. 488 (1911).

13. Id.

14. Idaho Const. art. 15, Sec. #3; Idaho Code Sec. 42-106 (1977).

15. Idaho Code Sec. 42-602 (1977).

16. Idaho Code Sec. 42-604 (1977) directed the Department to do this.

17. Idaho Code Sec. 42-605 (1977).

18. Idaho Code Sec. 42-607 (1977).

19. State v. Twin Falls Canal Co., 21 Idaho 410, 433, 439-43, 121 P. 1039, 1046-47, 1049-50 (1911); Helphery v. Perrault, 12 Idaho 451, 86 P. 417 (1906).

20. Helphery v. Perrault, 12 Idaho at 454, 86 P. at 418.

21. Idaho Const. art. 15, Sec. 3 & 5.

22. W. Hutchins, Selected Problems in the Law of Water Rights in the West 356 (U.S.D.A. Misc. Publ. 418 1942); F. Trelease, Water Law: Cases and Materials 110 (3d ed. 1979).

23. Muir v. Allison, 33 Idaho 146, 191 P. 206 (1920).

24. 33 Idaho at 163, 191 P. at 211.

25. Id.

26. Beecher v. Cassia Creek Irrigation Co., 66 Idaho 1, 10, 154 P.2d 507, 510 (1944).

27. To understand why the law would allow a cushion in appropriations, consider the following statement from Caldwell v. Twin Falls Salmon River Land & Water Co., 225 F. 584, 595-96 (D. Idaho 1915): "If the settler's right is barely sufficient for his needs in the ordinary years and in the absence of mishaps, manifestly he must suffer loss when the run-off falls below the average, or when, through accidents to the system, there is partial or temporary loss of the use of water, or when, because of light precipitation and other weather conditions, the need of water is unusually large. Ordinarily for the farmer not to make provisions against such contingencies would be counted against him for carelessness . . . . Conservation of water is a wise public policy, but so also is the conservation of the energy and well-being of him who uses it. Economy of use is not synonymous with minimum use. Better four prosperous farmers than five who are unsuccessful because of the uncertainty in the water supply, and better four farms uniformly fruitful than five upon which failure is ever imminent, and to which it is bound to come on the average one year in five."

28. But see text accompanying note 2 supra.

29. Idaho Code Sec. 42-904 (1977).

30. Idaho Constiution art. 15, Sec. 5.

31. Brose v. Board of Directors of Nampa & Meridian Irrigation Dist., 20 Idaho 281, 118 P. 504 (1911). See also Brose v. Board of Directors of Nampa & Meridian Irrigation Dist., 24 Idaho 118, 132 P. 799 (1913).

32. Brose v. Board of Directors of Nampa & Meridian Innigation Dist., 20 Idaho at 286, 118 P. 15

33. See, e.g., Johnson v. Strong Arm Reservoir Irrigation Dist., 82 Idaho 478, 356 P.2d 67 (1960).

34. Idaho Code Sec. 42-2-2,-217,-219 (1977 & Supp. 1980).

35. Idaho Code Sec. 42-1410 (Supp. 1980).

36. See, e.g., Harris v. Chapman, 51 Idaho 283, 5 P.2d 733 (1931) (noting that an adjudication decree entered in 1909 failed to state the place of use of a particular right).

37. See Dunn v. Boyd, 46 Idaho 717, 722, 271 P.2, 4 (1928) (limitation as to period of use).

38. Idaho Code Sec. 42-108,-222(1) (1977 & Supp. 1980).

39. 1981 Idaho Sess. Laws, ch. 147.

40. See Grant, Reasonable Ground Water Pumping Levels under the Appropriation Doctrine: Law and Economic Goals, 21 Nat. Res. J. (1981).

41. See Bennett v. Nourse, 22 Idaho 249, 253, 125 P. 1038, 1039 (1912).

42. Idaho Code Sec. 42-222(1) (Supp. 1980) (the Director "shall approve the change in whole, or in part, or upon conditions, provided no other water rights are injured thereby and the change does not constitute an enlargement in use of the original right."

43. 66 Idaho 173, 157 P.2d 1005 (1945).

44. 66 Idaho at 180-81, 157 P.2d at 1008.

45. 66 Idaho at 182, 157 P.2d at 1009.

46. Brief for Respondent at 17, Colthorp v. Mountain Home Irrigation Dist., 66 Idaho 173, 157 P.2d 1005 (1945).

47. 44 Idaho 410, 258 P. 176 (1927).

48. 66 Idaho at 179, 157 P.2d at 1007.

49. 73 Idaho 152, 248 P.2d 540 (1952).

50. 73 Idaho at 161, 248 P.2d at 545.

51. 73 Idaho at 162, 248 P.2d at 546.

