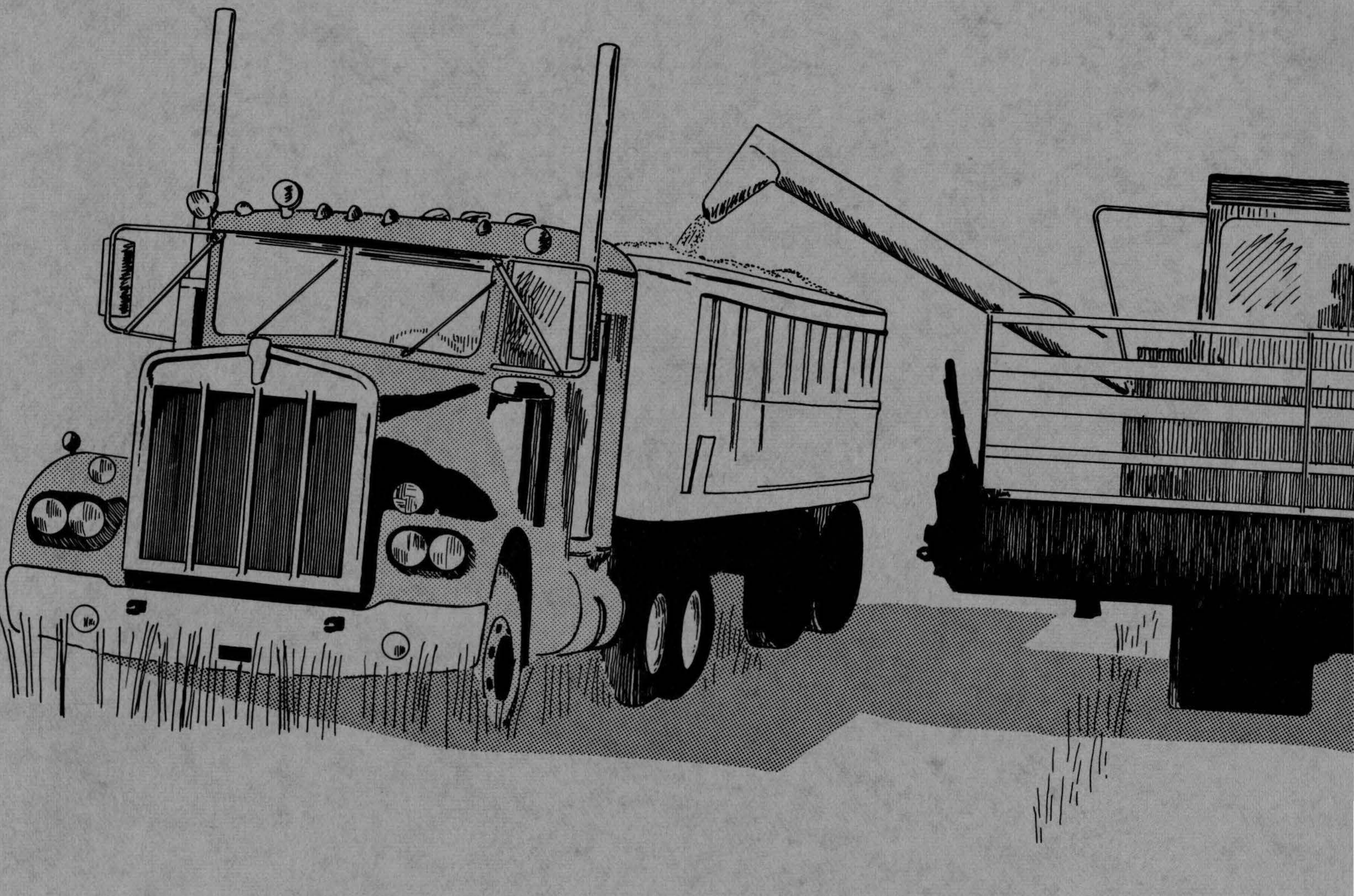
BARLEY PRODUCTION in the DELTA-CLEARWATER AREA of INTERIOR ALASKA

by

Carol E. Lewis and Frank J. Wooding



Agricultural Experiment Station
School of Agricultural and Land Resources Management
University of Alaska

James V. Drew, Director

Bulletin 49

April 1978

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Barley Production in the Delta-Clearwater Area of Interior Alaska

Cropping Systems, Costs of Production, Yield, Cost, and Price Considerations

by

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and

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The study reported on herein was funded by USDA-CSRS Project #ALK-4381-2-34510, "Production Cost and Crop Management for Small Grains in Interior Alaska;" and USDA-CSRS Project #ALK-274-5425, "Small Grain Production in the Tanana Valley of Interior Alaska."

