THE IMPACT OF SUPPLEMENTAL IRRIGATION ON FARM ORGANIZATIONS IN POLK COUNTY OREGON

by

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A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

DOCTOR OF PHILOSOPHY

June 1956

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Date thesis is presented March 20, 1956

Typed by June Hutchings

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ACKNOWLEDGEMENTS

The writer gratefully acknowledges the assistance given by Dr. E. N. Castle, Department of Agricultural Economics. His guidance, criticisms and suggestions throughout the whole study were most helpful.

Valuable assistance and cooperation were obtained from the staff of the Extension Service of Polk County, especially Mr. John Hansen, County Agent. Also, Mr. Kenneth Millar, Economist, Department of Interior, Bureau of Reclamation was extremely helpful.

The cooperation of the farmers in the area under consideration was basic to the preparation of the budgets. Their friendly interest made the survey an enjoyable experience.

To all who supplied any information the writer is very grateful, and to Dr. C. V. Plath for his critical reading of the material.

Thanks are also extended to Mrs. H. M. Hutchings who has so carefully typed this manuscript.

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CHAPTER I

INTRODUCTION

Where moisture is a limiting factor, an adequate and stable supply of water will increase the yield of crops being grown in an area. This may increase farm income. In addition, when irrigation water is available, some of the uncertainty is removed from the farming operation. No longer is the farmer quite so dependent on the vagaries of the weather. Also, it will usually permit some further degree of diversification as new crops and enterprises may be added to the farm organization. Diversification tends to further stabilize farm income in areas where a one-enterprise system results in wide range in annual income if prices are unstable. Thus irrigation water may increase the productive capacity of the farm, remove some of the uncertainty prevailing where rainfall is a critical factor, and further stabilize farm income indirectly by permitting more diversification.

Water from the Willamette River is available for an irrigation project in the Monmouth-Dallas area of Polk county. This area, about twelve miles long and five to six miles wide is situated in the southeast corner of the county, between the Willamette flood plain on the east and the foothills of the Coast Range on the west. Rickreall Creek and the Luckiamute River, both tributaries of the Willamette River, drain the area.

In the prospective plan, developed by the Bureau of Reclamation, United States Department of Interior, the project known as the Monmouth-Dallas Project will consist of a pumping unit situated at Buena Vista on the Willamette River. This station will supply water through a main ditch to approximately 35,600 acres of land, of which about 33,000 acres are suitable for irrigation. The outlet for the main ditch will be Rickreall creek. A canvass of potential water users in the area indicated that approximately 10,000 acres would be irrigated within three years of the completion of the project (24, p.1 and p.3).

Monmouth, Independence, and Dallas, the urban centers in the area, are increasing in population and are interested in obtaining access to additional water resources. This will be possible when the project is completed. However this study is concerned chiefly with the impact of irrigation on the agriculture of the area.

At present irrigation is limited chiefly to the flood plain of the Willamette River and its tributaries where hay and pasture crops are irrigated in addition to the main irrigated crops, hops and snap beans. The large part of the area however is a dry land farming area. The crops now grown are mainly grains, and grasses for seed production. Relatively few livestock are raised in the area. The accompanying map of the area under consideration locates the boundaries.

General Description of the Area

Polk county has a moderate climate, with a rainy season, a dry summer, and a long growing season. The wet season is usually seven or eight months in length. The normal annual precipitation is about forty inches, almost seventy per cent of which falls during the period from November 1 to March 31. The summers are very dry, July and August having approximately 0.5 inches of rainfall. Because of the extremely light rainfall during the growing season, it has proven profitable to irrigate land for various crops where water is available. Farmers as a group are interested in obtaining an adequate supply of water for this purpose.

Soils

The soils in the area are relatively homogeneous having developed under similar environmental conditions. The main soil type is Amity Silt Loam (22, pp.1709-1710) located in a large block north of Monmouth and Independence. There are slight variations of this soil type but these variations are so small that the soils in this study are considered as homogeneous. Amity soils are limited in productive capacity by compacted subsoils but many different crops grow successfully on this soil type.

The Amity soil series is intermediate between the Willamette and Dayton series. Amity silt loam, the main soil type in this series, consists of 10 to 15 inches of light brown to light grayish brown silt loam with an average depth of approximately 12 inches. The subsoil in most places is composed of two sections. The upper section, extending to a depth of 24 to 30 inches varies from a mottled light brown to a light grayish brown silt loam or silty clay loam moderately compact in structure. The lower section is light-brown silt loam mottled with gray, rusty brown, or brownish yellow. It is usually lighter in texture and more friable in structure than the upper subsoil. Mottling is due to the imperfect drainage conditions in the subsoil and this mottling may be from 10 to 12 inches from the surface in flat areas and not within 30 inches from the surface where drainage is better.

The Amity silt loam is derived from old valley filling material. The topography is usually nearly level and water may lie on the fields during the rainy season. Many places are gently rolling permitting an adequate degree of surface drainage.

Amity silt loam responds to good treatment and is capable of high production. In the natural state it is low in organic matter and poorly drained but where these limitations have been overcome this soil type compares favorably with the Willamette soil series.

The topography of the area varies considerably from farm to farm ranging from almost level to gently rolling. As most irrigation water will be applied by sprinkler system, this is the only type of system that is considered in this study.

Problems Facing Farmers

The immediate problem facing individual farmers in the area is whether to irrigate or not. They are aware that introduction of water will increase productivity, permit some diversification and reduce uncertainty. They also know that the use of irrigation water on their farms will require changes in organization, may increase labor and/or capital requirements, and will likely affect farm income. They feel the need for information as to the extent of the adjustment necessary and the relative merits of different organizations possible with irrigation. The problem facing those who intend to irrigate is one of choosing among alternative enterprises and crops that can be grown with irrigation and the adjustment that such a choice involves.

Most farmers will not irrigate their entire acreage, at least not the first few years. The amount of irrigated acres per farm may perhaps increase to this point but growth is expected to be gradual. However, the big impact of the introduction of irrigation will be felt during the first year of its introduction and in the immediate transition period.

As a result of the present situation and lack of adequate information, many questions have arisen in the minds of those affected. Most farmers realize that their choices will have far-reaching consequences. Some of the specific questions that have been asked are:

(1) What crops and enterprises can be introduced with irrigation?

(2) Can these new crops and enterprises be integrated with other enterprises and crops on the non-irrigated land?

(3) What change in investment will occur with varying amounts of irrigation?

(4) What change in labor requirements will result with higher production or more intensive type of crop?

(5) What change may be expected in farm income under different organizations using irrigation?

Objectives

The main objective of this study is to provide information that will offer some assistance to farmers when they try to answer some of the questions raised. The objective is not to make decisions for the individuals involved but rather to give some guidance to enable each to make his own decision with more confidence. Specifically the objectives of the study are:

1. To estimate the farm income that might be expected from a vegetable farm of 40 acres with 35 acres irrigated.
2. To determine and compare investment required, labor necessary and income expected with the following organizations on a 103 acre farm, 60 acres of which are irrigated.
   a. A dairy herd of 40 cows with replacements being raised.
   b. A dairy herd of 60 cows with replacements being bought.
   c. A beef feeder enterprise with 92 head of steers purchased as fall calves and marketed the following year.
   d. A beef herd of 60 cows producing calves for sale as fall calves. Grain is also sold.

e. A beef herd of 75 cows producing calves for sale as fall calves.

f. An alfalfa and hay farm.

3. To determine and compare the investment required, labor necessary and income expected with the following organizations on a 280 acre farm, 80 acres of which are irrigated.

   a. A dairy herd of 60 milking cows with replacements being bought.

   b. A beef feeder enterprise with 153 head of steers purchased as fall calves and marketed the following year.

   c. A beef herd of 100 cows producing calves for sale as fall calves.

4. To compare the budgets of the various organizations with irrigation with income possibilities of dryland farming.

5. To compare the linear programming method with the budgeting method as a technique in this type of problem.

6. To consider some of the basic economic implications of introducing water as an input into existing farm organizations.

Although this study was made of the Polk county situation, it is hoped that the results may be applied to other areas when irrigation is contemplated and similar problems arise.

CHAPTER II

METHOD OF STUDY

The study is divided into three main parts. The first phase consisted of the survey and the analysis of the records taken. The preparation of several farm budgets for various sized farms comprised phase two. The third phase considered some of the possibilities using linear programming as a budgetary device as well as a consideration of some of the fundamental aspects of using water as a productive input.

Phase 1

The first phase of the study was devoted to collecting and analysing data concerning various present farm organizations and practices in the area. A survey of farmers who are interested in the project was considered to be the best method of obtaining this necessary information. Consequently a stratified random sample of farmers in the Monmouth-Dallas area of Polk county was drawn and forty records were obtained by personal interview. The sample was so drawn to include farms of different sizes. In addition to the farm survey, contacts were made and interviews held with vegetable and fruit processors, irrigation experts, and soil and marketing specialists to obtain their suggestions and opinions on the feasibility of various crops. The survey was made in June 1955.

The farm survey provided physical data such as present organizations, crop rotations used, average yields obtained, present value of land, investment in machinery and similar factual data on the farm operations being carried on at present on farms of different sizes. In addition, some notion of the enterprises that farmers are contemplating with irrigation was obtained. Most farmers have done considerable thinking about the organizations that would be possible when the project is completed. Most of them recognize some difficulties will have to be overcome. It is the concensus of their opinions regarding enterprises on which the budgets in the second phase of the study are based. In addition to the survey of interested farmers, records were obtained from 30 non-interested farmers and a detailed analysis of these records was made.

Phase 2

The second phase consisted of the preparation of budgets for some of the organizations expressed as practical possibilities in the first part of the study. The budget method was believed to be best suited to this study as it sets up the different organizations individually. It also permits some overlapping of the various resource situations. Organizational problems, capital investment and labor requirements have a certain degree of similarity in the various systems possible but may result in variation in income. Similarly the same incomes can be derived by manipulating the capital investment, labor requirements and enterprises on the various sized farms.

In order to keep the problem to a manageable size, budgets were constructed for only three sizes of farms. These sizes were considered to be sufficiently typical to include most of the variations in the area. Crops and enterprises also had to be restricted to a manageable number but several organizations are prepared for each size. The smallest size farm for which budgets were prepared was forty acres, thirty-five of which is under cultivation with irrigation available to all of the cropland. Although many smaller farms exist, a large percentage of them are part-time farms and mainly residential.

The second size of farm in the budgets is 103 acres, 100 of which is cropland with irrigation available for 40 acres.

The third size used as a basis for the budgets is a 280-acre farm with irrigation used on 80 acres. The remaining 200 acres is under the present cropping system.

Capital investment, labor requirements and income vary from one size group to another but fixed capital is held constant for each organization within the size group. For example, land and buildings are valued at $30,000 for the 103 acre farm and the irrigation system valued at $4,080. This total of $34,080 capital investment remains the same regardless of crop grown or enterprise suggested on this farm. Working capital and labor requirements are allowed to vary.

Sources of Additional Data Used in Budgets

Although information obtained from the survey was used when possible, much additional data were needed. Especially was this so for irrigation costs. Much of these data was obtained from a study of sprinkler irrigation in the Pacific Northwest under the direction of H. H. Stippler, Agricultural Research Service, U. S. Department of Agriculture. Cost of production studies of various commodities, especially strawberries (9), canning corn (5), and pole beans (4), published by the Agricultural Experiment Station, Oregon State College, also provided useful data on some of the costs involved in the production of these crops.

Feed requirements used were those recommended by the National Research Council. Rates of gain were those considered practical on the basis of the feed fed. A study on pastures (7) in the Willamette Valley was the basis for the rates of production (7, p.19) on pasture and forage crops.

Present prices of agricultural commodities were used in the budgets. This was done since present prices of machinery, gasoline, labor, feed and all other inputs were used. It is believed the budgets would be more realistic and useful at the present time than if some other price period were used. Where 1955 prices were not yet available, the 1954 prices were used. It is a matter of conjecture whether the price relationships between inputs and outputs at present are those likely to exist in the long run. If these relationships should change substantially from the present (1954-1955) level the budgets presented will have to be interpreted in the light of such changes.

Phase 3

The third phase of the study consists of the use of linear programming as a technique to arrive at the optimum combination of crops on the small farm. A discussion of the technique is given in Chapter VI. This phase was undertaken to substantiate or disprove the feasiblity of the organizations suggested in the budget on the small farm. An effort was made to test its scope and practicability in solving farm management and production problems of this type.

Use of the Budgets

The input-output relationships set forth in the study are used for the following purposes:

(a) to examine some of the organizations possible with irrigation;

(b) to estimate the total capital required for different sizes of operations and different organizations within the size group;

(c) to estimate the labor requirements for the various organizations;

(d) to estimate the farm and labor income from various farm organizations;

(e) to compare the merits of the various farm organizations under (a), (b), (c) and (d) above.

CHAPTER III

THE MONMOUTH DALLAS IRRIGATION SURVEY

Interest Shown

The number of property owners whose land is included in the Monmouth Dallas area is 664. All were contacted by the Polk County Water Development Committee. Of this total 226 indicated an interest in irrigation while 438 did not. However, because the total number includes a large number of small holders, it was anticipated that a large percentage of the total would not have use for water resources. Those not indicating a desire to irrigate and having less than 5 acres numbered 154.

The following table shows the numbers of farms in the different size groups and the number of farms in each size group in the

Table 1. Classification by Farm Size of Interested and Non-Interested Property Owners in the Monmouth Dallas Project Area with the Number in Sample Drawn from each Class. June 1955

Farm Size	Interested		Non-Interested	
Acres	No. Farms	Sample Size	No. Farms	Sample Size
Less than 5	21	0	154	0
5-20	34	10	91	14
21-50	49	14	73	11
51-100	38	11	46	6
101-200	42	12	49	7
201-300	16	4	21	4
301-400	14	4	2	0
401-500	7	2	1	1
Over 500	5	0	1	0
Total	226	57	438	43

respective samples. From the 57 farmers drawn in Group I, those showing interest, 40 records were obtained. From the non-interested group, Group II, 30 records were taken.

It will be noted that on the average, those interested in irrigation have larger holdings. In Group I, 104 have farms of less than 50 acres, while in Group II the comparable number is 318. On the other end of the scale, there are 42 farmers with over 200 acres who are interested in the project compared to 25 farmers in the same classification who are not. These figures do not tell the whole story as some of those who did not show interest in purchasing water from this project are irrigating at present. This is discussed more fully in the survey results of those not interested.

Survey of Those Interested in the Project

A random sample of farms in the Monmouth-Dallas area of Polk county whose operators are interested in the Monmouth-Dallas irrigation project was drawn and records were obtained by personal interviews. The sample was drawn to include farms of various sizes, which were arranged in groups as shown in Table 2. The average size of farm operated by farmers in group A is 19 acres, of which 12 will be irrigated eventually. Corn, potatoes, berries and other truck crops were specified by four as the crops they hope to irrigate; two are planning to irrigate pasture, grass and clover, and one, alfalfa. Those intending to use water on forage crops will have livestock, two preferring dairy cattle, the other beef. These operators have

Table 2. Size Grouping and Number of Records Taken in Each Group in the Monmouth Dallas Project Survey.

Group	Acres	No. of Farms
A	40 or less	7
B	41 - 75	7
C	76 - 125	7
D	126 - 300	9
E	Over 300	10

some livestock at present. One of the farmers intending to irrigate field corn is considering the possibility of a beef enterprise. Increase in laying flock is planned by two who at present have flocks of approximately 600 layers.

Operators of this size who were interviewed all hope to be irrigating all the land they want to irrigate within three years. Three of them plan to irrigate this amount the first year, two of them by the second year and the other two within three years.

No definite pattern of cropping system or rotation is followed by farmers in this group. Those with livestock on these small acreages necessarily have most of the land in pasture and forage crops, with little or no grain. The principal crops are barley, wheat, oats, oats and vetch, and rye grass. Those who grow grain may have grain for two years followed by an annual legume crop. Others alternate grain and legumes annually. Perhaps the fact that all the operators visited in this size group are part time farmers tends to dictate crops requiring less labor. When irrigation is introduced, those now growing grains will leave them out of their rotation, concentrating on the crops mentioned previously. One of the men hopes to increase the number of acres in the present operation by purchase of additional land. This, however, is recognized to be dependent on availability of adjacent land. The others in the group plan to farm the same number of acres as they operate at present.

Adjustments during the change-over period are not of major importance to the small operators. Most of them plan to continue their present part time occupations until such time as the planned organization can provide adequate income. Some land will have to be taken out of present production before it can be irrigated. This is true where the planned crops are those other than forage. None of the group plans to hire additional labor with irrigation but most plan to spend more time at home.

At present this group of small holders has an average total investment of $12,680, with a relatively small investment in machinery and equipment of $1,470. Only one of the group indicated that he thought his present machinery would be adequate. Machines that would have to be purchased depend on present equipment and intended crops. Row cropping equipment is needed by those planning truck crops. Two of this group estimated an outlay of approximately $3,000 would be required.

During the period of changing farm organization two of the operators expect a lower income after which income will be raised. The remainder expect income to be higher from the first year as the organization will not be really a changeover from the present situation but intensification of it.

Farmers recognize that difficulties will be faced but there is a difference of opinion as to what the greatest difficulties will be. Three of the seven think capital limitations will be the greatest problem, two that lack of adequate information on how to handle irrigation will be the greatest obstacle, one that drainage, and one believes that getting water from the main ditch to the farm will be harder to overcome than any of the other obstacles.

Group B -- (41 - 60 Acres)

The seven farmers in this group operate an average of 50 acres and plan to irrigate an average of 37 acres eventually. An average of 19 acres is planned for irrigation the first year. The range for first year expected irrigation is from 10 to 30 acres. There is some doubt as to the length of time before each is irrigating all he would like to irrigate. Three think perhaps it will be from two to three years, one estimated less than five years and the other three would not hazard a guess but think it will depend on the availability of finances for the equipment.

Six of the seven plan to irrigate pasture, the other field corn. One hopes to irrigate some canning crops such as corn, carrots and beets in addition to his pasture. Another planning to irrigate grasses and hay is contemplating leaving one stand for seed production.

The common rotation followed at present is hay, which usually includes clover or vetch, and grain. Barley and oats are the grains most commonly grown, with rye on some farms. Rye grass for seed production is also common as is the practice of sowing vetch with oats. As would be expected where pasture is the irrigated crop, grains will be the crops left out of the rotation when irrigation is introduced. Six of the seven are planning to farm the same number of acres as at present but farm more intensively by adding livestock. The seventh man hopes to increase the number of acres in his farm as well. A beef cattle enterprise is planned by each of the farmers in this group in the sample with three preferring beef cows, three preferring feeder cattle, and one a beef herd in addition to his present dairy cows. One hopes to increase his poultry by 1,000 as a supplement to the beef enterprise. All of these farmers have a small number of cattle at present, ranging from two to nine mature animals plus some young stock.