52. National Water Commission, A Summanry-Digest of State Water Laws 279 (1973). The same interpretation is set forth in 1 W. Hutchins, Water Rights Laws in the Nineteen Western States 636 (1971).

53. See 1 W. Hutchins, Water Rights Laws in the Nineteen Western States 497-99 (1971).

54. E.g., In re Robinson, 61 Idaho 462, 469, 103 P.2d 693, 696 (1940): "The lodestar of utility of irrigation water is application to a beneficial use without waste, i.e., using no more than is necessary according to the standards and practices of good husbandry for the particular crop sought to be grown, soil and all other essential factors and conditions being taken into consideration. . . ." See also Idaho Code Sec. 42-220 (1977).

55. Federal Land Bank of Spokane v. Union Central Life Ins. Co., 54 Idaho 161, 166, 29 P.2d 1009, 1010 (1934).

56. Hutchins, Idaho Law of Water Rights, 5 Idaho L. Rev. 1, 69 (1968).

57. 1969 Idaho Sess. Laws, ch. 303, Sec. 2, now codified as Idaho Code Sec. 42-222(1) (1977).

58. See Idaho Department of Water Resources, A Program to Promote Irrigation Conservation in Idaho 15 (1978).

59. Idaho Code Sec. 42-222(1), (3) and 42-1701A(2) (Supp. 1980).

60. Idaho Department of Water Resources, A Program to Promote Irrigation Conservation in Idaho 17 (1978).

61. Beker Industries, Inc. v. Georgetown Irrigation Dist., 101 Idaho 187, 610 P.2d 546 (1980).

62. 1981 Idaho Sess. Laws, ch. 147. The Legislature also passed a special statute authorizing the leasing of water rights for hydropower generation. 1981 Idaho Sess. Laws, ch. 267.

63. Muir v. Allison, 33 Idaho 146, 159-60, 191 P.206, 210 (1920).

64. Zezi v. Lightfoot, 57 Idaho 707, 711-12, 68 P.2d 50, 52 (1937).

65. 43 U.S.C. Sec. 641-45 (1976).

66. Idaho Code Sec. 42-108,-222(1) (1977 & Supp. 1980).

67. See Rayl v. Salmon River Canal Co., 66 Idaho 199, 215, 157 P.2d 76, 83 (1945) (Carey Act system).

68. Idaho Code Sec. 42-2501 (1977).

69. Idaho Code Sec. 42-2503 (1977).

70. Idaho Code Sec. 42-2504 (Supp. 1980).

71. In re Robinson, 61 Idaho 462, 103 P.2d 693 (1940).

72. Jones v. Big Lost River Irrigation Dist., 93 Idaho 227, 459 P.2d 1009 (1969); Bradshaw v. Milner Low Lift Irrigation Dist., 85 Idaho 528, 381 P.2d 440 (1963); Jensen v. Boise-Kuna Irrigation Dist., 75 Idaho 133, 269 P.2d 755 (1954).

73. See Idaho Constitution art. 15, Sec. 4; Idaho Code Sec. 42-914 (1977).

74. P.L. 95-18, 43 U.S.C.A. Sec. 502, note.

75. 1979 Idaho Sess. Laws, ch. 193, now codified as Idaho Code Sec. 42-1761 to - 1766 (Supp. 1980).

76. Idaho Water Resource Board. Water Supply Bank Rules and Regulations (hereinafter cited as Water Bank Rules). The regulations became effective on May 20, 1980.

77. Water Bank Rules 3 and 4.

78. Water Bank Rules 3.1 and 4.1.

79. The local public interest limitation first appeared in the 1979 Water Bank Rules. There was no public interest limitation in the general water transfer statutes until 1981.

80. Water Bank Rule 3.2.

81. Water Bank Rule 4.1.

82. Id.

83. Water Bank Rule 4.2.

84. Id.

85. Id.

86. Water Bank Rule 4.4.

87. Water Bank Rule 6.1.

88. Water Bank Rule 2.4.

89. Water Bank Rule 6.1.

90. Water Bank Rule 6.1.6.

91. Idaho Code Sec. 42-1766 (Supp. 1980).

92. Idaho Department of Water Resources, A Program to Promote Irrigation Conservation in Idaho 15 (1978).

93. Sebern v. Moore, 44 Idaho 410, 418, 258 P. 176, 178 (1927).

94. U.S. V. Haga, 276 F.41, 46 (D. Idaho 1921).

95. Hidden Springs Trout Ranch, Inc. v. Hagerman Water Users, Inc., 101 Idaho ___, 619 P.2d 1130 (1980).

96. Idaho Code Sec. 42-222(2) (Supp. 1980).

97. Yevjovich, op. cit. note 1, p. 23.

98. Idaho Code Sec. 42-229 (1977); Baker v. Ore-Ida Foods, Inc., 95 Idaho 575, 513 P.2d 627 (1973).

99. 1963 Idaho Sess. Laws, ch. 216, Sec. 1, now codified in Idaho Code Sec. 42-339 (1977).