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Foreword

The information presented in this bulletin is part of a report prepared for the ad hoc agriculture group of the State of Alaska. The group was formed at the request of Governor Jay S. Hammond and is headed by W. I. "Bob" Palmer, Special Projects Director of the Office of the Governor.

The report on the feasibility of barley production in the Delta-Clearwater Area presented to Governor Hammond through the ad hoc group was prepared by the authors of this bulletin and Wayne C. Thomas, Associate Professor of Economics, Agricultural Experiment Station, University of Alaska, Fairbanks; Dominic Carney, Alaska Department of Commerce and Economic Development; and Edward Kern, Alaska Department of Agriculture—all of whom are acknowledged with gratitude.

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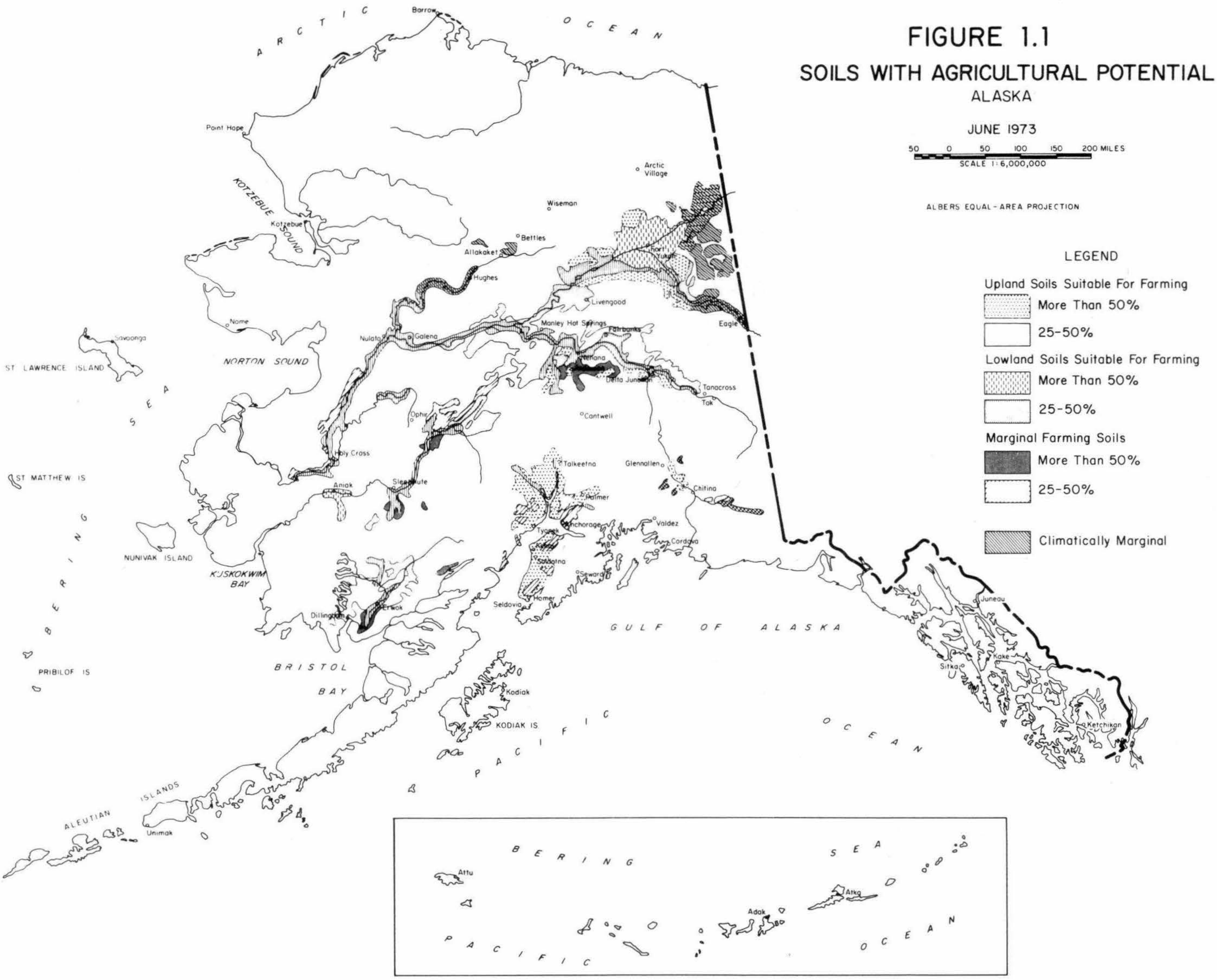

FIGURE 1.1
SOILS WITH AGRICULTURAL POTENTIAL
ALASKA

Section 1
Introduction

When oil from Prudhoe Bay on the northern coast of Alaska began to flow in the fall of 1977, it marked the beginning of another flow of perhaps equal significance. Eighty per cent of the revenue received by the State of Alaska in the foreseeable future will come from the oil industry. This prompts concern that long-term growth of the Alaskan economy is based on revenue from a single nonrenewable resource. Historically, nonrenewable resources have exhibited a boom-bust development pattern. Diversifying the economy of the state could contribute to economic stability. Of particular interest, when the development of renewable resources is considered, is the potential for agriculture.