The changeover period does not seem to cause concern. Most will continue making adjustments as required. With pasture already established, the men feel the waiting period for grass will be of no concern. Unless cattle are introduced too rapidly the farms with irrigation can support the extra livestock in addition to the present organization. Five of the seven operators are full time farmers, one works away from home half time and the other full time. Only one plans to hire additional labor with irrigation.

Total investment of this group shows considerable variation, ranging from $6,000 to $33,750, with an average of $18,860. Machinery investment averages $3,520 at present. Four consider their present machinery adequate, one needs a mower, another a row crop tractor and the third a cultivator. However, total investment in machinery will not be greatly increased. Two of the operators are considering a silo and one needs feeding sheds. Most believe it would cost more to install the irrigation system gradually but the capital required will necessitate it being installed this way. Six of the group think income will be raised, the other believes it will remain about the same during the period of introduction.

Problems mentioned were capital limitations by four, uncertainty of water supply from the main ditch through the laterals by two and making the farm produce additional revenue to pay for the system by the seventh. The last pointed out that a farmer cannot afford to experiment to see if irrigation pays.

Group C -- (75 - 125 Acres)

The average number of acres operated by this group of farmers is 103, sixty-two of which as an average will be irrigated. The average acreage planned for the first year's irrigation is 22 acres. Pasture is the crop that six of the seven will irrigate; clover and alfalfa are the crops considered by the other, with the possibility of some field corn. Most estimate it will be four to five years before all that they are planning to irrigate will be watered but two plan to introduce irrigation as quickly as possible.

Rotations vary, pastures being left from five to ten years, and grain crops alternated with legumes. Grain is usually grown two years in succession and followed by one year of legume. As would follow from the intentions specified, acres of grain will be cut down or eliminated on most farms. One farmer will eliminate sudan grass now grown for supplementary pasture and another will continue to grow crops as at present but will irrigate the present pasture acreage. Five of this group have livestock at present; two have dairy herds, and three have flocks of sheep. Those with sheep indicated a desire for a beef enterprise as did one with no livestock at present. The dairymen plan to increase their herds.

Three of this group have other employment; one would like to spend full time on the farm. Three would like to have a large enough business to hire a full time man, two would hire more part time help and the other thought additional help would not be required.

Capital investment averaged about $40,000 on these farms, with investment in machinery averaging $6,400. Six of the seven do not plan to buy any additional machines, the other thought a mower and perhaps a rake would be required.

A difference of opinion exists on the cost of installing the system gradually or all at once. Two have sold irrigation equipment. One believes a saving of 15% would result from a purchase of a complete system, the other that there would be no difference. Several pointed out the necessity of installing an adequate pump for future expansion. One hopes to get a suitable used system at a reduced cost. The group as a whole think income will be raised during the first year's operation. One believes introduction should be gradual enough to allow the operator to maintain balance. This is interpreted to mean to maintain his present income level.

The same difficulties were mentioned as with the smaller farmers --finance by two, getting the water through lateral ditches by three, lack of knowledge regarding the use of lime and fertilizer with irrigation by one, and getting information to make the increase in cost pay for the irrigated pasture by one. Keeping the lateral ditches in repair and cooperation among users are problems that are anticipated by some.

Group D -- (126 - 300 Acres)

The average number of acres operated by farms in the 126 - 300 acre group is 189 according to the sample. On these farms the average number of acres which operators intend to irrigate is 53. Of this amount only about 20 acres will be irrigated the first year.

Irrigation of pasture is planned by eight of the nine in this group. One plans to irrigate cherries. Alfalfa and ladino clover, field corn and some other row crop, perhaps sweet corn were mentioned in addition to the pasture. This group estimate two to three years with a possibility of five as the length of time before they are irrigating all they plan. Only one plans to irrigate it all the first year.

Rotations follow much the same pattern as on smaller acreages, -- clover seeded for two years, then one year of grain. With irrigation the grain will be cut back a little but most plan to irrigate the present pasture. This will make little change in rotation on most farms. Only one plans to increase total acres. This individual hopes to develop a unit large enough to support two families.

All of the men in this group plan to increase livestock. Beef is considered to be best by five, four of whom would prefer a cow herd to feeders. Expansion of dairy cattle herd is planned by three, one of whom plans a beef herd as well. Hogs, ten brood sows, are planned in conjunction with the beef enterprise by two of the operators. A third beef producer is planning on a flock of 80 ewes as well. One, more ambitious, is hoping to have dairy, beef, sheep, and hog enterprises.

These operators, with one exception, are full time men with hired or family labor. Those who have a full time man at present do not think additional labor will have to be hired but those without such help believe a full time man would be needed in addition to their present labor.

Average total investment on these farms is about $60,000 according to this sample, with an average of $9,500 invested in machinery. Only one plans to buy new machinery because of irrigation, (forage harvester and wagon) but likely total investment in machinery will be no higher. One may build a silo.

Most think that gradual installation of the system will be easier and not cost more provided the right sized pump is bought with future needs in mind. Much depends on whether a discount is given for large orders. All are hopeful that farm income will be raised from the first year with irrigation.

Major difficulties foreseen are lack of knowledge of irrigation practices. Examples are: the correct amount of water to use with fertilizer, readjusting farm operations, and water requirements for various crops. Getting water from the main ditch is recognized as a possible problem. It is interesting to note that only one in this group suggested capital as a possible difficulty and he sees no hope under the present administration.

<u>Group E -- (Over 300 Acres)</u>

The average size of farm in the sample in this group is 386 acres. The average number of acres per farm that operators on these farms hope to irrigate is 96, fifty-two of which will be irrigated the first year. Pasture is the crop planned for irrigation on seven of the ten farms. Hay, alfalfa, field corn, and canning corn are planned for the other three. Two or three years is the length of time most think it will take to irrigate all that is planned but two anticipate it will be established on their farms in two years. One believes five years would be a better estimate.

Rotations are varied but a legume crop for two or three years followed by grain is the standard practice. Rye grass can be grown consecutively for two years on some farms. Most think the crops grown will be the same, especially on the part of the farm not irrigated, but acreages of grain may be reduced. More of the crops will be fed at home.

All feel satisfied with size of operation — no one is planning to farm more or less acres than at present.

Six of the ten plan to add or increase livestock, beef cattle being the main enterprise considered. Two are planning sheep in addition to the beef and one plans hogs as a secondary livestock enterprise. One man stated that he does not think it pays to irrigate for livestock.

In the changeover period this group plans to farm as they are at present on most of their acres, increasing irrigation gradually. Labor force, which at present is 25 man months per year on the average, will have to be increased on farms where the present labor force is below average. Much depends on which irrigated crop is planned.

Average total investment on these larger farms is $114,000 of which $18,300 is invested in machinery. Only two of the ten need any additional machinery for their planned organization, that being haying equipment and row crop machinery.

The consensus of opinion is that complete installation may be more economical, especially if any pipe is placed underground. However, some believe outside interference may prevent installing the complete system at the outset.

Most hope the income will be raised but recognize the possibility of a decrease until the new organization is established, especially if pasture has to be seeded. Where this is not the intention, they believe income will remain about the same.

Lack of knowledge and availability of capital are thought to be the greatest difficulties by this group. Capital was considered by three as the most difficult hurdle, experience in the use of irrigation water and getting the farm on a paying basis with it by several. One thinks the availability and cost of labor will be the greatest hurdle to be met while two foresee no particular difficulties in establishing the farm organization they wish to have.

The following table summarizes the information obtained from the survey of those interested in the project.

Table 3. Summary of Information from Survey of Those Interested in Monmouth Dallas Project

Farm Size	Land Acres: Average Operated (Acres)	Land Acres: Irrigation Intended (Acres)	Land Acres: Irrig. 1st yr. (Acres)	Number of Years Until Irrigating All Intended: Years 1 (Number)	2	3	5	Labor: Present	Labor: Expected	Crops Planned: Straw-berries (Number)	Field Corn	Potatoes	Pasture	Clover & Alfalfa
Up to and including 40 acres	19	12	8	3	2	2	-	6 work out (part time farmers)	More time at home No hired	4	1	4	2	1
41 - 60	50	37	19		3		1	5 full time - 2 part time	1 operator expects to hire addtl.		1		6	
75 - 125	103	62	22	2			5	3 full time 3 part time 1 retired	5 expect to hire		1		6	1
126 - 300	189	53	20	1	5		1	1.5 men (1 man part time)	5 expect to hire more -Part time man at home	1 cherries 1			8	1
Over 300	386	96	52		2	7	1	2 men	6 expect to hire (4 of them 1 addtl. man)		1		7	2

Table 3 (continued)

Farm Size	Planned Livestock: Beef	Dairy	Hogs	Sheep	Poultry	Investment: Average Total	Average in Machinery	Operators Expecting to Buy Machinery	Difficulties: Capital	Infor-mation	Lateral Ditches	Drainage
	(Number)					(Dollars)		(Number)	(Number)			
Up to and including 40 acres	1	2			2	12,680	1,470	6	3	2	1	1
41 - 60	7 3 3	1			1	18,860	3,520	3	4	1	2	
75 - 125	2	2		3		40,000	6,400	1	2	2	3	
126 - 300	5 4 1	3	2	1		59,500	9,500	1	1			
Over 300	6		1	2		114,000	18,300	2	3 2 foresee no difficulties			

Survey of Those Not Indicating Interest in the Project

In addition to the 40 farmers who indicated interest in the Monmouth-Dallas project, 30 others who had not indicated interest were selected at random. Farms of various sizes were chosen as in the first sample. These records were taken by personal interview also. This survey was conducted to focus attention on some of the problems that might have been foreseen by this group, and to ascertain the reason for apparent lack of interest. Table 4 summarizes the reasons enumerated by the farmers visited. Several gave more than one reason as will be noted from the table.

Table 4. Reasons for Lack of Interest in the Monmouth-Dallas Irrigation Project.

Reason	No. of Farmers
1. Lack of Capital	1
2. Age of Operator	7
3. Lower Expected Income	1
4. Labor not Available	3
5. Unadapted Land	5
6. Lack of Information	0
7. Does not Fit Present Farm Organization	2
8. Lack of Markets	1
9. Other	21

The first eight reasons given are quite self explanatory. It is interesting to note only one man of the thirty mentioned capital requirement as his reason for lack of interest. One may contrast this with the interested group, many of whom indicated that capital would be an important obstacle to be overcome. Those who are not interested because of age are all over 60 years, the average age of the group being 67 years. None of them has a son who is interested in farming. It is quite understandable that irrigation for their particular farm would not appear attractive to these men since labor requirements will be increased.

One of the group foresees a lower income due to high cost of electric power, while three others who mentioned labor as an obstacle thought they might be able to hire additional help but would not want to do so.

The five suggesting unadaptability of their farms all have hilly acreages. One foresees drainage as a problem in the low spots and a possibility of leaching. Two think the presence of so many hills would make the cost of pumping too great and the system too expensive.

Only two listed the fact that irrigation would not fit the present organization as a reason for lack of interest. Actually one of these has only ten acres that could be irrigated so that unadaptability of land might have been considered the reason. The other operator and his wife both work off the farm and are happy with their present system.

Lack of markets was mentioned by one operator who can foresee no advantage in producing more while surpluses exist. Actually this objection may have been influenced by the age of the operator which is quite advanced, age being the real reason for lack of interest.

The item labeled "other reasons" was specified more often for lack of interest in the project than any of the first eight mentioned. This might be anticipated. Nine of these are using irrigation from wells, Rickreall Creek, or a small lake at present. Two others have water for irrigation available. Three of this group are not certain whether they were included in the project area; three specified poor health as the reason for lack of interest; three consider the farm as a residence, two of these being retired and one a full time logger. Only two of all those visited were antagonistic to the project. One of these has a farm for sale and anticipates the ditch cutting up his land. The other definitely opposed and mentioned practically all of the factors listed above as reasons for his opposition. On the other hand seven of the group stated they were definitely in favor of the project from a community and social point of view even though they themselves could not use the water in the immediate future.

The fact that reasons for lack of interest given were quite evenly spread over the array of possible reasons has some implications as far as policy may be concerned. No specific reason about which preventative or remedial action might be taken appears dominant. It is quite reasonable that the nine of the 21 under "other reasons" who are at present using irrigation are not interested in using water from the project. The second reason appearing most often was that of age of operator. This too is a very sound reason for not wanting to increase capital investment and labor requirements which would result from introduction of irrigation. Those with land unsuitable for irrigation cannot be expected to plan for irrigation, nor would it be practical for them to do so. Other reasons given in the most part are quite valid ones, and can be accounted for when one considers differences among individuals. The fact that many are interested in the project from a community viewpoint and anxious to see it completed, while only two of all those contacted were definitely opposed indicates the recognition of a need for more water resource in the area.

CHAPTER IV

THE EFFECT OF IRRIGATION ON FARM ORGANIZATION

The Budgeting Procedure

The use of budgets in agricultural production work is dependent upon the availability of dependable input-output data. Although its use is not confined to farm accounting, the budget procedure has been the method used in conjunction with farm account analysis in farm management studies. After analysis of the accounts has been made to establish the relationship between income and one or more of certain factors on a group of farms, these factors are examined on particular farms. The factors include size of business, labor efficiency, yields of crop and production of animals, capital efficiency, and number of enterprises. Each operator can compare his business with the data furnished by all those in the same type of farming. Broader comparison of different types of farming can be made in addition to the more detailed operational comparisons on similarly organized systems.

Comparisons made under such procedure assume similar productive capacities of land, labor, and capital. Where such similarities do not exist, the individual operator can be misled. Farmer A on a soil with a limited productive capacity and producing 30 bushels per acre may be superior in management ability to Farmer B on soil with greater potential production and getting 45 bushels per acre.

Thirty bushels per acre might be the yield at which Farmer A is maximizing his profits. Therefore although his yields are below the "average", yield of crops is not the "factor" which should be increased. Analysis of farm accounts suggests places to look for weaknesses in organization by supplying certain standards or benchmarks to guide the operator. It helps turn the manager's attention more closely to his operation. But a systematic plan of the future use of resources must be set up for each individual farm system. It is at this point that budgeting enters the picture. Much information on costs of production of various commodities is necessary to determine relative profitability of different enterprises. With such information available it is possible to compare various organizations and various enterprises, taking into consideration capital available, labor requirements, conservation practices, market outlets and many such factors. It is not always possible to devote the entire acreage of a farm to the crop which appears most profitable on a cost of production basis. Budgets take into consideration the integration of enterprises, labor use throughout the period, suitability of soil and climate, market outlets, and numerous other factors.

Discussion of the Budget

The budget procedure consists merely of using an informal device to set down input-output relationships of various enterprises and farm organizations for the purpose of appraising the merits of each. Complete budgeting as presented in this study considers the farm as a unit and estimates the various parameters of the farm business as a whole rather than estimating the investment, labor required, and income produced by a small part of the business. This circumvents the need to apportion the various fixed costs of the whole farm to the different enterprises on some arbitrary basis as would have to be done if one enterprise only were studied.

To eliminate the difficulties in the allocation of labor among enterprises and in arriving at a reasonable figure to use as hourly rate for labor, the farm income figures are used for comparative purposes. The farm income is the amount of money left to pay interest on the investment and the owner for his labor and management. This figure estimates the return to the farmer for his resources. When interest on the investment is taken from this farm income figure, the amount left is the labor income i.e., the amount of money returned to the operator for his labor and management after all expenses including interest on his investment have been paid. No attempt has been made to allocate this income between labor and management because in most cases the operator provides twelve months of labor in conjunction with his management. Therefore the residual income after all expenses have been paid except the labor and management of the operator is that figure shown as labor income. This figure is not the total real income to the operator as no account has been taken of his use of home grown products, such as milk in the case of the dairy farmer, beef in the case of the beef producer or rent for the house for any of them. However for comparative purposes, this will make little difference.

Budgeting Standards

The bases for the size of operations and for the choice of enterprises shown in the budgets were the results of the survey of the farmers. The yields of crops and production of animals used are average yields and production figures for the area based on estimates of the farmers themselves. Barley and oats are grown on the non-irrigated part of the farm, with peas added to the oats for its soil building effect and to add weight to the oats. However no increase in total digestible nutrients is added because of this nor is any increase in weight over average oat yields added. Barley usually averages approximately one and one quarter tons per acre and oats slightly less than one ton. The yield for non-irrigated hay is a modest two tons per acre, which may include two cuttings. Irrigated pasture and forage (hay) yields are estimated at 4733 pounds of total digestible nutrients, the yield reported in Hyer's and Becker's study (7, p.19) for these crops. This is equivalent to approximately four and three quarters tons of hay. The total yield for alfalfa is estimated at four and six tons per acre from three cuttings. Where livestock are part of the farm organization the first cutting of the irrigated hay acreage may be taken off as grass silage with an estimated yield of six tons silage which is equivalent to two tons hay per acre. The remaining two cuttings then yield two and three quarters tons per acre to give the total four and three quarters tons average yield. It was found in Hyer's and Becker's study (7, p.21) that of the total production on irrigated pasture, an average of three quarters of a ton per acre was harvested as hay from pasture clippings. Where this is done in the budgets the remaining production to be harvested by the livestock is equivalent to four tons of hay.

The July 1955 price for four per cent milk, $5.24 per cwt. for Grade A milk and $4.04 per cwt. for factory milk is used with an assumed quota of fifty per cent Grade A. The per cent quota for Grade A milk shippers is usually higher than 50 per cent. However, if production on dairy farms were increased, it might be difficult to increase the quota by any appreciable amount. This would lower the percentage of milk sold at the higher price. Therefore to keep the picture as realistic as possible, the figure of 50 per cent is used. If, however, the quota is higher than 50 per cent, or can be expected to be increased, the returns will be higher. On the other hand, if no quota can be established, the above figures will be too optimistic. Knowing that the production of 9,000 pounds of four per cent milk for 1000 pounds cows is used, it is relatively simple to adjust the labor income to show the returns for any quota.

The value of dairy cows, $200 each, is based on the value of cows producing 9000 pounds of four per cent milk in a study carried on by D. C. Mumford (12). It was found that the value of cows of this calibre in Mumford's study was approximately 50 per cent higher than the value of commercial milk cows. (The July price of milk cows in Oregon was $135). Two year old heifers for sale are valued in the same relationship to the mature cow value as in the study quoted.