100. Idaho Code Sec. 42-227 (Supp. 1980). A commercial well driller must be licensed, however, under Idaho Code Sec. 42-238 (Supp. 1980). See also Idaho Code Sec. 42-230(c) (Supp. 1980).

101. Idaho Code Sec. 42-228 (1977).

102. See 1 W. Hutchins, Water Rights Laws in the Nineteen Western States 573 (1971).

103. Gilbert v. Smith, 97 Idaho 735, 552 P.2d 1220 (1976).

104. Idaho Code Sec. 42-222(2) (Supp. 1980).

105. Application of Boyer, 73 Idaho 152, 160, 248 P.2d 540, 544 (1952); Carrington v. Crandull, 65 Idaho 525, 531-32, 147 P.2d 1009, 1011 (1944); Zezi v. Lightfoot, 57 Idaho 707, 713, 68 P.2d 50, 52 (1937).

106. Idaho Code Sec. 42-203 (Supp. 1980).

107. Id.

108. Idaho Code Sec. 42-233a (Supp. 1980).

109. See Idaho Code Sec. 42-226, -237a(g) (Supp. 1980); State ex rel. Tappan v. Smith, 92 Idaho 451, 444 P.2d 412 (1968).

110. Idaho Code Sec. 42-233a (Supp. 1980).

111. Idaho Code Sec. 42-233a (Supp. 1980).

112. Idaho Code Sec. 42-226 (Supp. 1980).

113. Idaho Department of Water Resources, An Economic Water Market as an Alternative to Reduce Return Flow From Irrigation, Boise, February 1979.

114. Idaho Department of Water Resources, Incentives for Improved Water-Use Efficiency, Boise, August 1976.

115. Gaffney, Mason, "Economic Aspects of Water Resource Policy," American Journal of Economics and Sociology, v. 28, p. 131.

APPENDIX A

Detailed Responses to the Question "Do you think the Federal agencies should do anything different in the future?"

Frequency	Comments Referring to Federal Agencies in General:
20	should do nothing different/did good job
14	stay out/let farmers handle it
11	more programs needed/not enough money available
11	unfair distribution within counties/favoritism/preferential treatment
10	more storage water needed/more dams or reservoirs
6	need to declare disaster area sooner
5	unfair distribution of aid to counties/big counties get most
5	don't know what else they could do
5	get more water/snowpack information to farmers/sooner
4	too much money spent
4	monitor water better to keep full storage
4	did the best they could
3	too much red tape/application forms too complicated
3	local authorities need more active role
3	programs conflict with each other
3	programs not publicized enough
3	individuals abuse or cheat on programs
3	do away with agency
2	programs penalized good operator/handout to inefficient one

Frequency	Comments Referring to Federal Agencies in General:
2	support irrigation system improvements
2	make money available at lower interest rate
2	put a stop on irrigation projects/don't reclaim more land
1	money came too late
1	better systems of drought/crop insurance needed
1	programs unfair to row crop people
1	need educational programs on water efficiency
1	people at agency don't know what is going on
1	keep Idaho's water for Idaho
1	programs should be more area specific
1	set up an across-the-board acreage reduction
1	get more water to this area
1	investigate recharging aquifer with spring run-off
1	give farmer priority over all other uses of storage water
1	has to be really bad before federal agencies become involved
1	better coordination among agencies
1	conflict with water needed to run downstream generators
1	programs were effective for some/useless for others
1	agencies need to be more accurate with information given out
	Comments Referring to the Extension Service:
1	helps plan improvements, low interest loans
	Comments Referring to the ASCS:
5	did good job

Frequency	Comments Referring to the ASCS:
3	too much red tape/application forms too complicated
3	unfair distribution of aid to counties
3	money came too late
3	more programs needed/not enough money available
3	individuals abuse or cheat on programs
2	unfair distribution of aid within counties
2	programs penalized good/helped inefficient farmers
1	programs conflict with each other
1	programs not publicized enough
1	too much money spent
1	need educational programs on water efficiency
1	monitor water better to keep full storage
1	program information too vague/can't tell what you qualify for
1	they treat you badly
1	people at agency don't know what is going on
1	do away with agency
	Comments Referring to the SCS:
2	did a good job
1	more storage water needed/more dams, reservoirs
1	need educational program for water efficiency
1	get more water/snowpack information to farmers
	Comments Referring to the Bureau of Reclamation:
3	more storage water needed/more dams, reservoirs

Frequency	Comments Referring to the Bureau of Reclamation:
2	monitor water better to keep full storage
1	did good job
1	local authorities need more active role
1	use less water for fish
1	earlier notification of what water would be available
1	BLM should be under Dept. of Agriculture rather than Bureau of Reclamation
	Comments Referring to the Farmers Home Administration:
2	hard to get to talk to agency
1	did bad job
1	unfair distribution of aid within counties/favoritism
	Comments referring to the Corps of Engineers
4	monitor water better to keep storage full
1	local authorities need more active role

APPENDIX B

Detailed Responses to "Reasons why either satisfied or not satisfied with management of delivery organization."