A half century ago, the Tanana Valley in interior Alaska produced a higher per-capita quantity of agricultural products for Fairbanks consumers than it does today. Now, more than 95 per cent of the food consumed in the area is imported from areas outside the state. Additionally, there is a growing worldwide concern abut increasing populations and the need for increased food production. This has created a new awareness of agriculture in Alaska as well as across the nation.

In 1973 the Soil Conservation Service, by means of an exploratory soil survey, identified 15 million acres[a] of latent agricultural land within the state (7). (See Figure 1.1.) Approximately 10 million acres are accessible either by highway or by the river transportation systems. However, only 15,000 acres in Alaska are currently under cultivation. This is not due to biological or climatic restrictions. As an example, barley, when grown in Alaska's interior using a fallow management system, will yield 60 bushels per acre, 40 per cent higher than the United States average for the years 1969 to 1973. Wheat and oats show similar yields, wheat being 41 per cent higher and oats 100 per cent higher than the United States average for the same period (8).

Restrictions to the development of Alaska's agriculture have been considered in various studies in the past several years (1, 4, 7). Charles E. Logsdon states succinctly in *Alaska's Agricultural Potential* (5):

> Twentieth-century man has discovered that he can move north and take his temperate-zone agriculture with him. He naturally has to modify it to fit the peculiar climatic and soil features of the circumpolar region, but he has millions of acres of virgin land to work with. Where he has been successful in moving northward with agriculture, success seems to have been dependent on a national policy which recognizes the desirability for development of agriculture in the north. Enough information is available from around the globe to indicate that agriculture is physically feasible in circumpolar regions. Whether Alaska's potential is realized will, therefore, depend on several social, economic and political considerations.

A major consideration necessary for expansion of commercial agriculture in Alaska will be the mechanism which will make available large blocks of land that can be cleared and broken for agricultural production. Sufficient area must be made available to warrant and support the development of a total agricultural system which would include production, processing, and marketing.

[a]This figure, as a result of more detailed soil surveys, has recently been revised to 20 million acres.