Beef prices are based on 1954 figures, those for 1955 not being available at the time the budgets were prepared. Barley is valued at $42 per ton, oats at $48 and hay for sale at $24 per ton. Hay for storage is valued at $20 per ton. The feed requirements used are those recommended for the levels of production used based on the amounts recommended by the National Research Council. Rates of gain for beef are those experienced by farmers with irrigated pastures (1.7 pounds per day in Hyer's and Becker's study (7, p.4) and 2 pounds per day when being fed five pounds ration per day while on irrigated pasture). Crop expenses include only the cost of fertilizer for the crops and the cost of repairs and fuel for the machinery used. The rate of fertilizer application is 200 pounds per acre, fertilizer valued at $80 per ton.

Depreciation on machinery calculated at the rates used in Adam's Farm Management Crop Manual (1, pp.19-26) averages approximately ten per cent of the present value. As there is variation in machines from farm to farm, a straight ten per cent of present value is used in the budgets. Interest is allowed at the rate of five per cent on fixed or long term capital and seven per cent on working capital. Fixed capital is the part of the investment in land, buildings and the irrigation system. Working capital is the capital invested in livestock, machinery, and feeds and supplies. Taxes are estimated at four dollars per acre on the smaller farms and $800 on the 280 acre farm. Insurance allowed is $300 per year. Telephone and electric power costs are estimated at present rates. Power cost for the irrigation system is included in the water cost. Allowance made for use of car is 5000 miles per year at five cents per mile cost. Labor is hired at the rate of $250 per month.

One of the large costs in each of the new organizations is that of irrigation water and equipment. The investment in irrigation equipment per acre varies with the number of acres irrigated. The value used is taken from H. H. Stippler's study (18, p.130-141). This figure is included in the total investment on which 5 per cent interest is allowed. The cost of water is assumed to be $15 per acre. Depreciation, power and repairs for the system varies to a certain extent with the investment. These costs are computed on the basis of Stippler's work. However for each size group, the same irrigation cost is used. The number of water applications on which this cost is based is seven for pasture and four for hay. This allows rotation of pasture where livestock are kept approximately once in four weeks. This is subject to some variation as is explained in the discussion of the various budgets.

40 Acre Farm

To keep the problem to manageable size, three size groups are used in this study. The small size, forty acres with thirty five irrigated has necessarily intensive crops, strawberries, pole beans, and canning corn.

The budget prepared for the small farm considers the three crops. These are the crops in which the operators of this size of farm are most interested. The figures used in the cost of crop production do not include depreciation, taxes and some other costs, which are accounted for when computing farm incomes. Only one budget is prepared for this size of farm as it is this specific size that is used in the linear programming model. A full discussion of the possibilities is given in Chapter VI. The budgets appear on page 49.

The possibility of a commercial laying flock was considered on this size farm but was omitted from the budget for its lack of dependency upon irrigation. However the introduction of such an enterprise would give a better distribution of labor in the winter months, but would also compete with the existing crops during the busy season. This would not be an insurmountable obstacle on most farms but for this reason and its remote association with irrigation, poultry as an additional enterprise has been omitted from the budgets.

Much of the information used in the budget was obtained from cost of production studies. Prices used are for the current year as in the other budgets. Price of corn is $20 per ton, strawberries 16 cents per pound and pole beans $125 per ton. The yields used are average for the area. The yield used for corn is 4.1 tons per acre, for pole beans 8 tons and for strawberries 2.25 tons per acre. The average yield of strawberries is the amount obtainable per year over the planting cycle. Actually a yield of three tons per acre per year with one year idle will produce nine tons in the four years to give an average of 2.25 tons per acre per year.

The investment in land, buildings and machinery is based on that ascertained from the survey. The implements considered necessary are listed in the Appendix, Table 3. The total investment in machinery considered necessary to operate the vegetable farm has been increased considerably from that obtained in the survey. Irrigation costs are obtained from Stippler's work (18, pp.130-141). Cost of production figures for the three crops are listed in Appendix, Table 8.

The return to labor and management is quite favorable considering the part of the year when the operator might be employed off the farm. Supplementary enterprises such as poultry or hogs would spread the labor more evenly over the year and should increase returns to labor and management.

One reason for such a favorable return is the relatively low capital investment. This reduces the interest charged for use of fixed and working capital.

The linear program model (Chapter VI) eliminates corn from the organization under the limitations placed on resources. In this budget, no rigid limitations were set and acreages are based on practical observations and suggestions. It is likely that all acres will be used rather than having some of the farm left idle. The price per ton of corn is below the usual price, making production of sweet corn appear in an unfavorable light. But having decided to use current prices throughout the study it was not believed advisable to adjust the price of one of the products.

103 Acre Farm

The one hundred three acre farm having sixty acres irrigated is the basic size used for the second group of farms. Budgets were constructed for this farm as (a) a dairy farm with forty cows with replacements being raised on the farm, (b) a dairy farm with sixty cows, with replacements purchased, (c) a beef-grain farm with a sixty cow herd with beef calves and grain sold, (d) a beef herd of seventy-five cows selling fall calves, (e) a farm producing grain and grass to finish feeders calves purchased October 1, (f) an alfalfa and hay producing farm, alfalfa on the irrigated acres. For comparative purposes this one hundred three acre farm was budgeted as a grain farm with no irrigation.

The forty cow dairy herd where replacements are raised does not return as high a labor income as does the sixty cow herd where replacements are bought. This may be partially due to the cost of raising heifers. It appears that raising replacements must be just about equal to the cost of buying them at the prices used. This conclusion is drawn from the fact that the farm and labor incomes are in approximately the same proportion on the two sizes of farms as the number of milking cows. No doubt some of the difference in income is due to returns to scale. The increase in costs on the large cow herd is small in relation to increase in receipts. In both herds replacements are at the rate of twenty per cent per year. No doubt a purebred herd where calves and two-year-old heifers are sold would command a considerable premium and would place the raising replacement program in a much more favorable light. However because managerial ability is so important a factor where purebred cattle are concerned, this study embraces only the possibilities with a commercial herd. The author believes that where managerial ability is high, raising replacements would be the more desirable system. In the program where replacements are bought it is necessary to assume that such replacements are available.

The forty cow herd organization employed a full time man in addition to the operator. In addition, spraying of the grain for weeds, harvesting the first cutting of irrigated hay as grass silage, and combining the grain were hired at custom rates. The sixty cow milking herd organization employed a full time man and one man for the six summer months in addition to the operator.

Turning to the beef enterprises, it does not seem that a beef cow-calf organization will be feasible on this scale of operations, assuming a calf crop of 86 per cent reaching 400 pounds weight by fall. It is impossible with the data used and under average management to get the gross income above the total expense. This type of farm organization is not sufficiently intensive to produce an adequate income to cover the fixed costs and leave much margin. It might be noted that total expenses are lower on the sixty cow beef farm than on any other farms. But the receipts are not high enough. The fact that the larger herd on this farm returned a lower farm and labor income suggests that the production of grain is subsidizing to a certain extent the production of beef.

Where feeder cattle are bought for feeding to finish for slaughter, the organization appears quite profitable for a one man operation. Although only ten days labor is hired as such, grass silage, crop spraying, and combining are hired at custom rates. Death loss of two steers is allowed although feed requirements are for the number purchased. Purchase price of feeder steer calves averaged from 16 to 19 cents per cwt. during the first week of October 1954, for choice grade. In the budgets, purchase price of 19 cents is used. Selling prices averaged 23 to 26 cents for the same period for the same grade. In the budgets 24.5 cents is used. It might be possible to buy a lower grade at a lower price and raise the grade by market time with irrigated pasture and the grain ration used in the budgets. However this is not done in the budgets as it is difficult to predict these possibilities. A word of caution might not be amiss. Beef feeding organizations contain an element of uncertainty that the other organizations do not. This is of less importance in the short run where home grown feed is fed, but fluctuations in prices at purchase and sale time can make a considerable difference in returns. The prices used in the budgets bear the same relationship to each other as usually exists, 1954 being neither a particularly favorable or unfavorable year for beef cattle feeding operations.

Steers are purchased at 400 pounds and fed to gain 200 pounds during the first six months. Three pounds of barley and oats are fed daily throughout the period. No grain is fed during the first three months on pasture during which time a gain of 1.7 pounds per day is made. Beginning the fourth month on pasture, five pounds of ration per day is fed. This ration comprises eleven parts barley and oats to one part cottonseed meal. Feeding at this rate on irrigated pasture for three months should increase the weight of the animals by two pounds per day. Thus during the whole period, the increase in weight is 533 pounds. However in the budgets the total gain in weight is estimated conservatively at 520 pounds.

Irrigated alfalfa yielding four tons per acre plus forty acres of non-irrigated hay at two tons does not appear attractive even if one considers the free time in winter months. However, this yield per acre may be too conservative. Also the price of $24 per ton is very moderate. If yields of six tons of alfalfa can be expected the picture changes considerably returning an attractive labor income. With a yield of less than six tons per acre it would not be economically feasible to irrigate alfalfa.

Contrasting the irrigated farm with a non-irrigated grain-producing farm, the introduction of irrigation will increase total investment by the cost of the irrigation equipment at least. For those who are owners at present this outlay may prove quite a good one if the value of the whole farm per acre increases. This aspect is less desirable for prospective buyers as the cost may involve a certain amount of speculation rather than an indication of the production capacity of the farm. In the budgets, increase in land value was not considered.

Labor requirements are greatest on the dairy farm but hiring additional labor is not considered a serious limitation by those contemplating expansion. The organizations, except perhaps the alfalfa hay organization, require a full time operator. Total work days required is the number of ten hour days that would be required working under average conditions to do the work to be done on these farms. Although this measure is somewhat arbitrary and does not reflect differences in machinery on farms, it gives an indication that the amount of work per man is not prohibitively high.

With regard to income, water used as an input should increase the farm and labor income considerably on this size of farm except with the beef cow-calf enterprises. In order to have a favorable return from alfalfa the production per acre would have to be at least six tons per acre with prices as they are at present.

280 Acre Farm

The labor incomes on the two hundred eighty acre farm with eighty acres irrigated show somewhat the same relationship as in the one-hundred-and-three-acre group. Budgets for three organizations with irrigation are prepared - a sixty cow dairy operation, a one hundred and fifty feeder steer operation and a one hundred cow beef herd producing calves to be sold at 400 pounds in the fall. The dairy herd is limited to sixty milking cows as that number is approaching an optimum. Production and sale prices of milk are the same as for the previous budgets as are feed requirements for livestock throughout, rates of gain for beef cattle and all other physical data. Beef feeders shows most profitable with the dairy cattle enterprise following closely. Even at this scale of operations it would not be practical to try to carry a beef cow-calf enterprise. Dry land farming will produce a better return with much less labor required and less capital investment than the cow-calf organization.

There is little difference in capital requirements for any of the three organizations with irrigation, each requiring over $100,000 total. This figure, although large, is only approximately $25,000 more than is required under the present dry land system. The increase in labor income for the dairy and beef feeder organizations would more than justify the extra investment involved. On the basis of these figures the increase in investment would pay for itself in less than six years.

Labor requirements would increase requiring one full time hired man on the beef enterprises in addition to the operator, and two on the dairy farm. Even so, the increase in labor income shows the relative profitability of the organizations.

It is not expected that every farmer in the area will produce fluid milk even though the budgets show it to be a fairly profitable enterprise. There are some who are not in a position to produce milk, because of small acreage, lack of market, no experience with dairy cattle, or some other reason. But for those who are in a position to produce milk, or who are already producing for a fluid market, it should point the way that expansion of the present enterprise might take, and give some notion of what might be done with water as a resource in milk production when consumer demand increases the market. Neither is it expected that everyone in the area will buy feeder cattle to finish. There are many obvious reasons why everyone will not and should not. But this study might prevent someone from failing when trying to set up a beef cow-calf type of organization at present price relationships on a scale similar to the ones here suggested. Changes in price relationships may change the picture considerably but physical data probably will not change greatly. It is possible that the water cost to the farmer may be considerably less than the $15 per acre here used. This would increase the labor incomes of all operators.

A summary of the budget for the various organizations is given in Table 5.

Table 5. Budgets for Various Farm Organizations, Polk County, Oregon.

	103 Acre Farm (60 Irrigated)							Dryland	280 Acre Farm (80 Irrigated)			Dryland	40 Acre Farm (35 Irrigated)	
	Dairy 40 Cows	Dairy 60 Cows	Beef 60 Cows	Beef 75 Cows	Beef 92 Feeders	Alfalfa	Alfalfa	Grain Farm 103 Acres	Dairy 60 Cows	Beef 100 Cows	Beef 150 Feeders	Grain Farm 280 Acres	Vegetable	Vegetable
Acres														
Barley	15 ac.	15 ac.	20 ac.		20 ac.			50 ac.	100 ac.	70 ac.	75 ac.	140 ac.		
Oats (and Peas)	15 ac.	15 ac.	20 ac.		20 ac.			50 ac.	100 ac.	60 ac.	75 ac.	70 ac.		
Ryegrass Seed												70 ac.		
Hay - Irrigated	20 ac.	20 ac.	10 ac.	10 ac.	20 ac.				30 ac.					
Hay - Non-Irrigated	10 ac.	10 ac.		40 ac.		40 ac.	40 ac.			70 ac.	50 ac.			
Alfalfa						60 ac.	60 ac.							
Pasture (Irrigated)	40 ac.	40 ac.	50 ac.	50 ac.	40 ac.				50 ac.	80 ac.	80 ac.			
Strawberries													4 ac.	
Sweet Corn													15 ac.	
Pole Beans													16 ac.	22.7 ac.
Livestock														
Cows	40	60	60	75					60	100				
Yearlings	16				92					20	153			
Two-Yr. Olds	15													
Calves	18		51	64					50	85				
Bulls	1	1	2	3					1	3				
Production														
Barley	37,500 lbs.	37,500 lbs.	50,000 lbs.		50,000 lbs.			125,000 lbs.	250,000 lbs.	175,000 lbs.	187,500 lbs.	350,000 lbs.		
Oats	29,250 lbs.	29,250 lbs.	39,000 lbs.		39,000 lbs.			97,500 lbs.	195,000 lbs.	117,000 lbs.	146,250 lbs.	136,500 lbs.		
Ryegrass												56,000 lbs.		
Hay	90 T.	90 T.	86 T.	151 T.	55 T.	80 T.			119 T.	200 T.	160 T.			
Silage	120 T.	120 T.			120 T.				180 T.					
Alfalfa						360 T.	240 T.							
Strawberries													9.0 T.	
Sweet Corn													61.5 T.	
Pole Beans													128.0 T.	181.6 T.
Sales														
Barley	$ —	$ —	$ 1,016.00	$ —	$ —	$ —	$ —	$ 2,541.00	$ 3,990.00	$ 3,528.00	$ 2,268.00	$ 7,098.00	$ —	$ —
Oats	—	—	902.00	—	—	—	—	2,256.00	3,336.00	2,688.00	1,632.00	3,156.00	—	—
Ryegrass Seed	—	—	—	—	—	—	—	—	—	—	—	5,040.00	—	—
Hay	—	240.00	—	160.00	—	1,600.00	1,600.00	—	1,440.00	—	140.00	—	—	—
Alfalfa	—	—	—	—	—	8,640.00	5,760.00	—	—	—	—	—	—	—
Strawberries	—	—	—	—	—	—	—	—	—	—	—	—	2,880.00	—
Sweet Corn	—	—	—	—	—	—	—	—	—	—	—	—	1,230.00	—
Pole Beans	—	—	—	—	—	—	—	—	—	—	—	—	16,000.00	22,700.00
Livestock	2,100.00	1,650.00	4,028.00	5,272.00	20,286.00	—	—	—	1,650.00	7,052.00	33,810.00	—	—	—
Livestock products	16,203.00	24,305.00	—	—	—	—	—	—	24,305.00	—	—	—	—	—
Gross Farm Income	$ 18,303.00	$ 26,195.00	$ 5,946.00	$ 5,432.00	$ 20,286.00	$ 10,240.00	$ 7,360.00	$ 4,797.00	$ 34,721.00	$ 13,268.00	$ 37,850.00	$ 15,294.00	$ 20,110.00	$ 22,700.00
Expenses														
Livestock purchased	$ 60.00	$ 2,460.00	$ 300.00	$ 400.00	$ 6,992.00	$ —	$ —	$ —	$ 2,460.00	$ 400.00	$ 11,628.00	$ —	$ —	$ —
Feed purchased and grinding	1,260.00	2,083.00	12.00	20.00	218.00	—	—	—	1,243.00	—	300.00	—	—	—
Milk hauling and trucking	989.00	1,677.00	42.00	56.00	—	—	—	—	1,677.00	—	300.00	—	—	—
Electricity and telephone/1	130.00	130.00	50.00	50.00	100.00	50.00	50.00	70.00	130.00	90.00	40.00	50.00	100.00	100.00
Tractor and auto expense	350.00	350.00	350.00	350.00	350.00	250.00	200.00	350.00	400.00	350.00	100.00	350.00	350.00	350.00
Insurance and Taxes	700.00	700.00	700.00	700.00	700.00	500.00	450.00	500.00	1,300.00	1,300.00	1,300.00	1,000.00	360.00	360.00
Crop expense	1,809.00	1,819.00	1,533.00	1,247.00	1,775.00	1,815.00	1,756.00	1,327.00	4,226.00	3,530.00	3,530.00	3,568.00	—	—
Strawberries	—	—	—	—	—	—	—	—	—	—	—	—	1,676.00	—
Sweet Corn	—	—	—	—	—	—	—	—	—	—	—	—	596.00	—
Pole Beans	—	—	—	—	—	—	—	—	—	—	—	—	9,822.00	13,872.00
Livestock expense/2	596.00	662.00	120.00	456.00	368.00	—	—	—	362.00	276.00	525.00	—	—	—
Fences, bldgs., repairs	150.00	150.00	120.00	150.00	150.00	100.00	100.00	50.00	150.00	150.00	150.00	50.00	—	—
Hired labor	3,000.00	4,500.00	200.00	300.00	100.00	750.00	750.00	—	6,000.00	3,000.00	3,000.00	1,500.00	1,500.00	750.00
Water and irrigation	1,664.00	1,664.00	1,664.00	1,664.00	1,664.00	1,664.00	1,664.00	—	2,217.00	2,217.00	2,217.00	—	986.00	637.00
Building depreciation	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	280.00	100.00	40.00	40.00
Machinery depreciation	700.00	700.00	640.00	610.00	640.00	640.00	640.00	640.00	1,450.00	1,450.00	1,450.00	1,450.00	400.00	400.00
Total Expense	$ 11,688.00	$ 17,175.00	$ 6,011.00	$ 6,283.00	$ 13,337.00	$ 6,049.00	$ 5,890.00	$ 3,217.00	$ 21,895.00	$ 13,043.00	$ 24,820.00	$ 8,068.00	$ 15,830.00	$ 16,509.00
Farm Income	$ 6,615.00	$ 9,020.00	$ -65.00	$ -851.00	$ 6,949.00	$ 4,191.00	$ 1,470.00	$ 1,580.00	$ 12,826.00	$ 225.00	$ 13,030.00	$ 7,226.00	$ 4,280.00	$ 6,191.00
Interest on Investment	$ 3,111.00	$ 3,202.00	$ 2,729.00	$ 2,879.00	$ 2,708.00	$ 2,222.00	$ 2,222.00	$ 1,955.00	$ 5,921.00	$ 6,128.00	$ 5,798.00	$ 4,331.00	$ 1,018.00	$ 1,018.00
Return for Labor and Management	$ 3,504.00	$ 5,818.00	$ -2,794.00	$ -3,730.00	$ 4,241.00	$ 1,969.00	$ -752.00	$ -375.00	$ 6,905.00	$ -5,903.00	$ 7,232.00	$ 2,895.00	$ 3,262.00	$ 5,173.00

/1 Electricity other than for irrigation
/2 Includes veterinary fees, strainer pads, spray, bedding (if bought)

CHAPTER V

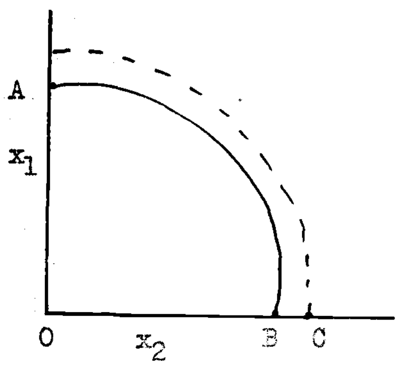
SOME METHODOLOGICAL PROBLEMS

Comparison of farm organizations of different types is a difficult task. Acreage used as a basis for comparison is not entirely satisfactory as different types of crops and livestock have varying requirements for land as well as labor and capital. An intensive crop or an enterprise such as poultry on a ten acre farm could not be compared with a beef herd on the same size of farm as labor, capital and management differ greatly. Capital investment per farm might be a better measure except for the variations in values placed on property and livestock by the operators. Unless comparable values are used, capital investment as a measure is not very useful. Also, one type of farm may have high capital requirements and low annual expenses while another may have low capital investment but high annual expenses.