Frequency	Reason
35	they did the best they could under the circumstances
24	managed water in a fair, timely manner
14	poor management of water
6	got information out
6	let too much water out of storage
5	low quality of ditch rider/water manager
2	did not get information out
2	satisfied--same as always
1	little warning of cutoffs
1	poor maintenance
1	accurate measurement with demand scheduling is superior to continuous flow
1	scheduled delivery used too much water so changed to demand
1	everyone cooperated to handle problem
1	problems of favoritism
1	ditches should be lined
1	ditches were well cleaned
1	yes, gates aren't locked, can turn off and on when they want
1	there's normally a lot of water, making system easy to manage
1	demand system is ideal

Frequency	Reason
1	dragline in channels improved system
1	cost is low, help is problem
1	on end of ditch, fluctuations in canal
1	directors from locality were sympathetic
1	worried at first, but everyone had enough water
1	helped make the decision to go to scheduling
1	rotation system doesn't work for sprinklers
1	got water as long as it was available
1	yes, but needed larger stream at first to wet canals
1	no, force farmers to install headgates, control weeds
1	yes, ditch riders and water managers cracked down on those using too much

APPENDIX C

Detailed Responses to "If the appropriation doctrine didn't work, what changes would you suggest?"

Frequency	Response
3	eliminate it
3	revise water allowance per acre
2	use water for farming, not power
1	need better adjudication
1	need better water master
1	160 acre limit should be changed
1	didn't work, people bought water but couldn't get it delivered
1	make an effort to stop leaks
1	improve methods for determining what water to let by and what to store
1	should work if everyone treated equally
1	based on power, you find who your friends are
1	another drought year will test it
1	need more enforcement of water laws
1	everyone agreed to share equally
1	storage helps

APPENDIX D

Detailed Reasons Given for Whether Water Bank Would Be Useful During a Drought

Frequency	Reason
17	no water available for transfer
7	would improve efficiency
5	would legalize existing practice
4	too complicated
2	rich will get richer
2	would allow flexibility
2	transfer out of system would be a problem
1	water company should handle this
1	too much government bureaucracy
1	hasn't had trouble buying water in past from individuals
1	farmers would save water for themselves, a waste of taxpayers money
1	he sold water to another delivery organization
1	shouldn't charge for water if they can't deliver
1	would help water short areas
1	useful in this area but not in general farming areas
1	good idea in principle--in practice, who knows?
1	violates purpose of appropriation doctrine
1	wouldn't sell any
1	what is cost to taxpayers?
1	have to consider water from land that has been subdivided

Frequency	Reason
1	many users would buy
1	good idea if I could help my neighbor without hurting my water right
1	not needed, leave things as they are
1	not needed, a market develops anyway
1	fine if rights to carry-over and excess water not harmed
1	might make it too easy to buy water and cause shortage
1	let farmers handle it and keep government out
1	let informal system handle it, water shouldn't leave system
1	need someone to put buyer and seller together, do that locally now
1	could sell 2-300 acre feet annually, but wouldn't
1	could have bought water from another district, but not allowed to
1	tried to get water but couldn't
1	more bureaucracy, don't like to lose freedom of choice
1	all subdivisions should be able to get water they pay for
1	would improve efficiency, cause problems
1	keep government out
1	useful on 1 year basis
1	if people have a pump, could sell extra water
1	water supposed to be attached to land
1	no, unused water goes down canal to next user, might work on storage
1	might work for canal companies, not groundwater users
1	oppose if handled by state or federal agency, OK between individuals

APPENDIX E

Enumerator _____ Farm No. _____

Date _____ County _____

Confidential

Farmer Response to Irrigation Water Shortage

and the

Implications for Drought Policy and Water Policy

Department of Agricultural Economics and Applied Statistics

University of Idaho

Name of Farmer _____

Mailing Address _____

Phone Number _____

Copy of Survey Report Wanted? Yes ____ No ____

I. Background Information

1. Rank the following factors in relative order of significance on crop loss. Most significant first, least significant last.

   Hail, Insects, Drought, Frost, Disease, Wind

2. Did you feel 1977 was a drought year, yes or no? _____.

3. What constitutes a drought in this area?

4. Total acreage operated _____, total owned _____.

   rented _____.