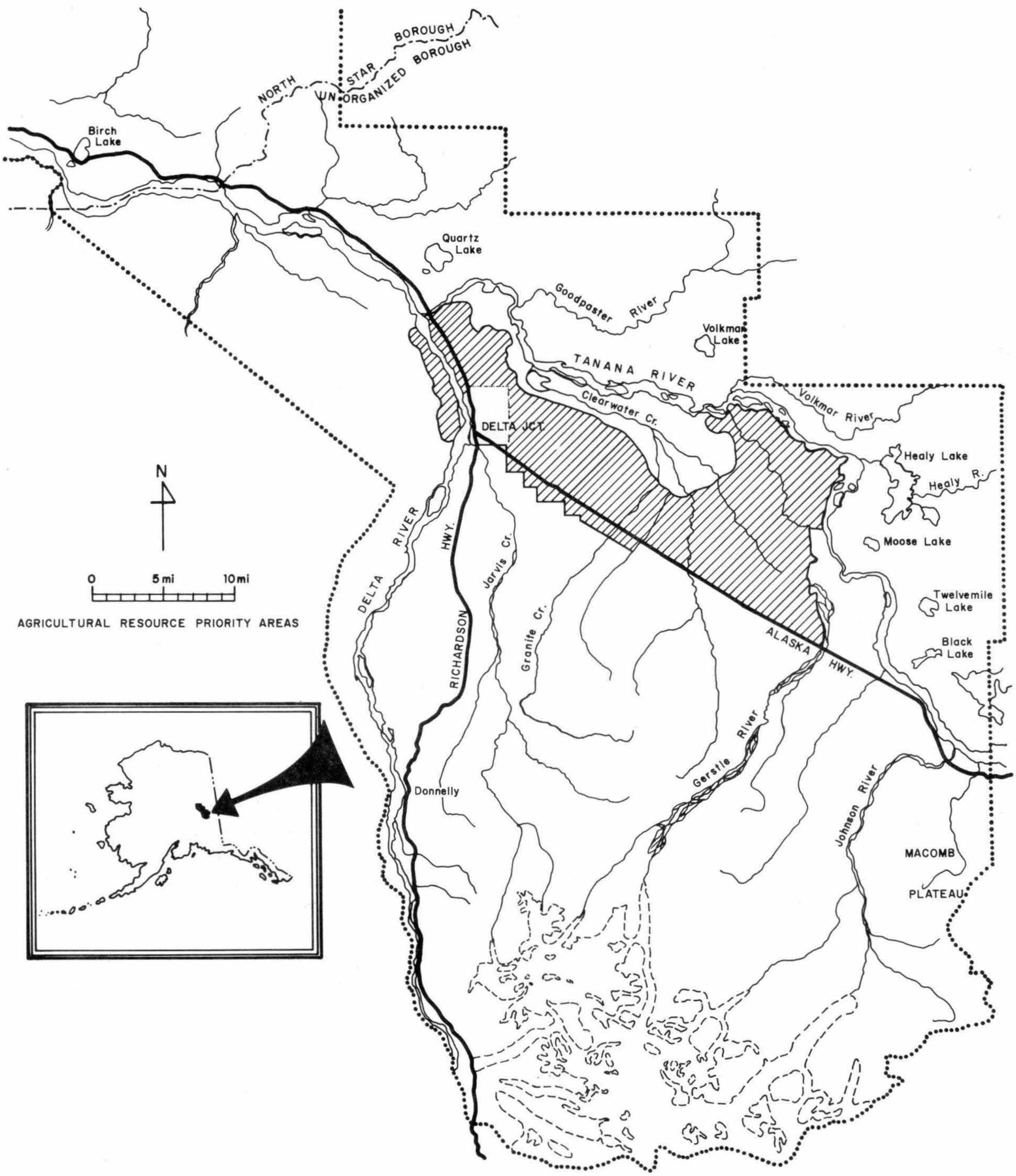

FIGURE 1.2: PROPOSED DELTA-CLEARWATER DEVELOPMENT AREA

Land availability has always been a serious political problem in Alaska. Only about .25 percent of the lands within the state are in private ownership. These private lands are predominantly in small homesites and city lots (6). Virtually all remaining land suitable for tillage is uncleared and is owned by the state, the federal government, or village or regional Native corporations (3). If there is to be any future for agricultural production in Alaska, land will have to be made available to the private sector.

In 1975, J. E. Faris and R. J. Hildreth, agricultural economists with Clemson University and the Farm Foundation, respectively, prepared a report for the Federal-State Land Use Planning Commission of Alaska in which they addressed the question: "Is there a legitimate reason or reasons to recommend that certain lands be designated or reserved for agricultural use?" They reached the conclusion that because of the potential for success, efforts should be made to designate a considerable portion of land for agriculture. Several perceptions the authors had during their stay in the state led them to reach this conclusion and make recommendations for a demonstration of the potential for agriculture (4).

Among their observations were:

1. Rather large quantities of land suitable for cereal grain and forage production are located in the state's interior along major rivers.
2. Alaska contains large land areas, so the creation of large farms is possible at the start of the development process.
3. Very satisfactory yields of barley and oats have been attained on interior Alaska agricultural-type soils. Wheat, in some years, is less certain.
4. Agricultural development occurs in a "step" fashion. A strong and dependable grain and forage economy is the first step to a strong livestock economy.
5. Limited data prevent a rigorous estimate of costs and benefits of the agricultural industry as it could possibly exist in Alaska. First, there is really very little comparable agriculture in Alaska at the present time. Secondly, public and private costs of the necessary infrastructure are not known.

Faris and Hildreth (4) observe further that:

> . . . there is a dilemma in many people's minds about agricultural development. The dilemma is: which comes first . . . the land reservation or the proof of success. Agricultural lands need to be available before development can take place. But it may be necessary to demonstrate that agricultural production is economically viable before lands could or would be set aside for agriculture.

The report concludes with a recommendation based on analysis of available data concerning markets, product prices, production costs and yields, that 50,000 acres in interior Alaska be cleared and put into barley production. This development-demonstration project should include the necessary processing, storage, and market infrastructure for the grain produced. It is suggested that this large area be developed in the near future "because of the potential for success, the possible world food shortage, the need for technical and pecuniary information and the time required for development" (4).