A measure frequently used to compare different organizations is the labor requirements of the farm specified in productive-man-work units. One unit, a P.M.W.U., is the amount of productive work that one man would accomplish in a ten hour day working under average conditions. The definition itself points to the weakness of this measure - average conditions are difficult if not impossible to define. The improvement in technology has changed the "average" condition under which many crops are produced so much that the figures on P.M.W.U.'s per acre or per animal are almost meaningless. In addition, the labor in relation to capital varies from one type of farm to the next.

An increase in size of farm may result in higher profits. If all inputs are increased in the same proportion, scale accounts for the whole change in net returns. But part of the increase in returns is probably the result of greater use of some of the fixed factors. This involves proportionality relationships which are usually involved in most discussions of scale as it is almost impossible to isolate the two.

If size of business is held constant, the products may be varied. Diagrammatically this is shown in the accompanying illustration.



The contour shows various amounts of two different products, x_1 and x_2, that can be produced with a constant bundle of resources available. If all the resources are applied to the production of x_1, the output of the firm will be OA of x_1. If the resources are all applied to x_2, OB of x_2 will be produced. Point A may then be compared with Point B under these conditions. However, if comparisons are made on an output basis, frequently A is compared with C, a point on a different iso-product curve. One reason for this is the difficulty of

cost!
OPPORTUNITY

holding available resources constant. To avoid the possibility of this inconsistency, the resources used are converted to an annual input basis (Table 6). This was done by combining the total farm expenses and the interest on the capital investment. This permits comparison of different types of organizations by sizes.

The interest on investment, considered an expense, has been added to the total farm expense in an attempt to measure the total input per farm, exclusive of the operator's labor and management. No attempt has been made to place a value on the latter as it is believed that to do so would involve the use of arbitrary values without changing the classification in any appreciable degree. The capital investment is included, the various sizes being reflected in the amount of interest charged. In this way variations in values placed on property have less weight than when capital investment alone is used. Number of acres is also reflected in the interest charged for capital investment. Labor inputs are also represented in the expense total, as all hired labor is included.

Table 6 shows the different farm organizations having approximately the same inputs. The first group contains four organizations on the 103 acre farm, dryland farming, alfalfa and hay, and the two sizes of beef cow herds. The gross income per farm is also shown. It is noted that the alfalfa and hay production is the only crop returning a positive income, and this only when alfalfa yields are six tons per acre. But a favorable feature of this organization is the amount of time free for outside employment. This applies to a

Table 6. Comparison of Farm Organizations with Comparable Total Annual Inputs

Type of Organization	No. Acres	Capital Invest. (Dollars)	Labor Req'mts (P.M.W.U.)	Expenses & Int. (Dollars)	Gross Income (Dollars)	Labor Income (Dollars)	Return per $100 Input (Dollars)
Beef Herd (75)	103	50,860	292	9,162	5,432	-3,730	59.
Beef Herd (60)	103	48,720	270	8,740	5,946	-2,794	68.
Dryland	103	36,400	100	5,172	4,797	- 375	93.
Alfalfa & Hay	103	41,480	108	8,271	10,240	1,969	124.
Dryland	280	79,300	280	12,399	15,294	2,895	123.
Vegetable	40	18,360	545	16,848	20,110	3,262	119
Dairy (40)	103	54,180	643	14,799	18,303	3,504	124.
Feeder Steers (92)	103	48,420	260	16,045	20,286	4,241	126.
Beef Herd (100)	280	109,040	535	19,172	13,268	-5,904	69.
Dairy Cows (60)	103	55,480	876	20,377	26,195	5,818	129.
Dairy Cows (60)	280	106,140	1,009	27,816	34,721	6,905	125.
Feeder Steers (150)	280	104,390	534	30,618	37,850	7,232	124.

lesser extent to dryland farming too. The table shows that at this level of input, approximately $8000 to $9000, alfalfa is the only crop that will yield a profitable return.

The second group of farms having approximately the same level of inputs, about $15,000 as an average, indicates a good return to the operators. The rate of return per $100 invested is highest for the feeder steers ($126) and the highest actual return to labor and management is received from this feeder cattle enterprise with that from the dairy farm close behind. The vegetable farm, although showing the lowest rate of return of $119 per $100 invested, returns higher gross and labor income than dryland because of the greater input. The third group with approximately the same level of input, $20,000 or more, contains the three 280 acre irrigated farm organizations and the 103 acre 60-cow dairy farm. Again the highest rate of return per $100 expended is to dairy on the 103-acre farm but the highest net return to labor and management is received on the larger dairy farm and the beef feeder organizations. The beef cow-calf system does not show a positive return for any level of input, returning only $69 per $100 invested at this level.

The above classification on the basis of inputs should prove useful especially to the operator with larger acreages. If capital, labor, or management is a limiting factor, an operator with a large number of acres might consider selling part of his farm and organizing the remaining part under a more intensive system. An alternative available to an owner of 280 acres who feels his management ability is not equal to that required under a more intensive organization, or who does not want to add to his managerial responsibilities, is sale of some land and the development of a more intensive farming system. On the other hand, an operator with a small acreage can see the possibilities of reorganizing to a more intensive system on his farm.

The one system which does not seem feasible on any size farm under consideration at any level of input is the beef herd under a cow-calf organization. Every other organization with the exception of the dryland farming on the small acreage is reasonably efficient as seen from the relation of output to input. When efficiency is combined with adequate size the return to labor and management is favorable. The difficulty lies in attaining adequate size, measured by input, for some of the systems.

Budgeting and Cost of Production Studies

It should be pointed out that the budgets presented in this study are not cost of production studies. Some of the data used in budget preparation were obtained from cost of production studies but as cost of production figures usually are above selling prices of the commodities, it seems evident that they are not always realistic. The main weakness of such studies lies in attempting to fix a value on the labor of the operator. When the rate of such labor is taken as equivalent to or higher than what labor in non farm occupations is receiving, with no limit on the hours the worker may be hired at this wage per week or per enterprise but based on an estimate of time spent per animal or per task, in all probability the labor cost will tend to push the cost of production figures of the product above its market price - and often by a considerable amount. In some cost studies too, feed costs on general livestock farms are valued at market price or opportunity cost even though they are produced on the farm. This is justified by the assertion that the operator could obtain this amount if the products were sold. This method of computation may involve double counting if the costs of producing the feed, depreciation on machinery, labor, fuel, repairs, etc., have been charged against the business. Even if this has not been done, such procedure attempts to isolate various enterprises, and to compare two enterprises managed in a way that is not being practiced on the farm. Feed is not being sold directly, nor is the home grown being bought directly. Could the farmer sell the feed and maintain his present livestock enterprise even in the short run? Could he maintain present crop yields in the absence of livestock as part of the farm organization? It is fair to charge for livestock feed an amount equal to what he would get if he sold the products only when this is what the product cost him. If such a charge is made, it assumes that the cost of production of the feed is equal to its selling price at the farm - hardly a fair assumption based on the results of most cost of production studies. If, however, the assumption is correct, cost studies are unnecessary as it is easy to determine the farm price.

In practice, the farm business is operated as a unit and any attempt to isolate enterprises is likely to be disappointing because of the joint products, complementary enterprises, and overlapping costs. How the enterprises are managed is dependent upon the decisions of the operator. It is he who decides how he will obtain feed for his livestock, whether he buy it directly from the feed merchant or produce it on the farm. If he decides to produce it himself, the decision to sell it directly to the grain dealer or to feed it to the cattle is a managerial decision for him to make.

In this study farm-raised feed when fed does not enter as an expense except in the cost of producing it. Neither does it show as a receipt if fed since its value will be reflected in livestock sales or livestock products sales. The farm business is considered as a unit with income as a return from the whole organization.

A weakness in the budget approach lies in the assumption that a farm operator will manage one enterprise as well as another. If comparing different sized organizations, the assumption becomes even more dangerous. Then it is assumed that an individual operator when contemplating expansion can manage a large scale enterprise as efficiently as a small one. This may not be the case even when the same enterprise is contemplated and certainly may not be a correct assumption when a new or different enterprise is introduced. However the budgets do show alternative plans for the estimation of the potential profitability of some of the alternatives and organizations. The limitation is the time involved in preparing the large number of budgets that would be necessary to cover all possible situations. But even though budgeting is not without limitations and weaknesses, it provides some measure of guidance for individuals faced with necessary changes in organization.

The above discussion should not be interpreted as meaning that cost of production studies are without value. The data obtained may have considerable value if used properly. The difficulty arises when an attempt is made to assign a cost of production to each commodity and then compare the profitability of different enterprises on this basis. The physical standards of production resulting from such studies have considerable value for planning work of the type carried on in this study.

Transition Problems

One of the major problems with several of the organizations will be that of making adjustments for the planned enterprise. This is true where livestock are concerned, especially with dairy cattle if production of milk is not a part of the present organization. A specific type of building is necessary for the cattle and special equipment such as milking machine, milk cooler, milk room, washing facilities, and utensils must be on hand before any milk is shipped. These preparations will involve some time especially where buildings have to be built or remodeled. Buildings for other livestock are necessary also, and some remodeling will improve present facilities. Most farms have some type of buildings which can be used for most kinds of livestock if some minor changes are made.

Where livestock is not now a part of the farm system, a pasture will have to be established. This requires time although adequate planning in advance may obviate any loss of time or crop year. This also applies to the organization considering the production of hay and alfalfa.

Where livestock is a part of the present organization, expansion of the farm business will require less time. This is especially true if additional cattle are purchased. Little planning in advance will be necessary unless the farm is at present carrying the maximum number for which housing is available. Pastures and meadows are already established on these farms and the necessary equipment is at present in use. If expansion is desired by raising heifers, planning for two or three years is required before any additional milk is produced. The increase in feed requirements before the heifers come into production may lower the output during this transition period, especially if the farm is at capacity at present. However the increase in production of forage expected when water is applied should increase the carrying capacity so that present output can be maintained even though no additional milking cows are purchased. This type of expansion has some merit in that it permits gradual development in experience and knowledge. It provides practice in meeting the managerial problems involved with the new and larger organization.

On the vegetable farms where such crops as strawberries or other small fruits are planned, almost a year is required for the establishment of the planting. As most of the farmers who are planning this type of crop have off-the-farm employment at present, the transition period will not cause great hardship. But the time for the establishment of the crop cannot be disregarded in the planning stage.

Another factor that should not be overlooked is the capital required for the transition from the present organization to the planned one. Table 7 shows the capital requirements for various systems.

Table 7. Capital Requirements for Various Farm Organizations.

Type of Organization	No. Acres	Present Investment (Dollars)	Required Investment (Dollars)	Additional Capital Required (Dollars)
Vegetable farm	40	13,495	18,360	4,865
Dry land	103	36,400	-	-
Alfalfa and Hay	103		41,480	5,080
Feeder steers	103		48,420	12,020
Beef herd (60)	103		48,720	12,320
Beef herd (75)	103		50,860	14,460
Dairy cows (40)	103		54,180	17,780
Dairy cows (60)	103		55,480	19,080
Dry land	280	79,300		
Feeder steers	280		104,390	25,090
Dairy cows (60)	280		106,140	26,840
Beef herd (100)	280		109,040	29,740

The capital required under the new organization is compared with the capital requirement for the dryland operation. This may be somewhat misleading because most of those considering livestock with irrigation have some livestock at present. If adjustment is made for present investment in livestock, the largest part of the increase in capital required is due to the irrigation equipment.

The same machinery or a similar amount of capital invested in machinery should be adequate for the organizations with the exception of dairying where milking equipment would have to be purchased if dairying is not now a part of the business. A manure spreader on farms where livestock is introduced for the first time would also be a necessary addition to the machinery inventory. Table 8 shows a classification of the total amount of capital that is considered necessary to set up the organizations for which budgets are prepared. The machinery investment shows little variation on farms of the same acreage. Irrigation equipment and increase in investment in livestock account for the greater part of the additional capital required.

Table 8. Classification of Capital Requirements for Various Farm Organizations.

Type of Organization	No. Acres	Total Capital Required (Dollars)	Investment in Irrigation Equipment (Dollars)	Investment in Machinery (Dollars)	Investment in Livestock (Dollars)
Vegetable farm	40	18,360	3,360	4,000	-
Alfalfa and hay	103	41,480	4,080	6,400	-
Feeder steers	103	48,420	4,080	6,400	6,990
Beef herd (60)	103	48,720	4,080	6,400	7,400
Beef herd (75)	103	50,860	4,080	6,100	9,250
Dairy cows (40)	103	54,180	4,080	7,000	11,860
Dairy cows (60)	103	55,480	4,080	7,000	12,400
Feeder steers (150)	280	104,390	5,440	14,500	11,650
Dairy cows (60)	280	106,140	5,440	14,500	12,400
Beef herd (100)	280	109,040	5,440	14,500	15,500

Risk and Uncertainty

Where only one enterprise comprises the farm organization, the risk and uncertainty involved are factors for serious consideration. Risk is usually referred to as connected with events whose probability of occurrence can be predicted and against the occurrence of these unfavorable events insurance can be procured. Thus risk is a cost of production. It is the unmeasurable elements causing variations in income that cause the stress and strains when circumstances are unfavorable but which are responsible for profits when events bring favorable conditions. If there were no uncertainty regarding future events, adjustments could be made far enough in advance to prevent losses or gains. But farming involves much uncertainty and farmers may sacrifice some future benefit in order to gain some greater degree of certainty about future income.

Table 9 shows the estimated incomes for a number of years for the various organizations on the 103 acre farm using the same yields of crops and production of animals as in the budgets. The variation is caused by variation in price.

The coefficients of variation for the different organizations are as follows: alfalfa and hay, 27.45; dairy farming, 39.4; beef feeder organization, 43.6; dryland farming, 38.1. The beef feeder operation which appears quite favorable when judged on the basis of net income, has a greater variation from year to year than any of the other organizations. Alfalfa and hay production show the

Table 9. Estimated Income from Various Farm Organizations for Years 1935 - 1953.

Years	Farm Organizations			
	Dry land (Dollars)	Alfalfa and Hay (Dollars)	Feeder Steers (Dollars)	Dairy Cows (Dollars)
1935	2,187		4,848	5,151
1936	3,132		4,287	5,692
1937	2,607		6,449	5,762
1938	2,256		4,877	4,679
1939	2,288	4,840	4,788	4,627
1940	2,288	4,580	5,382	5,325
1941	3,135	5,324	5,490	6,705
1942	3,379	7,436	6,975	8,119
1943	4,727	9.944	7,231	9,708
1944	4,817	10,296	7,385	9.813
1945	4,878	9,504	7,778	9,987
1946	6,091	10,692	9,046	12,589
1947	7,497	10,824	11,232	13,811
1948	5,849	11,880	13,221	15,173
1949	5,272	11,440	11,817	12,624
1951	6,558	12,496	17,026	14,806
1952	6,814	12,276	15,561	15,435
1953	5,586	8,800	11,466	14,108
Coefficient of Variation	38.1	27.4	43.6	39.4

least variation with dairy farming in an intermediate position.

The introduction of irrigation does not appear to reduce the variation in income except when alfalfa and hay are produced. This is expected in this particular case as the comparison is made among different enterprises. No doubt a dairy farm operation would show less variation in income under a system of irrigation than the same dairy farm without irrigation. The dryland farming organization has a much higher coefficient of variation than the alfalfa and hay organization which it most closely resembles. In addition the average incomes are much higher when the owner has some control over the water resource. Irrigation is necessary to permit livestock operations on this scale under the conditions assumed in the budgets.

There are other elements of risk and uncertainty in production in addition to price. Losses from disease, insects, and unfavorable weather are only a few examples of factors which can cause variations in production. These variations cannot be predicted accurately. But assuming these factors to be fairly constant for each type of farming under the same management, those who cannot absorb a loss from price variation and remain in business a sufficient time to realize gains from more favorable prices, should consider enterprises with the least variation in income.

CHAPTER VI

LINEAR PROGRAMMING

Some of the questions in the minds of farmers listed at the beginning of the study are partially answered. The various budgets show what capital requirements are necessary, make allowance for increased labor costs and indicate the incomes that may be expected under average management for the specific organizations. But the question which might now be asked is whether the organizations chosen are the best ones. More specifically, a critical appraisal might question the number of acres of corn, strawberries and beans on the small farm. Should an operator grow only strawberries, beans or corn rather than a combination of the three crops? If a combination of the three is decided upon, how must the decision be made?