5. Total acres you irrigate _____.

6. Number of irrigated acres owned _____, rented _____.

   rental agreement: crop share (each crop) _____,

   cash rent _____.

7. How long have you farmed in this area? _____.

8. What is your age? _____.

9. Are you a _____ sole proprietor _____ partnership _____ Father/son

   agreement _____ corporation?

II. Crops and Income

A. What crops did you have in 1977, the year of the drought?

1.

Crop (Specify dry or irrigated)	Variety	Acres Planted	Application System	Water Source (Surf.,G.W.,Mix)	Yield Per Harvested Acre	Normal Yield	Price Per Unit
Pasture	XXXXXX						
Idle Cropland	XXXXXX				XXXXXX	XXXXX	
Total	XXXXXX		XXXXXX	XXXXXX	XXXXXX	XXXXX	XXXX

2. Where there any unharvested acres?

B. Income for 1977

1. Was your 1977 gross income affected by the drought, yes or no?

How exactly and how much?

a. Changed crop mix. How did the drought affect your 1977 crop mix? (Probe for normal crop acreage mix or normal rotation)

b. Quality down. What was the effect?

c. Yields down due to other factors: hail, wind, insects, disease, frost, etc.

d. Other factors affecting gross income in 1977?

e. During the drought of 1977 did timely, rainfall in your area during the growing season help avert the shortage of irrigation water?

C. 1. What crops did you have in 1978, the year after the drought?

Crop (Specify dry or irrigated)	Variety	Acres Planted	Application System	Water Source (Surf.,G.W.,Mix)	Yield Per Harvested Acre	Normal Yield[a]	Price Per Unit
Pasture	XXXXXX						
Idle Cropland	XXXXXX				XXXXXX	XXXXX	
Total	XXXXXX		XXXXXX	XXXXXX	XXXXXX	XXXXX	XXXX

[a]Only for crops not listed in 1977 table.

2. Were there any unharvested acres?

D. Income for 1978

1. Was your 1978 gross income affected by the drought, yes or no?

   How exactly and how much?

   a. Changed crop mix. How did the drought affect your 1978 crop mix?

   b. Quality down. What was the effect?

   c. Yields down due to other factors: hail, wind, insects, disease, frost, etc.

   d. Other factors affecting gross income in 1978?

E. Livestock inventory, income and additional costs.

1. At what weight do you usually sell calves?

   Heifers _____ Steers _____; Yearlings?

   Heifers _____ Steers _____.

2. In 1977 were your 1977 calves light due to poor pasture? Yes or No? (If no, find out how many calves were sold, average weight and price anyway.) How light _____, number of calves sold; heifers _____ steers _____, average weight; heifers _____ steers _____, average price per lbs for heifers _____ steers _____.

3. In 1977 were your yearlings, that is your 1976 calves held over to 1977, light due to poor pasture? Yes or No? (If no, find out how many yearlings were sold, average weight and price anyway.) How light _____, number of yearlings sold; heifers _____ steers_____, average weight; heifers _____ steers _____, average price; heifers _____ steers _____.

4. Did you sell more calves or yearlings in 1977 than normal because of the drought?

5. In 1977 did you reduce your breeding stock due to the drought? Yes or No? (In any case) how many cows were sold in 1977? _____, How many of those were sold due to the drought? _____, average weight _____, average price _____.

6. How many bulls were sold in 1977? _____. How many of these, if any, due to the drought? _____, average weight _____, average price _____.

7. In 1977 did you make any extra feed or pasture purchases due to the drought? Yes or No? Cost; feed _____, pasture _____.

8. In 1978 how many calves did you sell? _____ average weight; heifers _____ steers _____, average price; heifers _____ steers _____. Was weight down due to the 1977 drought? Yes or No? How much? _____.

9. In 1978 how many yearlings (1977 calves held over) did you sell? heifers _____ steers _____, average weight; heifers _____ steers _____, average price; heifers _____ steers _____. Was weight down due to the 1977 drought? Yes or No? How much? ____.

10. In 1978 how many cows did you sell? _____ average weight _____ average price _____.

11. In 1978 how many bulls did you sell? _____ average weight _____ average price _____.

12. In 1978 did you make any livestock purchases to rebuild your herd as a result of the 1977 drought? Yes or No?

	Numbers	Price
Cows	_____	_____
Bulls	_____	_____
Calves	_____	_____

13. Did you keep more replacement heifers in 1978 to rebuild your herd because of drought reduction?

14. In 1978 did you purchase any extra feed or pasture as a result of the 1977 drought? Yes or No? Cost of feed _____, pasture _____.