In 1976, an ad hoc committee on agriculture was formed at the request of Jay S. Hammond, Governor of Alaska. Its specific objective was to investigate the feasibility of large-scale barley production in the Delta-Clearwater area of interior Alaska. The Delta-Clearwater area was selected as the site for the development-demonstration project because it includes a large tract of latent agricultural land owned by the state, a road system, some private land currently used for agricultural production, and a small but growing agribusiness community. Additionally, the citizens of the area have included as a part of an area land-use plan a priority request for planned agricultural development (2). The ad hoc committee concurred with the recommendations of Faris and Hildreth (4) to use barley as a primary crop. Research data and production experience using barley are available for the Delta-Clearwater area and barley is considered a favorable crop for production on new lands.

It is the purpose of this report to discuss crop management systems and assess costs of production for large-scale barley production using a set of assumptions appropriate to state development of a 64,000-acre tract of land in Alaska's interior (Figure 1.2). The information compiled is based on agronomic data from field trials in interior Alaska and production methods used for large-acreage production of small grains in climatically similar areas of the conterminous 48 states. Agronomic practices are confined to the production of feed barley dealing primarily with 1/2- and 1/3-fallow systems. Crop production systems are constrained by soils characteristics, topography, climatic conditions, and growing seasons. A synthetic, life-cycle cost method is used to prepare costs of production and to determine the most cost-effective systems for single-family farm units ranging in size from 800 to 3,000 acres.

Section 1

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Section 2
Assumptions

A limited agricultural data base for the state in general as well as for the Delta-Clearwater area in particular makes assessment of an agricultural potential difficult. About 10,000 acres near Delta Junction, Alaska, are presently in some form of agricultural production. Much of this activity is carried out by part-time farmers who have a limited investment in land and equipment. The marketing system is primitive in that farmers produce commodities, then search for buyers. This system results in a data base that is of little value in assessing the potential for a large-scale agricultural industry.

No political decisions have been made as yet concerning conditions for agricultural development near Delta Junction. Nevertheless, certain assumptions are necessary in assessing the potential for expanded agricultural development. Thus, the following assumptions are made but are subject to change as conditions warrant:

1. The land tenure system will involve the transfer of agricultural rights only to private parties; the State of Alaska will retain ownership of all other rights.
2. The agricultural rights will be transferred to private control through lease, purchase, or a lease-purchase agreement.
3. The value of the land in terms of agricultural rights will be zero at the time of the first transfer. This valuation is based on the premise that agricultural production from the land prior to clearing and breaking is zero.
4. The purchase price paid by the first private owner will cover all costs plus interest incurred in clearing, breaking, and surveying the land and in administering the sale.
5. Annual interest charges will be 6% for intermediate and long-term loans and 9% for short-term loans. An annual interest rate of 6% is charged currently for intermediate and long-term loans by the Alaska Agricultural Revolving Loan Fund.
6. Clearing and breaking of all project lands will be completed within two years.
7. Land developed for the project will be in full agricultural production within five years.
8. A marketing system for barley will be developed concurrent with development of project lands.
9. Involvement in the project by state or federal government will be kept to a minimum.
10. Financing for the clearing, breaking, and initial fertilizing will be arranged in the first two years of the project.
11. Management of the project will be assumed to be flexible. Many of the variables in this assessment are estimates. Common sense dictates that factors such as windbreak policy or financial repayment schedules should be administered as conditions warrant.

Section 3
Cropping Systems for Grain Production

Three basic cropping systems, or rotations, should be considered for grain production in the Delta-Clearwater area of interior Alaska. They are:

1. Grain—Summer fallow (1/2 fallow)
2. Grain—Grain—Summer fallow (1/3 fallow)
3. Continuous grain.

In a 6-year cycle, 1/2 fallow will produce 3 crops, 1/3 fallow 4 crops, and continuous grain 6 crops.

The choice of crop rotation system will be determined partially by the total moisture available during the growing season. Total annual precipitation for the Delta-Clearwater area averages 11.53 inches, which places it in the semi-arid climate classification. Grain production in areas located at more southerly latitudes and receiving similar amounts of precipitation is usually based on a system where one-half of the land is fallowed each year. However, efficiency of moisture use by plants increases as growing season temperatures decrease. At cooler temperatures there is less loss of moisture from evaporation and transpiration (13). Therefore, since the effective moisture available for crop growth is greater at northern latitudes, more intensive cropping systems, such as 1/3 fallow and continuous grain, should be considered.

This section will be confined to agronomic practices for production of feed barley and will deal primarily with two systems: 1/2 fallow and 1/3 fallow. The more intensive cropping system of continuous grain is not included in this report due to lack of long-term production records for the area. However, limited data collected at the Fairbanks Research Station indicate that barley yields decrease progressively the second and third year after fallow and appear to level off the fourth year. With a continuous grain production system, considerable fluctuation in yields could be expected between wet and dry years. When a summer fallow is included in the production system, there should be a greater stability in yields. With slight modification, agronomic practices described in this report could be adapted to production of malting barley, wheat, grain oats, and forage oats.