It must be admitted that the organizations suggested in the budgets are based on some assumptions which may not be valid for all farms. One such assumption is that the livestock numbers where livestock is suggested will be limited by the forage produced. Then too, one enterprise only is suggested for these organizations, yet a second or even a third might be practical on some farms. A poultry enterprise could profitably be added to the organizations suggested in the budgets. This was not done as it was believed that irrigation would have a very limited effect on such an enterprise. The organizations might well increase profits with addition of a commercial flock regardless of irrigation.

But on the small farm it must be admitted that a considerable amount of subjectivity, influenced somewhat by the opinions expressed by farmers themselves, determined the acreages of crops suggested. The reason is obvious. It would take a great length of time to prepare a budget for each possible combination of acreages and crops in order to find the optimum combination.

Fortunately a new technique, variously called "activity analysis," "mathematical programming," and "linear programming" has been developed and applied to farm management problems. The technique was developed by Lieontief, Koopmans, Dantzig and others and is being applied to various phases of farm management, from determining a minimum-cost dairy feed to optimum combinations of competitive crops.

It was decided to apply the technique to the problem at hand - by the use of linear programming to determine the optimum combination of the three crops, canning corn, strawberries and pole beans on the forty acre farm, thirty-five acres of which would be irrigated. These three crops are selected as they are the ones which farmers contemplate growing. They are not the only enterprises or "activities" that could be included in the problem, nor are the limits set on acreage, labor available in June and September applicable to all organizations. But the problem as set up shows the possibilities of using the linear programming technique to solve the economic problem of combining or eliminating several enterprises to give the most profitable organization without preparing a budget for every possible combination of the various enterprises.

In order to use the technique on such a problem, data similar to that used in the budgets are essential. The yields expected per acre are those used in the budgets - eight tons of pole beans per acre, three tons per acre of strawberries for three years with one year idle to give an average of 2.25 tons per acre per year, and 4.1 tons of corn per acre.

If no limitations are placed upon the resources with which a farm operator works, the problem becomes a very simple one. The most profitable organization would be the whole farm producing the crop yielding the highest net return per acre. But most farmers are restricted in their use of capital, their use of labor at various seasons, or their acreage. The typical farm operator has at his command a certain bundle of resources which may be applied to the production of various commodities within limits. In this study the number of acres of cropland was limited to 35, the amount of working capital available for crop production was limited to $5,000 for one system, to $8,000, to $10,000 and to $15,000 for succeeding organizations while the other restrictions remained constant throughout. Labor available was limited to 500 hours per month, the approximate equivalent to two full-time men including the operator. This is not the total amount of labor used. One half of the labor required for hoeing the strawberries and all labor for picking the berries was hired in addition to the 500 hours. Pre-harvest labor and labor for picking beans was also hired in addition to the 500 hours. The two months June and September were selected because these are the two months requiring the most time excluding harvesting time. Harvesting is not restrictive when hired labor is assumed available for this purpose.

On a larger farm, in addition to the restrictions placed on production a farmer would limit the size of a specific enterprise if for no other reason than management limitations. With enterprises such as those suggested the uncertainty resulting from variation in yields and prices would almost certainly dictate some limit even though no such absolute restrictions as those used were involved. But on the small farm, it is believed that the uncertainty, although still present, would not restrict the acres devoted to each or any of the crops beyond the absolute limitations stated. Thus the quantities of resources listed in Column I of Table 10 are those which might limit the choice of farm organization in Situation 1. The maximum of 35 acres of land could be used; $5,000 in the first instance is all the money available for variable expenses; 500 hours of labor excluding harvesting labor and other labor as outlined above is the maximum available in any one month. The problem is that of choosing the most profitable system, either a single crop or a combination of crops, the only limitations being those defined.

An assumption of the linear programming technique is that the rate of return is constant, that the income received from two or four (or any number of) acres of crop is equal to two or four times the income received from one acre of that crop. This assumption is not unrealistic in this specific problem because costs which are constant for the individual farm are omitted from the process. After the optimum combination of crops is determined, these costs can be deducted from the income figure produced by the process if farm or labor income is required. For example, depreciation on machinery and buildings, cost of telephone, cost of electricity other than that used for irrigation, taxes, use of automobile, and such relatively fixed costs are omitted in the process because the cost per ton would diminish as number of acres in production increases if such relatively fixed costs are included. Price per unit of output remains constant, therefore omission of as many fixed costs as possible makes the assumption more valid. This assumption that constant rate of return to relative proportions of all inputs is one basic to the linear programming technique. In addition it is assumed that the inputs are divisible, that an operator could produce one acre or any number of acres up to the 35 acres of one crop if not limited by the other quantities of resources available. The third basic assumption is that the incomes from any two enterprises carried on simultaneously are additive - that is, that the income received from any two or three enterprises carried on simultaneously would be the sum of the incomes produced by these enterprises if they had been conducted separately. In other words, the enterprise relationships are competitive rather than supplementary or complementary. For many enterprise relationships this assumption would be unrealistic but for the enterprises under consideration, it is consistent with the facts of the case.

The additional assumptions made are similar to those used in budgeting. Only a single method of production is assumed. Costs for equipment and materials are computed at a constant rate for those which the operator could buy with the capital limitation stated. Current prices of products are assumed to be fairly typical under the price-cost relationship existing at present. Perhaps most important and most subject to error is the assumption that the farm operator could manage one organization as successfully as the others within the framework of the problem, or any combination of the three enterprises suggested.

Information Required

Most of the information used in the linear programming model is the same as that used in the budget on the forty acre farm. In addition labor requirements, exclusive of harvesting labor and other exceptions previously indicated, were obtained from the three publications which supplied the data on costs (9, p.19), (5, p.13) and (4, p.17). Production estimates and prices are the same as those used in the budgets.

The limitations set in the first situation are listed in Column I, Table 10, with the heading A_0, A_1, A_2, and A_3 being used for the activities or enterprises. The A_0 column indicates the amounts of the various inputs or resources available for the production of any one or a combination of the three crops. In Table 10, Row A_4, Column A_0 indicates the number of acres available, (35 acres);

Row A_5, column A_0 is the amount of capital available ($5000); Row A_6, column A_0 is the amount of June labor available (500 hours); Row A_7, column A_0 is the maximum amount of September labor available (500 hours). The column A_1 lists the requirements per ton of corn produced for each of the resources being considered. A_2 shows the amounts of each input required per ton of strawberries produced and A_3 the same information per ton of beans produced. For example, to produce one ton of strawberries requires .4444 acres of land (based on average yield), $198.667 of capital (omitting the fixed costs as previously defined), 17.7778 hours of June labor and 5.7778 hours of September labor. The columns A_4, A_5, A_6, A_7 may be referred to as disposal processes, allowing the various resources or some part of them to remain idle if need be.

Table 10. A Linear Programming Solution by the Simplex Method for Three Processes with Four Limitational Resources in Polk County (Situation I).

		Disposal Processes				Corn	Strawberries	Beans	
	A_0	A_4	A_5	A_6	A_7	A_1	A_2	A_3	R
Plan 1									
A_4	35	1	0	0	0	.243	.444	.125	78.7
A_5	5,000	0	1	0	0	16.585	198.667	80.250	25.1
A_6	500	0	0	1	0	1.951	17.777	2.750	28.1
A_7	500	0	0	0	1	2.926	5.777	1.625	86.5
Plan 2									
A_4	23.81	1	-.002	0	0	.206	0	-.054	
A_2	25.16	0	.005	0	0	.083	1	.403	
A_6	52.55	0	-.089	1	0	.467	0	-4.431	
A_7	354.58	0	-.029	0	1	2.444	0	-.708	
Z	8,053.70	0	1.610	0	0	26.713	320.	129.261	
Z-C	8,053.70	0	1.610	0	0	6.713	0	4.26	

C values are zero for A_4, A_5, A_6, A_7 and $20 for A_1, $320 for A_2 and $125 for A_3.

The R column in Table 10 is derived from taking the requirements for one of the processes and dividing the resources available by the corresponding requirements. To start the process, A_2 was chosen arbitrarily and the requirement of .44444 acres per ton was divided into the total number of acres available (35) to give an R value which indicates the number of tons of strawberries that could be produced within the acreage limitation. The same procedure was used for each value under A_2 and the R column obtained. From this R column it is seen that the maximum production of strawberries will be 25.17 tons, the capital limitation restricting production at this point. The next step in the process replaces A_5 with A_2, A_2 being the process under consideration and the minimum value in the R column determining the position of A_2. The values for the second matrix in Table 10 are computed by first dividing each figure in Row A_5 in the first matrix by 198.667. This gives the figures for Row A_2 in the second matrix. The A_2A_o figure 25.1678 is the tons of strawberries that can be produced with the available capital. The A_5 row for columns A_1 and A_3 represents the rate at which corn and beans substitute for strawberries in the use of capital. To get the figures for Row A_4 in the second matrix, the ratio of .44444 to 198.667 is computed and the values in Row A_5 in the first matrix are multiplied by this ratio or .0022371. Each resulting product from this multiplication is then subtracted from the corresponding value in Row A_4 in the first matrix to give the new values for Row A_4 in the second matrix. The purpose of this procedure is to establish a new matrix with all figures expressed in terms of strawberry requirements. For example, in the A_0 column, A_4 row, second matrix, the figure is 23.814. This is calculated by the formula $35 - (\frac{.444}{198.667} \cdot 5000)$. Another way of expressing this is to divide \$5000 by 198.667. This gives the number of tons of strawberries that can be produced with the available capital or 25.17 tons. We can then multiply this figure by .444, which is the acre requirement per ton of strawberries. The resulting quantity, 11.2, is the acre requirement for 25.17 tons of berries. This is substracted from 35, the acreage originally available, to give the quantity of unused land or 23.81 acres.

To get the values for Row A_6 in the second matrix, the same procedure is followed. The ratio used for multiplication is that of 17.7778 to 198.667. Each figure in Row A_5 in the first matrix is multiplied by this value and the products are subtracted from the corresponding values in Row A_6 in the first matrix to get the values for Row A_6 in the second matrix. The same method is used to obtain the Row A_7 values to complete the second matrix. The C values are zero for A_4, A_5, A_6 and A_7, the disposal processes, and \$20 for A_1, \$320 for A_2 and \$125 for A_3. These are the prices per ton for the respective crops. The Z values are obtained by multiplying Row A_2 (in A_0 column this figure is 25.1678 which is the number of tons of strawberries) by the value of the strawberries per ton \$320. The Z-C value is then computed. When the Z-C values for the activities A_1, A_2 and A_3 show no negative value, this is the end of the process; that is, the highest possible return from the farm under the limitations set will be obtained when the entire bundle of resources is applied to the production of strawberries. The gross income received from berries would be \$8,053.70, from a production of 25.17 tons if the price is \$320. per ton or approximately 11.2 acres using 2.25 tons per acre as the expected yield. With this organization the remaining 23.8 acres would remain idle. Unless a secondary enterprise is added, a small amount of June labor and two-thirds of the available September labor will remain idle. If only one enterprise comprises the farm business, the hired labor could be disposed of at the end of June.

The second situation increases the capital available to \$8,000. The process was begun with strawberries A_2 and the same method was used for the computations shown in Table 11. The R values in the first matrix show June labor to be the restricting resource. In the second matrix the R values are obtained by using A_3 as the activity. When the figures are computed for the second matrix, the negative sign of the Z-C value for A_3 indicates A_3 must replace A_5 in the third matrix, the smallest R value dictating the position of A_5, and the negative Z-C value for A_3 determining the activity. When the new vector is completed, absence of negative values for A_1, A_2 or A_3 indicates the end of the process. The highest returns \$12,676. can be obtained from a combination of strawberries and pole beans with approximately 20.56 tons or 9.15 acres of strawberries and 48.72 tons or approximately 6.1 acres of pole beans. These tons

Table 11. A Linear Programming Solution by the Simplex Method for Three Processes with Four Limitational Resources in Polk County (Situation II).

		Disposal Processes				Corn	Strawberries	Pole Beans	
	A_0	A_4	A_5	A_6	A_7	A_1	A_2	A_3	R
Plan 1									
A_4	35	1	0	0	0	.243	.444	.125	78.7
A_5	8,000	0	1	0	0	16.585	198.667	80.25	40.2
A_6	500	0	0	1	0	1.951	17.777	2.750	28.1
A_7	500	0	0	0	1	2.926	5.777	1.625	86.5
Plan 2									
A_4	22.5	1	0	-.02	0	.195	0	.056	400.
A_5	2,412.5	0	1	-11.17	0	-5.219	0	49.518	48.
A_2	28.12	0	0	.05	0	.109	1	.154	181.8
A_7	337.5	0	0	-.32	1	2.292	0	.731	461.5
Z	9,000.	0	0	18.00	0	35.12	320.	49.499	
Z-C	9,000.	0	0	18.00	0	15.12	0	-75.499	
Plan 3									
A_4	19.75	1	-.001	-.012	0	.201	0	0	
A_3	48.71	0	.020	-.225	0	-.105	0	1	
A_2	20.58	0	-.003	.021	0	.126	1	0	
A_7	301.62	0	-.014	-.159	1	2.369	0	0	
Z	12,676.29	0	1.523	-21.381	0	27.162	320.	125.	
Z-C	12,676.29	0	1.523	-21.38	0	7.162	0	0	

and acreages are computed in the same way as in Situation I, using yields of 2.25 tons for strawberries, 8 tons for pole benas with prices \$320. and \$125. per ton respectively.

With the limitations listed, the most profitable organization will leave approximately 20 acres idle. Capital and June labor will be used but some September labor will not be utilized. Where part time seasonal labor is available, this will prove no problem.

The figures for Situations III and IV are presented in Tables 12 and 13.

Table 12. A Linear Programming Solution by the Simplex Method for Three Processes with Four Limitational Resources in Polk County (Situation III).

		Disposal Processes				Corn	Straw-berries	Pole Beans	
	A_0	A_4	A_5	A_6	A_7	A_1	A_2	A_3	R
Plan 1									
A_4	35	1	0	0	0	.243	.444	.125	280.0
A_5	10,000	0	1	0	0	16.585	198.667	80.25	124.6
A_6	500	0	0	1	0	1.951	17.777	2.75	181
A_7	500	0	0	0	1	2.962	5.777	1.625	307.7
Plan 2									
P_4	19.4	1	-.001	0	0	.218	.134	0	144.2
P_3	124.61	0	.012	0	0	.206	2.475	1	50.3
P_6	157.3	0	-.034	1	0	1.382	10.969	0	14.4
P_7	297.5	0	-.020	0	1	2.591	5.417	0	54.9
Z	15,576.	0	1.58	0	0	25.83	309.45	125.	
Z-C	15,576	0	1.58	0	0	5.83	-10.55	0	
Plan 3									
P_4	17.47	1	-.001	-.012	0	.201	0	0	
P_3	89.11	0	.020	-.225	0	-.105	0	1	
P_2	14.33	0	-.003	.091	0	.126	1	0	
P_7	219.82	0	.003	-.493	1	1.908	0	0	
Z	15,727.55	0	1.522	.98	0	27.163	320.	125.	
Z-C	15,727.55	0	1.52	.98	0	7.163	0	0	

From the information presented in Table 12, the most profitable organization is a combination of strawberries and beans, obtained by producing 89.11 tons of beans or approximately 11 acres of this crop and 14.339 tons or approximately 6.4 acres of strawberries. As in the first two situations part of the land will remain idle. This might be devoted to pasture if the restricting resources cannot be raised.

Situation IV, with $15,000 capital resource available, shows highest returns will be received when total available resources are devoted to the production of pole beans. The process was begun with this activity (A_3) rather than with A_2 without specific reason but for the sake of variation. When no negative value appears in the Z-C values, the maximum value in the A_0 column has been obtained. Thus an income of $22,727. will result if pole beans only are grown. This is not a net income figure as some fixed costs have not been accounted for. But because the capital requirement used per ton includes variable costs, the net income obtained will be highest when beans only are produced.

The production of corn does not appear in any of the organizations within the limits set. The process was not begun with corn as an activity for any reason but by chance. However, the process may be started with the highest priced crop. No doubt if the tables had been set up with R values obtained by using A_1, corn, the process would have required additional computation, but this would prove no obstacle or problem. The final answer would be the

Table 13. A Linear Programming Solution by the Simplex Method for Three Processes with Four Limitational Resources in Polk County (Situation IV).

	P_0	Disposal Processes P_4	P_5	P_6	P_7	Corn P_1	Strawberries P_2	Pole Beans P_3	R
Plan 1									
P_4	35	1	0	0	0	.243	.444	.125	280.0
P_5	15,000	0	1	0	0	16.585	198.667	80.25	186.9
P_6	500	0	0	1	0	1.951	17.777	2.75	181.
P_7	500	0	0	0	1	2.926	5.777	1.625	307.7
Plan 2									
P_4	12.27	1	0	-.045	0	.155	-.363	0	
P_5	409.09	0	1	-29.182	0	-40.355	-320.133	0	
P_3	181.81	0	0	.363	0	.709	6.464	1	
P_7	204.54	0	0	-.590	1	1.773	-4.727	0	
Z	22,727.27	0	0	45.46	0	88.69	808.08	125.	
Z-C	22,727.	0	0	45.46	0	68.69	488.08	0	

same regardless of the activity used to start.

The optimum combination of crops may also be obtained from a diagram of the information used in the tables. However, only two crops can be shown on one diagram. Figure 1 is the diagrammatic illustration of Situation I with strawberries and pole beans as the two crops under consideration. The June labor curve indicates the number of tons of each crop which could be produced with the labor available; the September labor curve shows the total production possible within the same restriction. The capital resource curve indicates the number of tons of each crop, or various combinations of the two crops that could be produced with $5,000. The acreage curve shows the same possibilities.