III. Additional Costs:

1. Did you make any irrigation system changes in 1977 in response to the drought?

		Quantity	Cost	Cost/share	Agency
Conversion to Sprinkler	handlines				
	wheeline				
	center pivot				
Wells	drilling				
	casing				
	pumps				
Pumpback Systems	new				
	more intensive use				
	mainline				
	gated pipe				
	line ditches				
	other				

2. Did the Idaho power moratorium on new power hook ups affect your decision regarding sprinkler conversion?

3. Did you make increased use of existing groundwater systems? Yes or No? How much additional water was used _____, additional pumping cost _____.

4. Did you use more labor to operate your irrigation system in 1977 versus past years? Yes or No?

   a. Did you hire extra labor? Yes or No? How much? Cost?

   b. Did you use a larger proportion of your normal hired labor for irrigation activities? Yes or No? How much?

   c. Did you and/or your family increase your work week in order to irrigate in 1977? Yes or No? How much?

   d. Did you and/or your family spend a larger proportion of your normal working hours on irrigation activities? Yes or No? How much?

e. What tasks were accomplished with all additional irrigation labor mentioned? (monitoring of siphons, sprinklers, increased maintenance or irrigation system, etc.)

f. When extra labor cut into you and your hired man's time, what normal activities were sacrificed? (weed control on fallow ground, farm maintenance, checking fields, etc.)

5. Did you irrigate less frequently than usual on any crops? Yes or No?
Which ones? _____ How much less? _____.

6. Did you apply less water per irrigation on any crops? Yes or No?
Which ones? _____ How much less? _____.

7. Did you sacrifice one crop to save water for another?
What for What?

8. Did you idle any land you ordinarily would have cropped? Yes or No?
How much of each crop?

9. In anticipation of water shortage and reduced yield potential, did you reduce the application of fertilizer, herbicides or pesticides? Yes or No? On which crops? (Try to have farmer figure a dollar amount of savings per acre for each crop mentioned.)

Crop	Change in input	Change in cost

10. Did you acquire any additional water in 1977? Yes or No___How much?____For which crops?_____Cost_____
Was it transferred, rented or uncommitted water?

11. Did you transfer or lease water to someone else in 1977? Yes or No____How much?_____Price?_____.

12. Were there any other changes in your farm operation due to the drought which affected your costs (plus or nimus)?

IV. Water rights

A. Name of delivery organization_____.

B. Do you have storage rights? Yes or No____(If no, go to C).

1. How many acre feet of water per acre or share are provided in in your storage right(s)?_____.

2. Are these rights figured from the point of diversion on the river or at the point of farm delivery? (In case these categories are not appropriate, get their definitions.)

3. Do you usually receive water on demand, continuously, or on a scheduling system?_____
Was there a difference in 1977?_____
What effect did it have on your operation?

4. Did you have any carry over storage water rights available for 1977? Yes or No____How much?_____
Were they used?_____

5. Did you run out of storage water in 1977? Yes or No_____
When?_____

6. Do you normally run out? Yes or No____When?_____

C. Do you have flow rights? Yes or No?
If yes:

1. What are your flow rights - cfs or M.I.?

2. Are these rights figured from the point of diversion on the river or at the point of farm delivery?

3. What is the priority date of your flow right(s) (independents only)? (The date for each flow right if more than one)

4. Do you usually receive this water continuously, on demand, or on a scheduling system? _____. Was there a difference in 1977. Yes or No? What effect did this have on your operation?

5. Were you cut off from your flow rights in 1977? _____ When? _____

6. Are you normally cut off? _____ When? _____

D. Ground water

1. How many wells do you use for irrigation purposes? _____,
depth(s) _____,
lift(s) _____, pump size(s) _____
_____, electric _____ or PTO _____,
other _____.

2. How many acres is your groundwater right(s) for?

3. How many A.F./ac _____ & cfs _____ are your groundwater rights for?

4. Did drawdown from other wells interfere with your groundwater rights in 1977? _____not at all, _____mildly,
_____significantly.

What was your response to this?

E. Water Assessment

1. What was your total irrigation assessment in 1977?

2. How was it calculated? per acre _____, per AF, or cfs _____.

3. Was this a constant charge or did it vary with the amount of water used?

V. Drought Information and Institutional Assistance

1. Where did you get information about the drought?

_____IDWR	_____Not useful	_____Somewhat useful	_____Very useful
_____Drought Task force	_____Not useful	_____Somewhat useful	_____Very useful
_____Extension agent	_____Not useful	_____Somewhat useful	_____Very useful
_____ASCS Director	_____Not useful	_____Somewhat useful	_____Very useful
_____SCS	_____Not useful	_____Somewhat useful	_____Very useful
_____US Geological Survey	_____Not useful	_____Somewhat useful	_____Very useful
_____ARS	_____Not useful	_____Somewhat useful	_____Very useful
_____Bur. of Reclamation	_____Not useful	_____Somewhat useful	_____Very useful
_____Water Master	_____Not useful	_____Somewhat useful	_____Very useful
_____Ditchrider	_____Not useful	_____Somewhat useful	_____Very useful
_____Farmers	_____Not useful	_____Somewhat useful	_____Very useful
_____Media	_____Not useful	_____Somewhat useful	_____Very useful
_____Other (Specify)	_____Not useful	_____Somewhat useful	_____Very useful

a. Was this information timely?

b. Was this information coordinated between sources, or were there contradictions?