SUMMER FALLOW

Summer Fallow Defined:

Summer fallow is the practice of managing the soil from one harvest through the next summer period and until seeding time in such a manner that the moisture which falls penetrates the soil and is not used during that period. The term "fallow" can refer to either the practice of cultivating without seeding or the bare land itself (4, 6). Several types of fallow have been defined:

Black fallow: a bare soil surface free of crop residues (7). This can be accomplished in one tillage operation with a mold-board plow or in two or three tillage operations with a disk.

Trash fallow: the use of shallow tillage equipment such as sweeps and rod weeders that control weeds and result in the maximum amount of stubble and trash remaining on the surface of the soil at next seeding (8, 9).

Chemical fallow: the use of herbicides for weed control during the fallow period. This practice minimizes loss of moisture from tillage and can be used when it is desirable to maintain crop residue on the surface (1, 3).

Of the three types of fallow, black fallow presents the greatest erosion hazard but usually results in the highest yields. In actuality, most farmers in dryland areas use a combination trash fallow-black fallow system whereby black fallow is finally approached toward the end of the fallow period. Crop residues are gradually reduced with each successive tillage operation. With this system, crop residues are present on or near the soil surface in sufficient amounts to provide protection from wind erosion throughout most of the fallow period.

Why Summer Fallow?

In many dryland farming areas, a crop-fallow rotation compared with continuous annual cropping has shown higher total production, greater stability of production, lower unit costs of production, and greater efficiency in moisture use (2, 6).

Benefits of Summer Fallow:

The practice of summer fallowing in the semiarid regions of the continental United States is based primarily on the benefit of moisture storage (6, 12). However, in more northern regions, other benefits are obtained from a crop-fallow system which may be of equal importance to moisture conservation. The following benefits can be gained from summer fallowing, particularly as it may be used in northern agriculture.

1. **Accumulation of moisture in the seeding and root zone.** Fallow may conserve from 20 to 30 percent of the precipitation that reaches the soil during the noncrop period. Efficiency of fallow for the storage of moisture decreases as more southerly latitudes are approached (2).
2. **Weed control.** Annual broad-leaved weeds, frequently a problem in Alaska grain fields, compete with grain for both moisture and nutrients and may also delay or interfere with harvesting operations. If temperatures are cool during herbicide application, only partial control is obtained as the efficiency of herbicides decreases below 70°F. Although growth is usually stunted, many weeds survive and go on to produce seed (14). Fallow period tillage practices can be managed so as to create optimum conditions for weed seed germination and subsequent destruction (9, 10, 12).
3. **Decomposition of residues from the previous crops.** In interior Alaska, crop residues left on or above the soil surface undergo virtually no decomposition during the 7 months of winter. If these residues are incorporated into the soil in the spring just prior to seeding, they will compete with the grain crop for moisture and nutrients during the first 7 to 8 weeks of the growing season. At the end of this period there will be a surge of nitrogen released from the decomposed crop residues which will stimulate growth of late tillers just when grain heads, which emerged several weeks earlier, are starting to ripen. This situation can delay or hinder drastically harvest operations and frequently results in low test weights and poor seed germination. Summer fallowing results in a more even release of soil nitrogen and increases the likelihood of early, uniform ripening (15).
4. **Release and accumulation of nitrogen and other nutrients resulting from microbiological and chemical actions during the fallow period.** Microbial activity and mineral weathering is negligible in frozen soils. Release of available nutrients from these processes occurs for only a few months of the year under interior Alaska conditions. This results in lower natural fertility and higher fertilizer requirements. During the fallow period, the soil accumulates or stores nutrients. This makes it possible for the soil to contribute more of its natural fertility toward the production of a crop. Fertilizer requirements, particularly nitrogen, are noticeably decreased by summer fallowing (6, 11, 15).
5. **Faster soil warming in the spring.** A soil surface which is dark and bare warms more quickly than does a soil surface covered by significant amounts of light-colored crop residues. Summer fallowing can result in earlier planting, faster seed germination, and more vigorous seedling growth.
6. **Minimum disturbance of the soil for spring seedbed preparation.** Soil that has been fallowed requires less tillage to prepare a suitable seedbed. This reduces soil moisture losses and enables the farmer to complete seeding operations at an earlier date.
7. **Reduction of soil-borne diseases and insects that attack barley.** Plant diseases and insects frequently overwinter in crop residues. Continuous cropping of barley can result in a buildup of these organisms. Summer fallowing reduces disease-causing organisms and insect populations by interrupting their cycles (9).
8. **Control of regrowth of woody vegetation on newly cleared lands.** Additional tillage operations carried out during the fallow period provides greater opportunity for control of regrowth of trees.