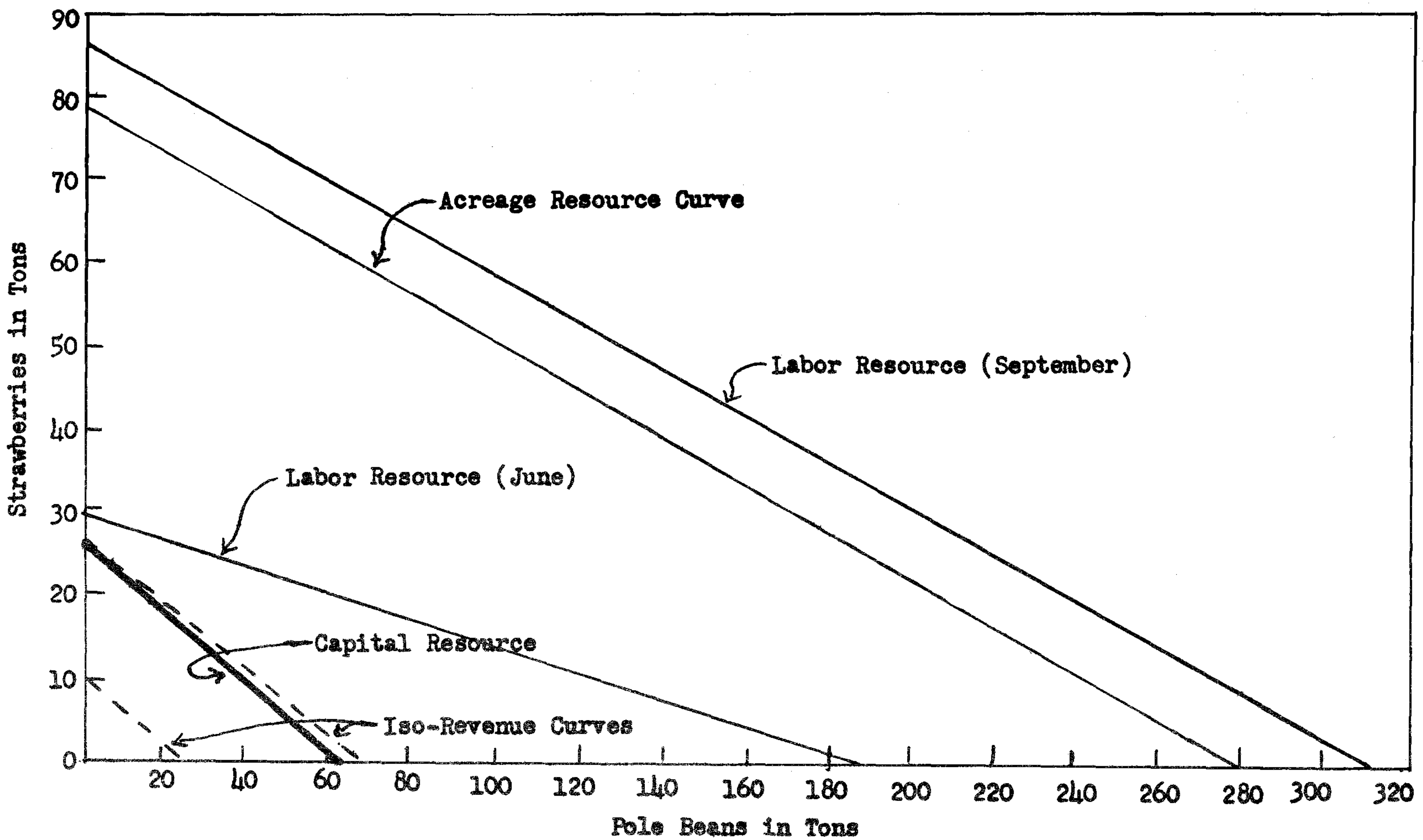


Figure 1. Optimum Combination of Strawberries and Pole Beans, Situation I.

Table 14. Number of Tons of Each Crop That May be Grown with Resources Available, Situation I.

	Corn	Strawberries	Pole Beans
Acreage	143.5	78.75	280.0
Capital	301.5	25.17	62.3
June Labor	256.2	28.12	181.8
September Labor	170.8	86.54	307.7

The slope of the iso-revenue curve is determined by the ratio of price per ton of the two products and indicates the number of tons of strawberries, beans or the different combinations of the two crops which will produce the same income. The farther this iso-revenue line is shifted from the origin the higher the income. Therefore if this iso-revenue line is placed as far as possible from the origin within the limits determined by the iso-resource curves the most profitable position can be determined. In Figure 1 the iso-revenue curve intersects the capital iso-resource curve at the extreme left of the diagram. This indicates the highest income for the operator can be attained from using all available resources in the production of strawberries. The amount of the crop that will be produced will be 25.17 tons, or approximately eleven acres. The remaining acreage would remain idle because it would be more profitable to use the $5,000. for production of strawberries than to reduce the number of acres in this crop in order to have capital available for a second crop. The curves for June labor, September labor and number of acres do not restrict production at this point. Table 14 shows the number of tons of each crop that may be produced with the resources available in Situation I.

After establishing the fact that strawberries are more profitable under Situation I than pole beans, the comparison of strawberries with corn is made (Figure 2). As in the first comparison, strawberries prove more profitable. The iso-revenue curve intersects the restricting capital curve at the extreme left of Figure 2. In the following situations when corn is compared with strawberries and beans, corn is eliminated from the production plan. Only strawberries and pole beans are used in the diagrams presented in Figures 3, 4, and 5. The method of eliminating corn as a possibility in the succeeding organizations is the same as used in Figure 2.

In Figure 3, the second situation is presented diagrammatically. The acreage and labor limitations remain the same as in Situation I but the capital available has been increased to $8,000. This places the capital resource curve farther from the origin, permitting an increase in total production. The June labor curve is intersected by the capital curve. Figure 1 has shown that strawberries are more profitable than beans with $5,000 capital, and under the other limitations. Figure 3 shows that capital now limits the production of beans and June labor the production of strawberries. The highest return in this situation may be obtained from a combination of the two crops, with a production of 20.58 tons or 9.15 acres of strawberries and 47.18 tons or 6.09 acres of pole beans. September labor and acreage may be left off the diagram as neither is a limiting factor as seen in Table 15.

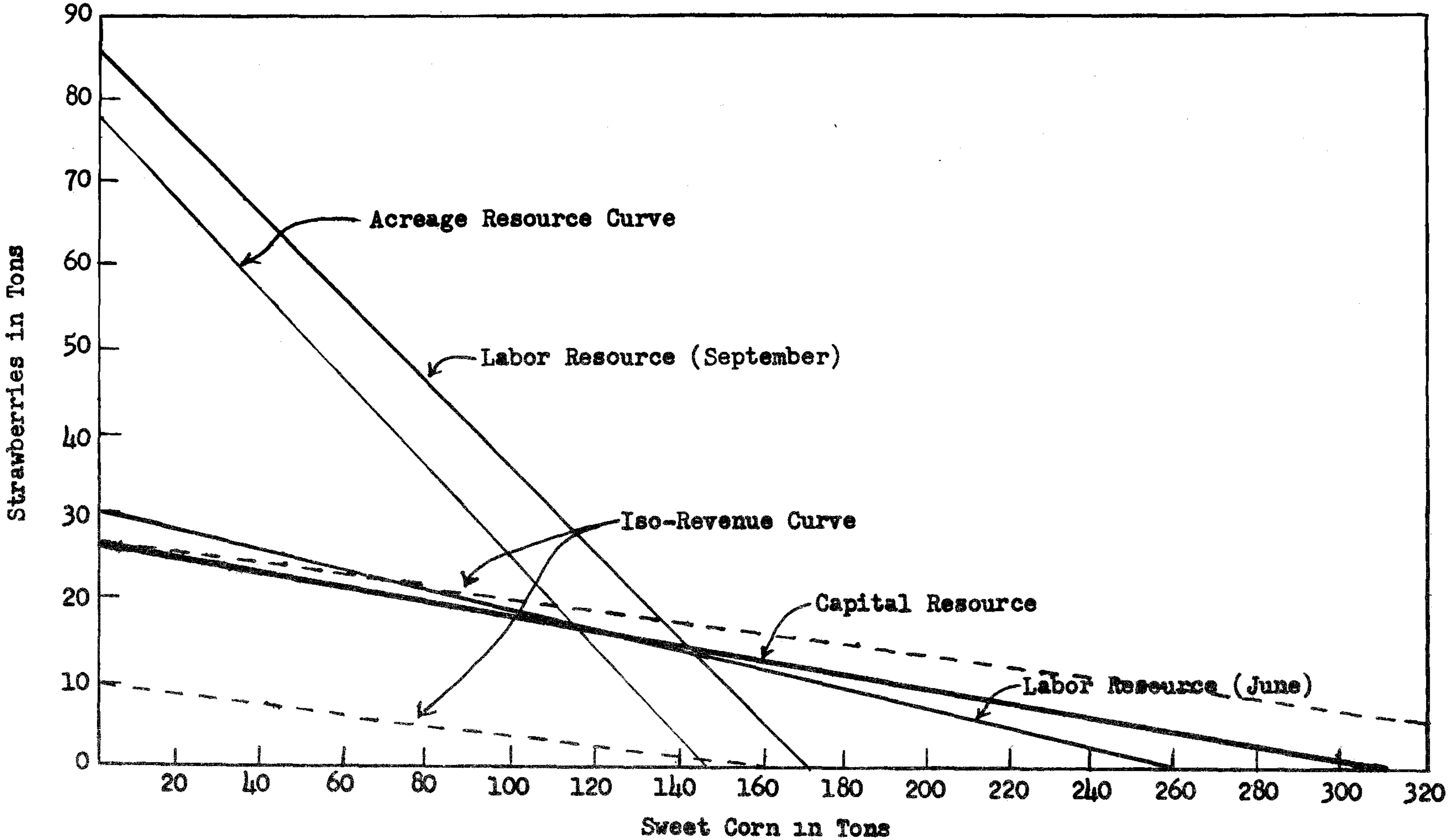


Figure 2. Optimum Production of Corn and Strawberries, Situation I.

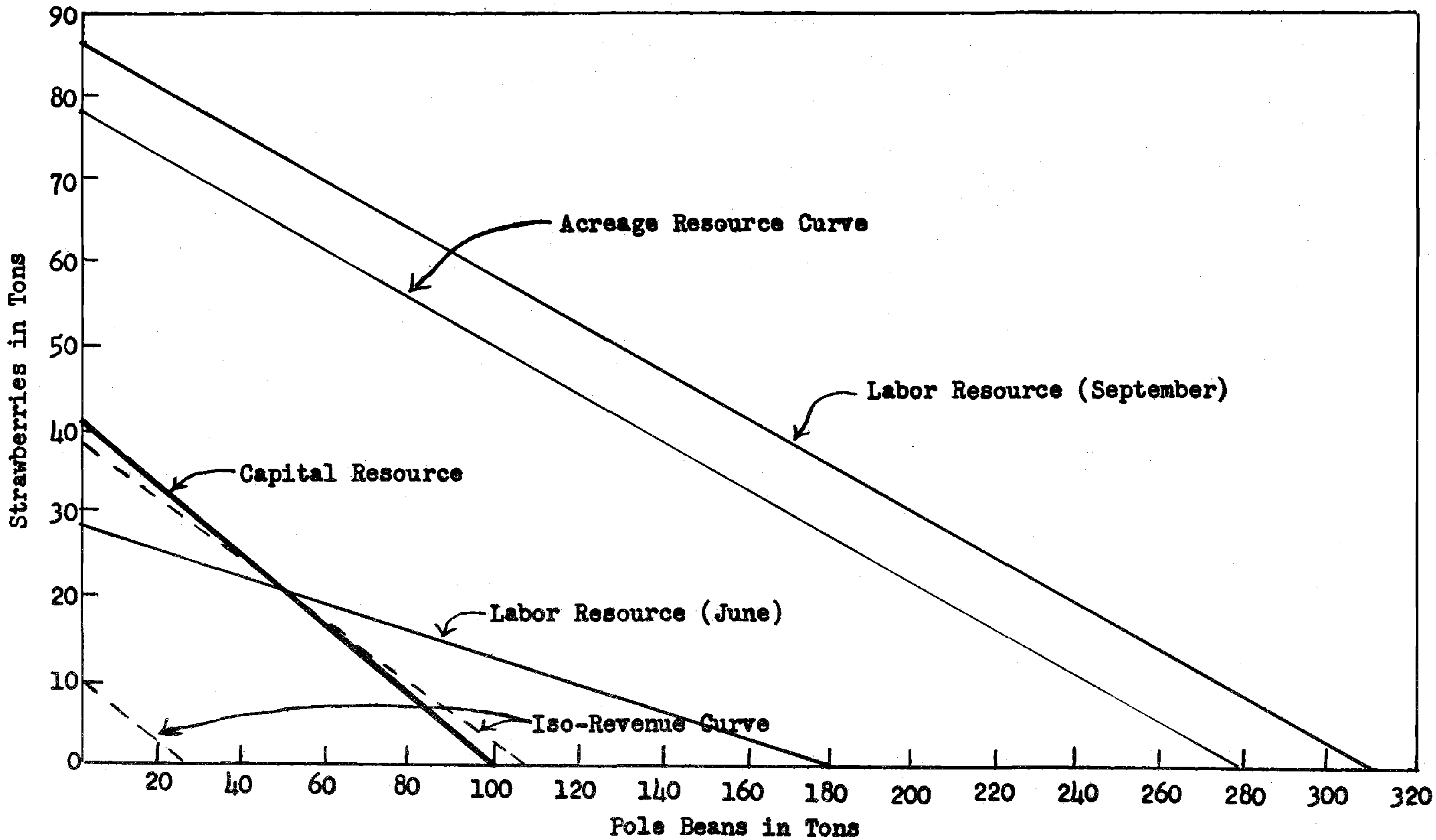


Figure 3. Optimum Combination of Strawberries and Pole Beans, Situation II.

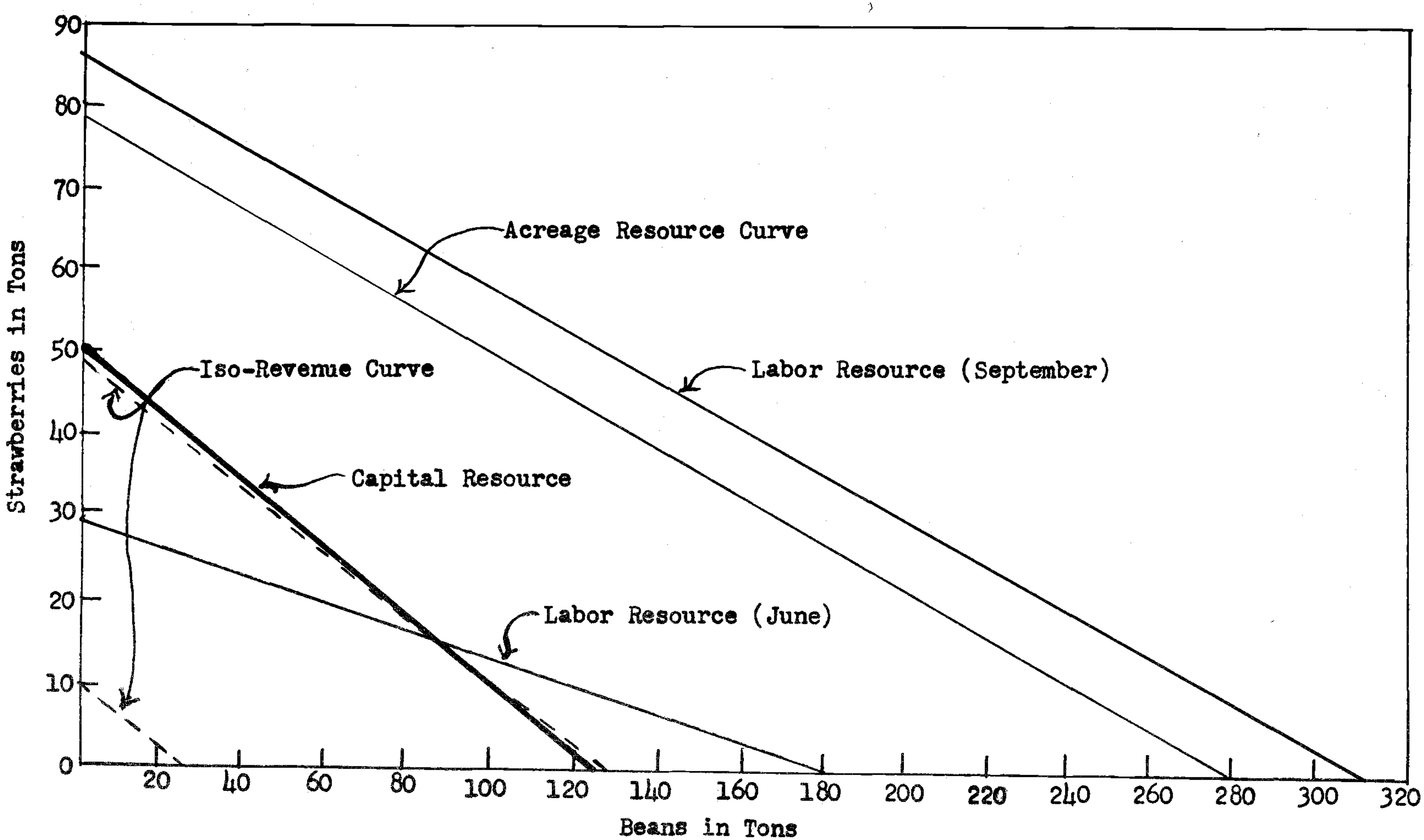


Figure 4. Optimum Combination of Strawberries and Pole Beans, Situation III.

Table 15. Number of Tons of Each Crop That May be Grown with Resources Available, Situation II.

	Corn	Strawberries	Pole Beans
Acreage	143.5	78.75	280.00
Capital	482.4	40.27	99.69
June Labor	256.2	28.12	181.80
September Labor	170.8	86.54	307.70

Figure 4 shows the third situation with acreage and labor restrictions remaining the same as in the two previous systems and capital available increased to $10,000. June labor is restricting production of strawberries and capital the production of beans, but not to the same extent. Table 16 summarizes the limitations placed on each crop in Situation III. As in the previous situations, acreage and September

Table 16. Number of Tons of Each Crop That May be Grown with Available Resources, Situation III.

	Corn	Strawberries	Pole Beans
Acreage	143.5	78.75	280.0
Capital	603.0	50.34	124.6
June Labor	256.2	28.12	181.8
September Labor	170.8	86.54	307.7

limitations are not restrictive. From Figure 4 it is seen that the highest return may be attained from producing a combination of the two crops, the acreage determined by the point of intersection of the capital and labor resource curves. The most remunerative combination would be 14.39 tons or 6.4 acres of strawberries and 89.11 tons or approximately 11 acres of beans.

Situation IV is depicted in the same manner. In this instance the capital resource has been increased to $15,000. Table 17 shows the maximum number of tons of each crop that could be produced within the limitations of the problem. Figure 5 indicates that capital

Table 17. Number of Tons of Each Crop That May be Grown with Available Resources, Situation IV.

	Corn	Strawberries	Pole Beans
Acreage (35)	143.50	78.75	280.0
Capital ($15,000)	904.50	75.50	186.9
June Labor (500 hrs.)	256.25	28.12	181.8
September Labor (500 hrs.)	170.80	86.54	307.7

is no longer restricting production of either crop at this point, but June labor limits both. It is easily seen from the diagram that the operator may reach a higher place on the revenue curve by devoting all his resources to the production of pole beans. Labor will restrict his total production to 181.81 tons or approximately 22.7 acres. This crop will produce a higher return, $22,727, than any other of these crops or combination of them.