2. What communication existed between you and your delivery organization?

3. Did you seek and/or receive drought assistance from any of the following agencies in 1977? (Specify):

_____ ASCS? (Agricultural Stabilization and Conservation Service)
a) Conservation program_____ Total Cost_____ ASCS share (gated pipe, portable sprinklers, drill wells, install mainline)
b) Disaster payments for wheat (to 60% of yield level)_____
c) Disaster payments for feed grains_____
d) Emergency feed program_____

_____ FmHA? (Farmers Home Administration)
a) Major adjustment operating loan (8% for 7 years for machinery, livestock purchases, etc)_____
b) Annual operating loan (8% for one year)_____
c) Major adjustment to real estate loan (8% upto 40 years for irrigation systems and other real estate improvements)_____
_____.

_____ Small Business Administration_____

_____ Other lending institutions (PCA, Banks, etc.)_____

4. Did you have crop insurance that covered drought in 1977?_____
From whom?_____ Cost?_____
Did you collect any payment from it in 1977?_____ How much?_____

VI. Opinions (Read verbatim)

1. What do you think the chances of a drought next year are? For example:

2. What would convince you that a drought was coming?

3. If you were convinced of an impending drought next year what would you do?

4. Would you do some things differently as a result of your 1977 experience?

5. What had you done in the past that may have aided your ability to deal with the 1977 drought?

6. Have you done anything since the '77 drought that would aid your ability to deal with future droughts. What? Cost?

7. What did the Idaho Department of Water Resources do to help farmers in 1977?

8. Do you think the Department of Water Resources should do anything differently in future droughts? What?

9. Do you think the federal agencies should do anything differently in future droughts? Which agencies and what?

10. Were you satisfied with the management of your delivery system(s) during the 1977 drought? What did you like and what did you not like about it?

11. What practical improvements could be made to your delivery system(s).

12. In your opinion did the appropriation doctrine (first in time, first in right) function effectively during the drought?

    a. If not, what changes in water right law would you recommend to improve the management of water during future drought?

13. Are you aware of the water bank act? Yes or No? (if no, explain briefly). Do you think this program would be useful during a drought?

Thank you for your cooperation, a summary of the survey will be sent to you when it is completed next year if you have so requested.

APPENDIX F

Enumerator _____ Farm Number _____

Date _____ Delivery Organization _____

CONFIDENTIAL

Water Managers

Farmers' Response to Irrigation Water Shortage and the Implications for Drought Policy and Water Policy

Department of Agricultural Economics, University of Idaho

Water Manager _____

Mailing Address _____

_____

Phone Number _____

Copy of Results Requested -YES or NO-

I. WATER DELIVERY SYSTEM

1. Does your system have storage rights, flow rights, or both? (Circle answer)

a. If storage right(s):

1. Reservoir	Percent of Storage	Priority Date

2. Number of water users _____

3. Number of irrigated acres _____

b. If flow right(s):

1. Diversion Stream	Diversion Rate	Yearly Maximum AF/A	Priority Date	Acres Per Date

2. Number of water users _____

3. Total number of irrigated acres _____

c. Groundwater

1. How many wells are in your system? _____
depths _____ lifts _____
pump sizes _____ electric or PTO _____
2. How many acres are the groundwater rights for? _____
3. How many AF/ac _____ & cfs _____
are your groundwater rights for?
4. Did drawdown from other wells interfere with your system's groundwater rights in 1977?
Not at all _____, mildly _____
significantly _____. What was your response to this (drill deeper, legal action, etc.)

d. Pumpback systems

1. How much water does this provide for your system?
AF _____, cfs or % of total _____.

2. Was there any change in 1977 on your reliance on this system, more or less?
how much?

2. Measurement and Delivery

a. What type of water metering devices do you have between the point of river diversion and farm delivery?

b. Are they used in allocating water?

c. How accurate are they?

(not accurate) 1 2 3 4 5 (accurate)

3. What price structure do you use to charge farmers?
per acre, per AF, flat rate, varying rate, price _____

4. Do you usually deliver water continuously, on demand, or by a schedule?

How in 1977?

5. Do you normally have a water shortage in your system? (storage, flow)

How often? _____ How do you manage this shortage? (Explain scheduling system and if users are shut off, normally how many, when and selection method.)