Disadvantages of Fallow:

The major disadvantages of summer fallowing are the wind and water erosion hazards resulting from a bare, exposed soil surface (black fallow). Soil erosion has been overcome largely by tillage practices which leave a portion of the crop residues on the surface throughout most of the fallow period (trash fallow) or by use of packers. Where the wind erosion hazard is great, fallowing in strips on the contour has been very successful in preventing wind erosion of soils in dryland farming areas of the Great Plains (2, 5, 8, 9).

SECOND-YEAR CROPPING— GRAIN AFTER GRAIN

If barley is to be grown for a second year, fall tillage is very important and the sooner it can be started after harvest the greater the yield prospects for the following year. Fall tillage carried out in early September permits a two- to four-week period of microbial decomposition of crop residues before freeze-up. Also, crop residues incorporated into the soil surface will act as a sponge to store moisture from late fall rains and spring snowmelt. If crop residues saturated with moisture are in contact with soil, decomposition will have considerable influence on the nitrogen fertilizer requirements for the next crop. Phosphorus, sulfur, potassium, and other nutrients are also influenced, but to a lesser extent than nitrogen.

Fall tillage is also important in that it reduces the amount of tillage required for preparation of a suitable seedbed the following spring. A good seedbed will result in a higher percentage of seed germination (thus requiring less seed), more uniform germination, and more uniform ripening. The less the soil is disturbed during seedbed preparation the more moisture will be retained and become available for seed germination and early growth.

CROPPING SEQUENCES AND SCHEDULES OF OPERATIONS

Cropping sequences and schedules of operations for 1/2-fallow and 1/3-fallow grain production systems are outlined in Figures 3.1 through 3.4. For any given area, the 1/2-fallow system involves a two-year cycle, while the 1/3-fallow system spans a three-year cycle. Types of machinery, tillage methods, and timing of operations, as described in Figures 3.2 and 3.4, are not meant to be rigid. They are given as an example of one way in which barley production can be carried out in the Delta-Clearwater area. In fact, there should be considerable flexibility in any farming operation to allow for variations in weather, availability of machinery, equipment breakdown, and management decisions relating to production costs.