The advantage of the linear programming technique is evident when one computes the farm and labor incomes for the number of acres of crops which the method indicates as the most profitable organization. The inputs for the vegetable farm with 4 acres of strawberries, 15 acres of corn, and 16 acres of pole beans are approximately equal to these with the $15,000 capital limitation. The linear programming technique shows 22.7 acres of pole beans to be the most profitable organization under the restrictions placed on available resources.

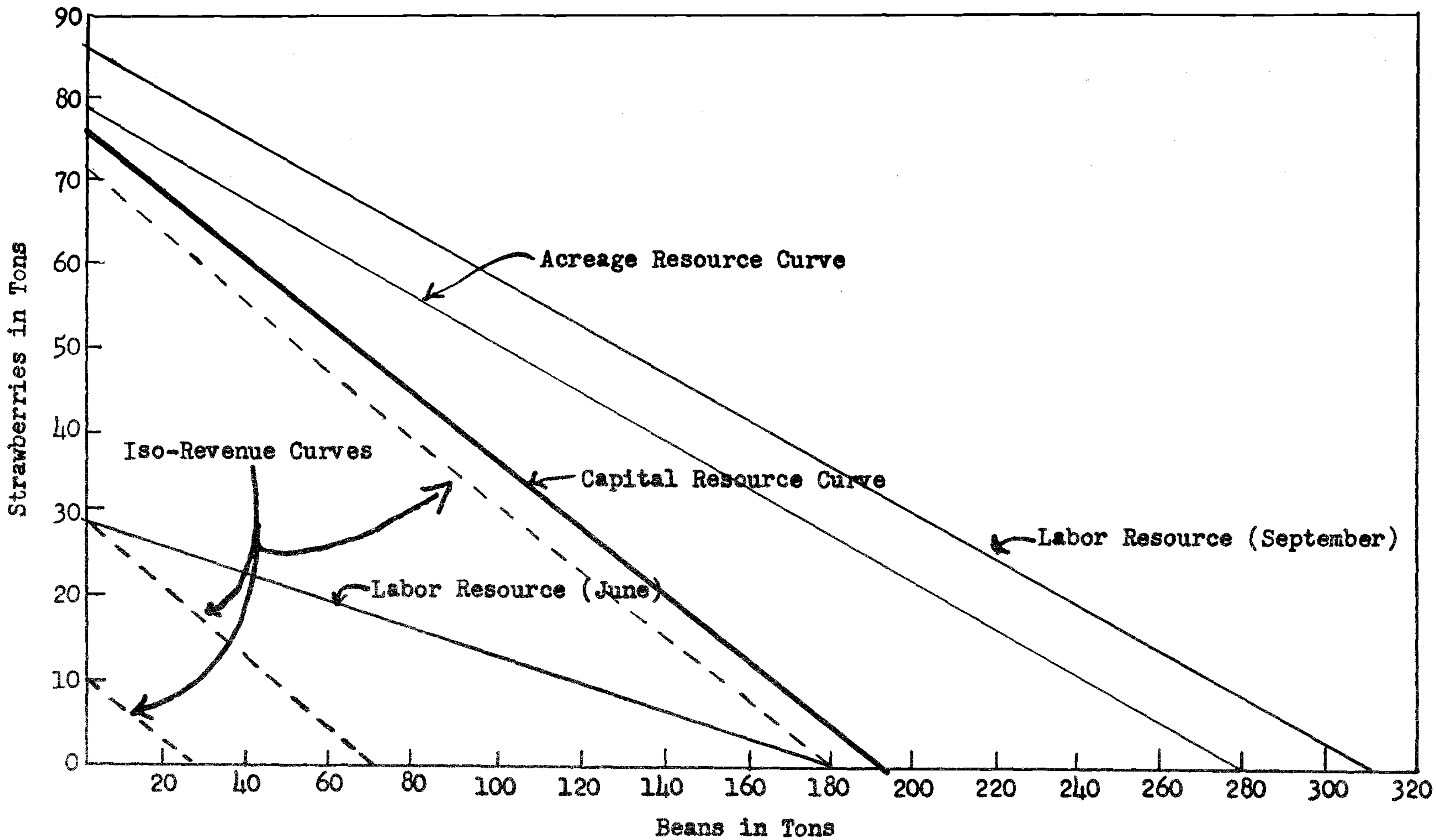


Figure 5. Optimum Combination of Strawberries and Pole Beans, Situation IV.

Although approximately 12 acres of land remains idle, the ordinary method of budgeting shows the farm income from the 22.7 acres of pole beans to be $1,911 higher than from the 35 acres producing the three crops. This assumes all other costs except labor, which would not be required after June, to be the same. Of course, it would cost less to irrigate 22.7 acres than 35 acres and the cost is computed on an acre basis. The return to labor and management is at least $1,911 higher as the interest charged would be somewhat less than $1,018 because of the smaller investment in irrigation equipment necessary. Even if labor costs are held constant the increase in income from the 22.7 acres of pole beans over the original 40 acre budget is at least $1,160.

There may be some reasons why a farmer would not want to produce 22.7 acres of pole beans even if this organization proves most profitable under the limitations placed on resources. Uncertainty of yields and the higher risk involved might prevent him from placing all his resources in the production of one crop. Desire to keep hired labor on a full time basis might merit some sacrifice in income. But linear programming points the direction the organization should take with less time and money than the traditional method of budgeting would require. For this reason linear programming is not an end in itself but a device which should be applied to the organizational problem of a farm before a budget is prepared, assuming the available resources are known. A budget can then be prepared in the light of this information and with intelligent interpretation of it, more useful budgets should result.

Water as a Production Input

Water used for irrigation purposes must be considered an input, just as other materials used in the production of crops. Irrigation is a practice that may be followed by the operator where water is available just as the practice of fertilization may be carried out where fertilizer is available. Indeed crop response to the application of water as an input follows much the same pattern as a response to fertilizer input. Where water is a limiting factor in production, a small application will give a relatively large increase in yield. As the water input is increased, production will increase but the additional responses will not be so marked. As further quantities are added, a point will be reached where maximum production will result with no increase in yield with the last application of water. Beyond this point, additional water will have a detrimental effect resulting in a decrease in production. The principle of diminishing productivity is more evident with irrigation than with some other inputs.

As is the case with most agricultural products, the point of maximum physical production is not likely the most economical point at which to produce. This would be the optimum point only if water for irrigation were free and its application involved no cost. But this is not the case. The farmer must apply the principle of maximization of returns and cease to apply water or any other input at the point where the marginal revenue is equal to the marginal cost. Even this principle applies only to those who have unlimited capital. Where capital is limited and opportunities to invest the capital in other parts of the farm business exist, the farm manager will cease application of water or any other input before the point where marginal cost equals marginal revenue is reached; he will apply his capital to other more remunerative parts. If the quantity of water is restricted, he will apportion his supply among the various crops to obtain the maximum total returns. This may require giving only two applications to each of four crops, rather than an optimum of four applications each. He may find his maximum total returns are higher when each crop receives the two applications than when only two of the crops received the optimum four applications.

In the proposed plan of the Monmouth Dallas project, however, the quantity of water used is not restricted, although a limit may be set on the total amount used. The water user probably will be required to pay a fixed cost per acre for the water within the maximum limitation regardless of the amount used. The water itself thus becomes a fixed cost and the added irrigation cost will be that of the extra power necessary to make additional applications, the additional labor required to move the system for these applications, and perhaps a slight increase in depreciation rates due to the increased use of the equipment. The problem thus becomes one of applying the right amount of water to reach the point where marginal revenue equals marginal cost on the specific number of acres for which the contract was made. The opportunity costs will be those associated mainly with the labor where its supply is limited. If the labor required to move the system for additional application of water will produce a higher return when applied to some other use, it should be employed in the latter occupation and the additional water application should not be made. However, as crops respond to water as to labor, seed, fertilizer, etc., there will be some substitutability of these factors. While the system is placed in one specific area, it may be more economical to apply more water and less of some of the other inputs because the additional cost may be very small. It may well prove economical to substitute water to a limited extent for seed, fertilizer and labor.

Where water will be sold at a flat rate per acre, it seems reasonable to expect that farmers will tend to irrigate crops that require considerable quantities of water, or irrigate those crops being watered artificially rather heavily. An operator can afford to go farther on the production surface under this kind of arrangement approaching more nearly the point where the marginal cost equals the marginal revenue. He can give an extra application to a crop already being watered with little or no extra cost, but to give one application to a crop needing irrigation only once at a critical stage will cost an additional $15.00 per acre if $15.00 is the rate charged. The expected returns from this one application would have to be at least $15.00 higher than the expected increase in revenue from the first field. This will probably not be conducive to the best use of water resources. There are many crops which will not respond sufficiently to application of water to return the cost of irrigation at the flat rate per acre but which could use water economically if the cost were based on the amount of water used. This is true with cereal crops in general. One application at a critical stage might be very productive in terms of the physical production per unit of water input. Information on crop response to water is limited especially for cereal crops, but farmers in general are not contemplating irrigation of these crops under the proposed method of purchasing water.

Some interesting observations may be made from work carried on by the Soils Department at Oregon State College (10, p.4). Four moisture treatments were tested in the production of sweet corn. In treatment M-1, soil moisture was kept high during the entire growing season. M-2 had low soil moisture until early tasselling and then had water applied to bring the soil moisture content to M-1 level. M-3 had high soil moisture until tasselling and was then allowed to dry. M-4 treatment had low soil moisture during the entire season. Table 18 shows the amounts of water used. It is seen that no irrigations were necessary to maintain the level of M-4 in 1954 because of rain at an opportune time. M-3 required three applications of water in 1954 and five applications in 1955.

The average yields per treatment were as follows:

M-1	8.28 tons per acre
M-2	7.03 tons per acre
M-3	7.67 tons per acre
M-4	5.81 tons per acre.

Table 18. Amounts of Irrigation, Rain, and Water Use for 1954 and 1955 Season in Inches. (10, p.4)

Irrigation Treatment	No.	Amount	Rain	Soil Moisture Depletion	Water Used
1954					
M-1	5	8.16	4.94	3.8	16.90
M-2	1	4.57		3.8	13.31
M-3	3	4.35		6.2	15.49
M-4	0	-		5.4	10.34
1955					
M-1	11	15.76	2.85	-1.03	17.58
M-2	5	9.94		-1.32	11.47
M-3	5	8.02		2.95	13.82
M-4	3	9.70		-1.83	10.72

These data appear to substantiate the claim that purchasing water on an acre basis regardless of amount used will not lead to the best use of water. In 1955, eleven irrigations were made and 15.76 inches of water applied to produce a yield of 8.28 tons per acre. Treatment M-3, however, required only five irrigations totaling 8.02 inches to produce a yield of 7.67 tons per acre. In other words, six additional irrigations and 7.74 inches of water produced an increase of only .61 tons of sweet corn per acre. If the additional amount of water and six extra irrigations had been applied to an unirrigated area it would have been approximately sufficient for the M-3 treatment. Unirrigated sweet corn in river bottom soil averages 2.6 tons per acre (5, p.17).

Looking at this from an economic point of view, the additional cost of applying this water for treatment M-1 would be mainly power, equipment and repair cost. Labor to move the equipment might be a factor depending on whether labor is a fixed or variable cost. But power cost, use of equipment, and repair cost would be approximately double for treatment M-1 compared with M-3, disregarding extra labor and increased depreciation. On an acre basis, this would amount to approximately $6.78. Add to this the increase in harvesting costs and it might still be profitable for an operator to go this far in production with corn at $20 per ton. Suppose, however, the yield on a similar unirrigated field had been increased from 2.6 to 7.67 tons by application of the additional water used in M-1 compared to M-3. The increase in production is considerably more without more total water used. But with water at a flat rate per acre, it is obvious which plan of production will be used, especially if the number of acres to be irrigated has to be contracted for in advance.

Another problem, or the same one carried farther may follow. In the work carried on by H. H. Stippler (18, p.116) it was found that on the 15 fields of sweet corn yielding five tons per acre or more, 6.4 acre-inches of water were applied, while on the remaining seven fields yielding less than five tons per acre, the amount of water used was 7.3 acre-inches. The same situation existed with beans. The fields yielding ten tons or more per acre had an average of 12 acre-inches applied per acre. On the 14 fields yielding below 8.3 tons per acre, 15.5 acre-inches per acre were applied.

Although it cannot be concluded that high water applications are the cause for lower than average yields, the danger of applying too much water is present. This is especially true where farmers are irrigating for the first time and may feel water to be the only limiting factor.

It appears, therefore, that some consideration should be given to supplying water at a cost based on use. This would probably expand the number of acres irrigated, increase total production and lead to a better use of water resources. It would also put the cost of water on a more equitable basis, each paying according to his use. It would permit the possibility of irrigating some crops which need only a small amount of water but whose response to such application would not be great. Admitting the extra cost involved in keeping records when water is sold according to amount used, the points in favor of supplying water at a cost based on amount used merits careful consideration.

To apply the common principle of production economics to the practice of irrigation, it is necessary to have pertinent information available. One of the major difficulties is faced when physical data on responses by various crops to water resources are required. It is impossible for a farmer or agricultural worker to find the optimum point at which to produce unless he knows the increase in yield he can expect from irrigation. It is not enough to know that production will be increased. The question is by how much it will be increased. Physical data on crop response to water application on different soil types is limited, especially the response to combined water and fertilizer inputs. The yield from irrigated pasture and hay crops used in this study is believed to be very conservative. If so, a good manager would be able to carry a greater number of livestock than the number suggested in the budgets. However, it was thought underestimation of yields would be preferable to being too optimistic. More information on crop response to varying amounts of water would be very valuable.

CHAPTER VII

SUMMARY AND APPRAISAL

The proposed Monmouth-Dallas Irrigation Project will make water available to approximately 30,000 acres of farmland which is now a dryland farming area. This study was undertaken to explore some of the implications and organizational problems which will result from the introduction of irrigation water. An attempt was made to show changes in farm organization, in capital and labor requirements, and in net incomes of farms in the area. No attempt was made to determine for the individuals concerned what enterprises they ought to introduce. However, comparative profitability of various types of farm organizations was calculated. The data presented augment available information so that the operators may be in a better position to make their own decisions.

In general those who indicated no interest are in favor of the project and hope to see it completed. Those who do not plan to use water from the project slightly outnumber those who do. However, three out of four who indicated no interest have holdings of less than 50 acres. Many of these are in favor of the project but are not in a position to use water from it. Many of those more favorably situated have valid reasons for not planning to use water from this development. Some are irrigating at the present time. Other obstacles such as age, health and unsuitability of land dictate non participation.

A survey was also made of 40 interested farmers. From the information obtained and other available information a comparison of various sizes and types of organizations was made. Budgets were prepared for farms of three different sizes - a 40-acre farm of which 35 acres are irrigated; a 103-acre farm of which 60 acres are irrigated; and a 280-acre farm having 80 acres under irrigation. On the 40-acre farm, strawberries, pole beans and corn were the crops considered. The enterprises on the 103-acre farm for which budgets were prepared were:

(1) A 40-cow milking herd raising replacements.

(2) A 60-cow milking herd buying replacements.

(3) A beef feeder enterprise with 92 feeders. Calves are bought at 400 pounds and sold the following year.

(4) A 60-cow beef herd selling fall calves.

(5) A 75-cow beef herd selling fall calves.

(6) An alfalfa and hay farm producing 4 tons of alfalfa per acre.

(7) An alfalfa and hay farm producing 6 tons of alfalfa per acre.

For each of these systems, the total capital required, labor required and income expected was computed. These various categories were compared with the corresponding requirements under the present system of dryland farming.

The budgeting procedure was also used on the 280-acre farm. The organizations for which budgets were prepared were:

(1) A 60-cow dairy herd buying replacements.

(2) A beef feeder enterprise with 150 feeders.

(3) A 100-cow beef herd.

Again comparisons were made with a dryland farming operation. In all budgets average yields based on the farmers' estimates were used. Current prices (July 1955) were used throughout. Irrigation by sprinkler system is the only method of irrigation considered in this study.

The introduction of irrigation will increase capital requirements in varying amounts depending upon the organization introduced. On the vegetable farm of 40 acres the additional capital required is estimated at $5680. Of this total $3360 is required for irrigation equipment, the remainder for machinery. On the 103-acre farm the additional capital required ranges from $5,080 on the alfalfa and hay farm to $19,080 on the 60-cow dairy farm. Of the total increase estimated, $4080 is in irrigation equipment. On the livestock farms the greater part of the increased capital requirement is in livestock. The dairy farm of 60 cows will require an estimated $12,400 to establish a milking herd of this size. A beef enterprise will require $6990 investment in livestock if feeder steers are introduced, $7400 for a beef herd of 60 cows and $9350 for a beef herd of 75 cows. Most farms have an adequate investment in machinery at present. However, it is expected that the dairy organization will require additional equipment - milking machine, milk cooler and dairy utensils. Livestock farms may require investment in a manure spreader.

Some farms may require additional fences.

Labor requirements will increase not only because of irrigation itself but also because a more intensive type of farming is involved. The dryland farming organization requires approximately one man work day per acre. On the 103-acre farm this is approximately 100 man work days. With irrigation the number of man work days required will vary from 108 on the alfalfa and hay farm to 1009 on the 280-acre dairy farm having 60 milking cows. The beef herd and the feeder steer enterprises on the 280-acre farm will require approximately 535 man work days.

The additional labor is not believed to have a restricting influence on the use of irrigation. In the study it is assumed the necessary labor will be available at the going wage rate.

The net income as indicated in the budgets will be increased under the conditions assumed where dairy, beef feeder, or vegetable enterprises are introduced. The farm income on the 103-acre farm shows increases from \$1580 under the dryland operation to \$6615 with the 40-cow dairy herd, \$9020 with the 60-cow dairy herd, \$6949 with the beef feeder enterprise and \$4191 with the alfalfa and hay organization. The latter appears profitable only if six tons of alfalfa per acre can be expected. The cow-calf beef enterprise, however, does not appear feasible on any size of farm under the conditions assumed in the budgets. On the 280 acre farm the dairy organization has an estimated farm income of \$12,826; the beef feeder system has an income of \$13,030; the beef herd returns \$225. The estimated farm income under the dryland farming system on this size of farm is $7226. The technique of linear programming is used to explore its possibilities in such a problem. It is a technique which may be used advantageously to precede the preparation of the conventional budget. A budget was prepared for the 40-acre vegetable farm in the conventional manner prior to the linear programming investigation. The farm income from this organization is estimated at $4,280. When linear programming is used to determine the most profitable combination of the three crops, strawberries, sweet corn, and pole beans, the estimated farm income is $6191 under comparable inputs. This indicates the advantage of using the linear programming technique with the budgeting procedure. Its use should lead to the preparation of better conventional budgets.