6. Efficiency:

a. What is your delivery system's efficiency? _____
Was it different in 1977? _____

b. How great is the need to improve your delivery system's efficiency?

(No Need) 1 2 3 4 5 (Great Need)

c. How should it be improved?

II. DROUGHT RESPONSE

1. Did your system experience a water shortage in 1977? (Storage, Flow)

When? _____ What % of normal supply? (Storage, Flow)

2. Was there an increase in transfers or rentals of water between irrigators in your system during the 1977 season because of the drought? Yes or No If yes, (how many?) _____
System costs? _____

3. Were there any water transfer or rentals with outside sources during the 1977 season due to the drought? _____
How many and how much water? _____
Cost for each? _____.

4. Problems:

   a. What problems did you encounter during the drought in your role as water manager? (Physical system or delivery problems, equitable allocation, farmer resentment, etc.)

   b. How did you respond to these problems? (More or closer measurement, system improvements, extra labor, pump back, more groundwater, etc.)

   c. What cost was associated with this response?

5. How were user assessments affected by these additional drought related costs? _____
_____

6. Are you better prepared as a result of 1977 for a future drought? Yes or No.

   a. Managerial experience, what you would do differently?

   b. System modifications since 1977, describe and cost:

7. What farmer responses were particularly appropriate for coping with the water shortage?

8. Did any farmer responses aggravate the water shortage situation?

III. DROUGHT INFORMATION AND INSTITUTIONAL ASSISTANCE

1. Where did you get information about the drought?

____IDWR	____Not Useful	____Somewhat Useful	____Very Useful
____Drought Task Force	____Not Useful	____Somewhat Useful	____Very Useful
____Extension Agent	____Not Useful	____Somewhat Useful	____Very Useful
____ASCS Director	____Not Useful	____Somewhat Useful	____Very Useful
____SCS	____Not Useful	____Somewhat Useful	____Very Useful
____US Geol. Survey	____Not Useful	____Somewhat Useful	____Very Useful
____ARS (Ag. research service)	____Not Useful	____Somewhat Useful	____Very Useful
____Bur. of Reclamation	____Not Useful	____Somewhat Useful	____Very Useful
____Water Master	____Not Useful	____Somewhat Useful	____Very Useful
____Ditchrider	____Not Useful	____Somewhat Useful	____Very Useful
____Farmers	____Not Useful	____Somewhat Useful	____Very Useful
____Media	____Not Useful	____Somewhat Useful	____Very Useful
____Other (Specify)	____Not Useful	____Somewhat Useful	____Very Useful

a. Was this information timely? _____

b. Was this information coordinated between sources, or were there contradictions?

2. Communication:

a. What communication existed between you and your users during the drought?

b. Did this differ from previous years?

c. Was communication with users adequate? (Explain)

IV. DROUGHT POLICY (Read verbatim)

1. What did the IDWR do to assist delivery organizations in 1977?

2. Do you think IDWR should do anything differently in future droughts? What?

3. Did the appropriation doctrine function effectively during the drought?

   a. If not, what changes in water right law would you recommend for improving the management of water during future drought?

4. Are there any other policies or programs which you feel should be changed or added in order to improve the management of water during future droughts?

5. Are you aware of the Water Bank Act? _____
   (If not, explain it)

   Do you think this program would be useful during a drought?

Thank You for your cooperation.

SELECTED WATER RESOURCES ABSTRACT

Input Transaction Form

1. *Report No.*

2.

3. *Accession No.*

4. *Title*

The 1977 Drought in Idaho: Economic Impacts and the Responses of Irrigators and Water Delivery Organizations

5. *Report Date*

6.

8. *Performing Organization Report No.*

7. *Author(s)*
Joel R. Hamilton, David J. Walker, Douglas L. Grant

9. *Organization*

Idaho Water and Energy Resources Research Institute

10. *Project No.*

11. *Contract/Grant No.*

13. *Type of Report and Period Covered.*

12. *Sponsoring Organization*
OWRT

15. *Supplementary Notes*

16. *Abstract*

The objectives of this study were to use survey methods to document changes in cropping patterns, irrigation systems, and water management strategies caused by the 1977 drought; to document the way institutions such as water delivery organizations and government agencies respond to drought; to measure the economic consequences of drought in southern Idaho; to draw implications regarding probable farmer response in future droughts; and to make suggestions for drought management strategies.

While some farmers changed crops and varieties or idled land in anticipation of water shortage, the majority proceeded with normal cropping patterns. When water shortage occured, the result was reduced yield, or in some cases complete lost of the crop. These yield declines and lost crops comprised the largest part of the economic impact of the drought.

17a. *Descriptors*

drought, cropping patterns, irrigation systems, and water management

17c. *COWRR Field & Group*

02 B, E

18. *Availability*

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