Water must be considered an input factor when applied artificially. Response to its use is very similar to that from fertilizer, but the point of diminishing productivity may be reached much more quickly. Sale of water on an acre basis may not be conducive to its best use especially when little information is available on crop response to varying amounts applied. Lower crop yields are associated with too heavy applications of this resource. Sale of water based on the amount used will tend to more efficient use and merits careful consideration.

Introduction of irrigation will increase capital requirements, labor requirements and farm income. It may increase the stability of the income under some organizations if accompanied by adequate management. It will also increase the management ability required under the more intensive type of organization. It will introduce problems some of which are foreseen - keeping the lateral ditches in repair, obtaining the necessary additional capital and gaining experience with the different type of farming. Market outlets for the increased production must be considered before embarking on a specific plan. But no insurmountable obstacle to the introduction of irrigation seems to exist.

Appraisal

The Monmouth-Dallas irrigation project has been proposed in response to an expressed need in the area for increased water resources for urban and rural purposes. For this reason the project has received almost unanimous support. Although this study has considered the impact of irrigation on farm organizations, the additional water for urban purposes cannot be overlooked. Its value to the towns to which water would be available might merit a separate study. The Bureau of Reclamation will consider the value of water in all uses in their economic feasibility study which will soon be available.

The impact of irrigation on agriculture in the area has many facets. The type of agriculture will change from the present fairly extensive type of dryland farming to a more intensive type. Vegetable and small fruits represent one of the most intensive forms of agriculture. Farm business, measured by any standard except total acres, will increase in size. Labor requirements will be increased depending on the organizations introduced but in all cases more labor will be required. Capital requirements too will be increased by at least the cost of the irrigation equipment. It is probable that the value of the land per acre will also increase when irrigation has been introduced. If the value of land increases more than the cost of the irrigation system, the introduction of irrigation will prove a profitable capital investment for present holders of land but will increase the capital requirements for future purchasers of farm land. The increase in capital value should be a reflection of the increase in the productive capacity of the land. This in turn will be reflected in higher net incomes, provided the change in land value is reflected more slowly than the change in production. Speculation in land, however, might reverse the order of increase.

Problems will arise, some of which are foreseen, others of which will develop as the project is undertaken. Most operators believe that the maintenance of lateral ditches, acquiring the necessary capital, hiring additional labor, gaining knowledge and experience in artificial watering and many such related problems can be successfully solved.

Perhaps the most difficult problem will be that of management. Lack of experience with a different organization in addition to inexperience with the application of water by sprinkler system may delay the benefits briefly. But farmers will gain knowledge from practice, from available information, from extension and other agencies and from observation. Those who desire to learn will.

A word of caution might be appropriate especially for the small holders. Many of these at present have off-the-farm employment at least part time. With the availability of irrigation, they are planning to spend more time at home. However, unless the owner of a small acreage is prepared to become engaged in a very intensive type of agriculture, he should consider carefully before relinquishing his supplementary income.

In total, the proposed project when completed should prove very beneficial to the whole area, both rural and urban. The fact that it has received such widespread support indicates that those affected recognize the possibilities that will be available.

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APPENDIX

Table 1. Yields and Prices of Crops and Livestock Used in the Budgets.

Item	Yield	Price
Barley	2500 lbs.	$42 per ton
Oats	1950 lbs.	$48 per ton
Silage	6 tons	-
Hay (non-irrigated)	2 tons	$20 per ton
Hay (irrigated)	4.75 tons	$20 per ton
Pasture (irrigated)	4750 lbs. TDN	-
Alfalfa (non-irrigated)	4 tons	$24 per ton
Alfalfa (irrigated)	6 tons	$24 per ton
Strawberries	2.25 tons	$320 per ton
Sweet corn	4.10 tons	$20 per ton
Pole beans	8 tons	$125 per ton
Dairy cows	9000 lbs. milk (4%)	50% at $5.24 per cwt. 50% at $4.04 per cwt.
Beef feeder steers	520 lbs. gain	Purchase $19.00 per cwt. Sale $24.50 per cwt.

Table 2. Approximate Labor Requirements in Man Work Units for Various Organizations.

Number of Acres	Work Units per Head or per Acre		Total Work Units
60 CowsDairy Herd	100 acres		
60 cows	12	=	720
1 bull	5	=	60
20 ac. irrigated hay			
1st cutting	0.6	=	12
2nd cutting	0.4	=	8
10 ac. non-irrigated hay			
1st cutting	0.6	=	6
Silage - 20 ac.	0.8	=	16
40 ac. pasture clipping	0.6	=	24
15 ac. barley	1.0	=	15
15 ac. oats	1.0	=	15
Total			876
60 Cow Beef Herd	100 acres		
60 cows	3	=	180
2 bulls	5	=	10
10 ac. irrigated hay			
1st cutting	0.6	=	6
2nd cutting	0.4	=	4
50 ac. pasture clipping	0.6	=	30
20 ac. barley	1.0	=	20
20 ac. oats	1.0	=	20
Total			270
Alfalfa	100 acres		
40 ac. non-irrigated	0.6	=	24
60 ac. irrigated alfalfa			
1st cutting	0.6	=	36
2nd cutting	0.4	=	24
3rd cutting	0.4	=	24
Total			108

Table 2. (continued)

Number of Acres	Work Units per Head or per Acre		Total Work Units
75 Cow Beef Herd		100 acres	
75 cows	3	=	225
3 bulls	5	=	15
10 ac. irrigated hay			
1st cutting	0.6	=	6
2nd cutting	0.4	=	4
40 ac. non-irrigated hay			
1st cutting	0.6	=	24
30 ac. pasture clipping	0.6	=	18
Total			292
92 Feeders		100 acres	
92 yearlings	2	=	184
20 ac. irrigated hay			
1st cutting	0.6	=	12
2nd cutting	0.4	=	8
20 ac. grass silage	0.8	=	16
20 ac. barley	1.0	=	20
20 ac. oats	1.0	=	20
Total			260
Grain Only		100 acres	
50 ac. barley	1	=	50
50 ac. oats	1	=	50
Total			100

Table 2. (continued)

Number of Acres	Work Units per Head or per Acre		Total Work Units
Beef Feeders	280 irrigated		
153 steers	2	=	306
80 ac. pasture clipping	0.6	=	48
50 ac. hay per cutting	0.6	=	30
75 ac. barley	1.0	=	75
75 ac. oats	1.0	=	75
Total			534
100 Cows - Beef	280 acres		
100 cows	3	=	300
3 bulls	5	=	15
70 ac. non-irrigated hay	0.6	=	42
80 ac. pasture clipping	0.6	=	48
70 ac. barley	1.0	=	70
60 ac. oats	1.0	=	60
Total			535
60 Dairy Cows	280 acres		
60 cows	12	=	720
1 bull	5	=	5
30 ac. irrigated hay			
1st cutting	0.6	=	18
2nd cutting	0.4	=	12
30 ac. silage	0.8	=	24
50 ac. pasture clipping	0.6	=	30
100 ac. barley	1.0	=	100
100 ac. oats	1.0	=	100
Total			1009

Table 2. (continued)

Number of Acres	Work Units per Head or per Acre		Total Work Units
40 Cow Dairy Herd			100 acres
40 cows	12	=	480
15 two yr. olds	2	=	30
16 yearlings	2	=	32
1 bull	5	=	5
20 ac. irrigated hay			
1st cutting	.6	=	12.0
2nd cutting	.4	=	8.0
10 ac. non-irrigated hay			
1st cutting	.6	=	6.0
20 ac. grass silage	.8	=	16.0
40 ac. pasture clipping	.6	=	24.0
15 ac. barley	1.0	=	15.0
15 ac. oats	1.0	=	15.0
Total			643.0
Dryland			280 acres
Barley	140 x 1		140
Oats	70 x 1		70
Rye grass	70 x 1		70
Total			280
Vegetable farm			
Strawberries	45 x 4		180
Canning corn	15 x 3		45
Pole beans	16 x 20		320
Total			545

Table 3. Size, New Cost and Present Value of Machines Used on Vegetable Farms in Polk County, Oregon

Machine	Size	New Cost (Dollars)	Present Value (Dollars)
Tractor	2 P., 20 H.P.	1,900	1,420
Truck	Pickup	1,700	1,360
Plow	2-14"	210	100
Cultivator	Tr.-2 row	152	100
Disk	6' Double	240	192
Harrow	Spike 10'	45	30
Seed Drill	10' Double Disk	325	225
Fertilizer Spreader		76	54
Wagon	2½ ton	159	111
Duster	2 row	185	100
Miscellaneous		600	308
Total			4,000

Table 4. Size, New Cost and Present Value of Machines Used on 103 Acre Farm in Polk County, Oregon.

Machine	Size	New Cost (Dollars)	Present Value (Dollars)	
Tractor	2 P. 20 H.P.	1,900	1,420	(2)
Plow	2, 14"	210	150	(2)
Disc (Double Harrow)	6'	240	192	(4)
Harrows	10'	45	30	(6)
Drill	10', double disc	325	225	(6)
Fert. drill		76	54	(8)
Baler	Pick-up twine tie	2,070	1,863	(1 yr.)
Manure spreader		225	225	(new)
Mower	Tr. - 7'	155	110	(3)
Rake	S.D., 10'	154	110	(4)
2 Wagons	2½ ton	159 each	222	(6)
Bale loader		350	315	(1)
Truck	1½ ton	1,700	1,360	(3)
Small tools		120	107	(1)
Miscellaneous			617	
Total			7,000	

Table 5. Size, New Cost and Present Value of Machines Used on 280 Acre Farm in Polk County, Oregon

Machine	Size	New Cost (Dollars)	Present Value (Dollars)
Tractor	3 P., 33 H.P. Track	4,000	3,000
Tractor	2 P., 20 H.P. Rubber	1,900	1,520
Plows (2)	2-14"	210	150
	4-14"	265	200
Disc	6' Double	240	200
	10'Double	400	300
Harrows	Tr. 10'	45	30
Seed Drill	10' Double Disk	325	225
Fertilizer Drill		76	54
Hay Baler	Pick-up Twine	2,070	1,863
Manure Spreader		225	225
Mower	Tractor 7'	155	110
S. D. Rake	10'	154	110
Wagons (2)	2½ ton	159 each	222 (2)
Bale Loader		350	315
Combine	12'	3,600	2,880
Truck		1,700	1,360
Sprayer	400 gal.	1,200	960
Small Tools		600	300
Miscellaneous		600	476
Total			14,500

Table 6. Current Investment, Design and Operations of Representative Sprinkler Systems in the Willamette Valley. (60 Acres Irrigated)

	Total	Per Acre	
Non cash costs			
Depreciation 1/15 of 4,080. =	272.00	4.53	
Farm equipment use 33.4 x .85	28.40	.47	
Total non cash costs	300.40		
Cash costs			
Power, 27,500 @ .015	412.50	6.88	
Repairs -----	50.00	.83	
Water $15.	900.00	15.00	
			27.71
Total costs, not including int.	$1,663.00		
Cost per acre	$ 27.71 (not including int.)		

Table 7. Costs for Sprinkler System on Vegetable Farms in Polk County Area.

	Total	Per Acre
Depreciation on material and equipment		
1/15 of 96 x 35	224.00	6.40
Farm equipment use		
32 hrs. @ .85	27.20	.78
Power 13166 @ .014	185.00	5.29
Repairs	25.00	.71
Total cost per acre		13.18

Table 8. Costs in Production of Truck Crops Per Acre as Used in the Budgets for Polk County.

	Canning Corn (Dollars)	Pole Beans (Dollars)	Strawberries (Dollars)
Hired Labor (Picking)	19.60	434.00	225.00
Hired Labor (Excluding Picking)	-	115.20	48.00
Supplies	11.80	44.80	25.80
Tractor Fuel and Repairs	3.12	4.20	10.88
Truck and Auto	3.72	13.68	-
Planting Cost (over 3-year)	-	-	108.83
Irrigation Equipment	13.18	13.18	13.18
Other Equipment	.85	1.92	-
Water Cost	15.00	15.00	15.00
Total Cost Per Acre	67.27	641.98	446.69
Cost Per Ton	16.585	80.25	198.666

Table 9. Approximate Requirements of Man Nours Labor Per Acre for Strawberries, June and September.

Operation	June	September
Cultivating	1.0	1.0
Hoeing*	5.0	5.0
Fertilizing		.4
Dusting		
Baiting	.9	.2
Mowing	.5	
Picking*		
Other Harvest	31.0	
Direct Labor	38.4	11.6
Indirect Labor	1.6	1.4
Total Labor Per Acre	40.0	13.0
Total Labor Per Ton	17.7778	5.7778

*100% of picking labor and 50% of hoeing labor hired in addition to above.

Table 10. Approximate Requirements of Man Hours Labor Per Acre for Sweet Corn, June and September.

Operation	June	September
Seed bed preparation	.3	-
Fertilizing and Manuring	.1	-
Planting	.6	-
Hand cultivation	4.7	-
Machine cultivation	1.2	-
Irrigation	.6	.2
Picking and Hauling Crop	-	11.5
Hauling Workers	-	.1
Cover Crop	-	.1
Indirect	.5	.1
Total Labor Per Acre	8.0	12.0
Total Labor Per Ton	1.9512	2.9268

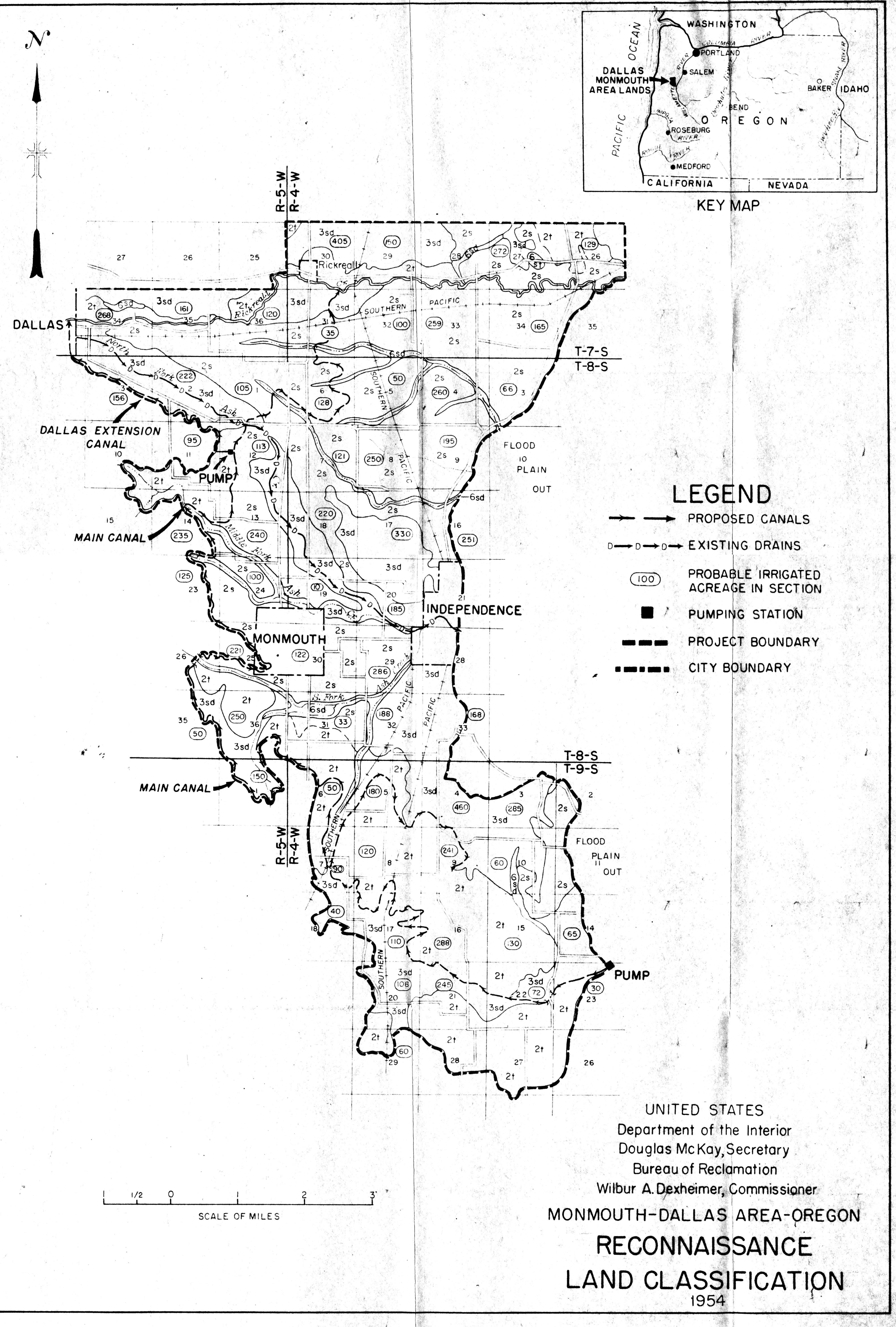
Table 11. Approximate Requirements of Man Hours Labor Per Acre for Pole Beans, June and September.

Operation	June	September
Planting	.2	-
Hand Cultivation	14.9	-
Machine Cultivation	3.4	-
Yard Preparation*	-	-
Stringing*	-	-
Fertilizing and Manuring	.2	-
Irrigation	3.0	.7
Dusting	.3	-
Picking and Other Harvest*	-	-
Hauling Crop		1.3
Hauling Workers		.8
Fall Cleanup		9.3
Cover Crop		.9
Total Hours Per Acre	22.0	13.0
Total Hours Per Ton	2.750	1.625

*Hired

Table 12. Resource Requirements Per Acre and Per Ton for Sweet Corn, Strawberries and Pole Beans.

Resource	Sweet Corn		Strawberries		Pole Beans	
	Per Acre	Per Ton	Per Acre	Per Ton	Per Acre	Per Ton
Cropland	1	.24390	1	.44444	1	.12500
Capital	$68	16.585	$447	198.6667	$642	80.250
June Labor	8	1.9512	40	17.7778	22	2.7500
September Labor	12	2.9268	13	5.7778	13	1.6250



UNITED STATES
Department of the Interior
Douglas McKay, Secretary
Bureau of Reclamation
Wilbur A. Dexheimer, Commissioner

MONMOUTH-DALLAS AREA-OREGON

RECONNAISSANCE LAND CLASSIFICATION

1954