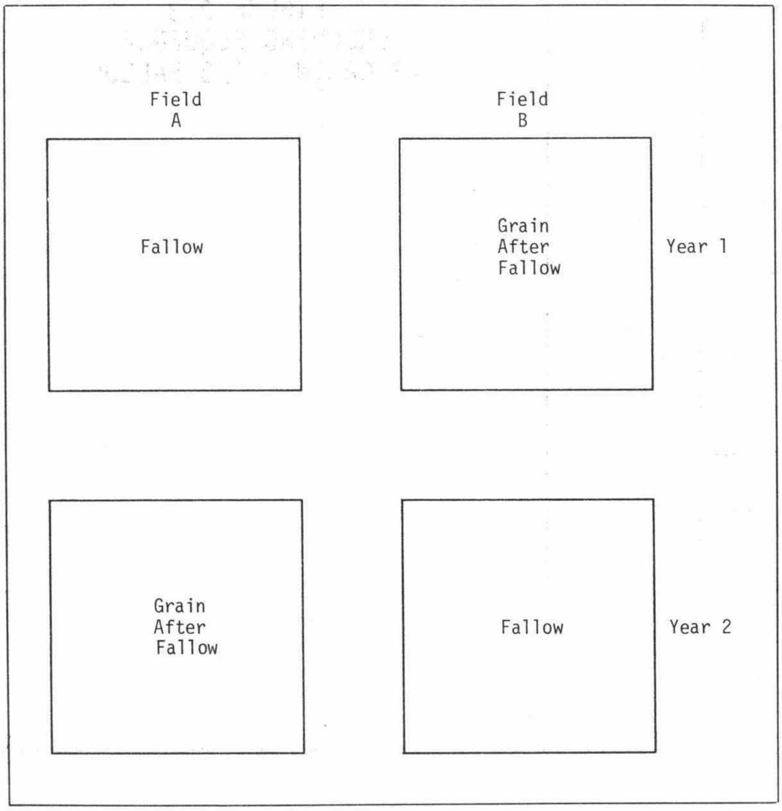

FIGURE 3.1
CROPPING SEQUENCE
1/2 GRAIN - 1/2 FALLOW

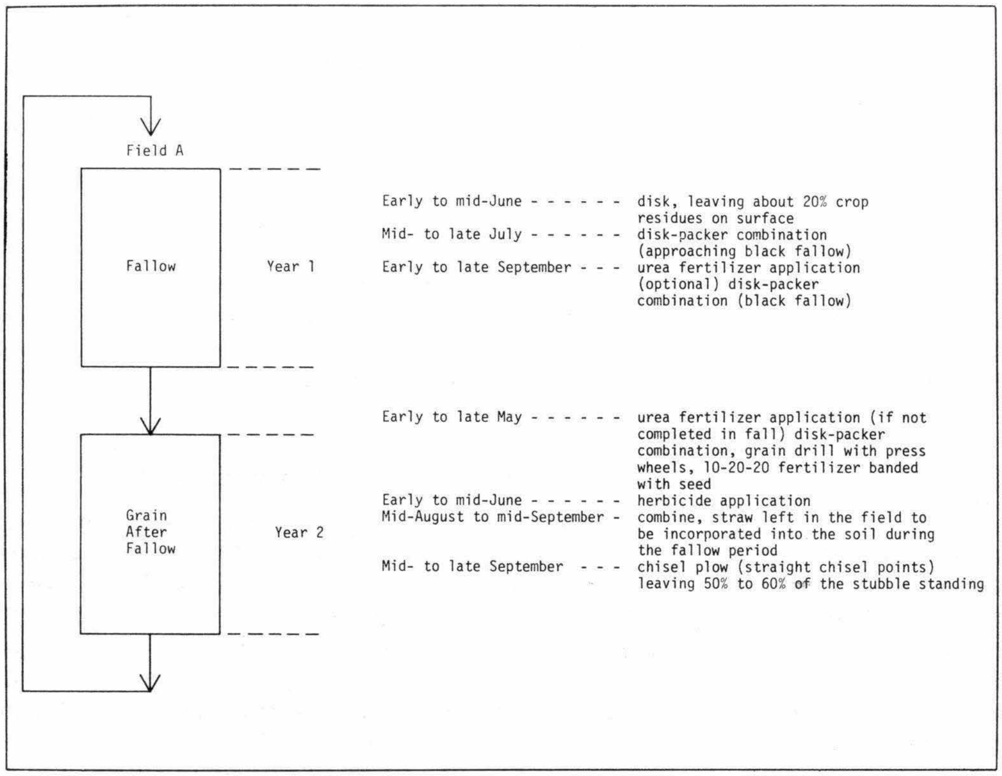

FIGURE 3.2
SCHEDULE OF OPERATIONS
1/2 GRAIN - 1/2 FALLOW

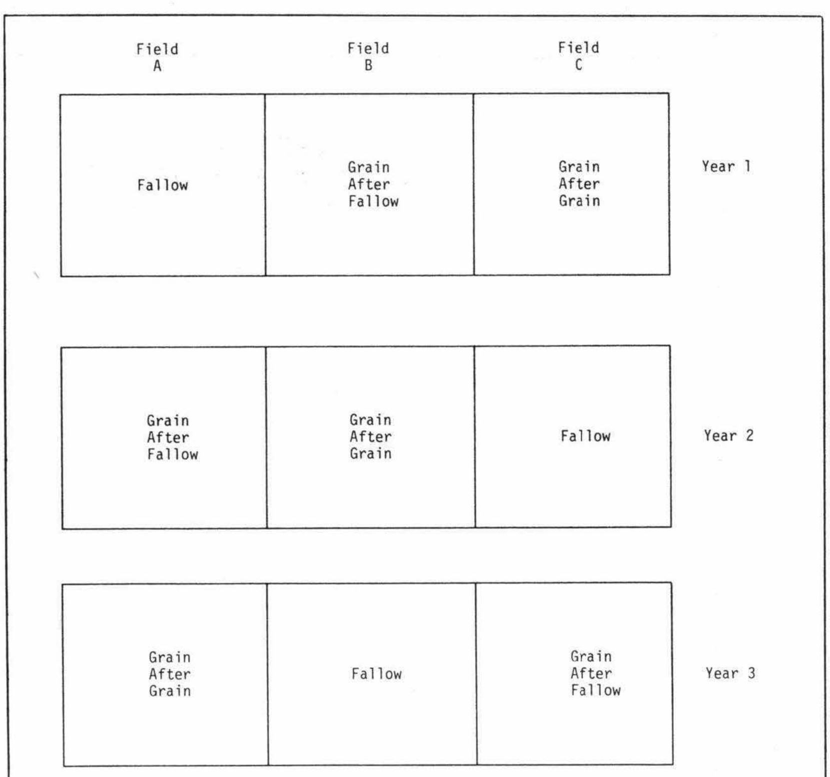

FIGURE 3.3
CROPPING SEQUENCE
2/3 GRAIN - 1/3 FALLOW

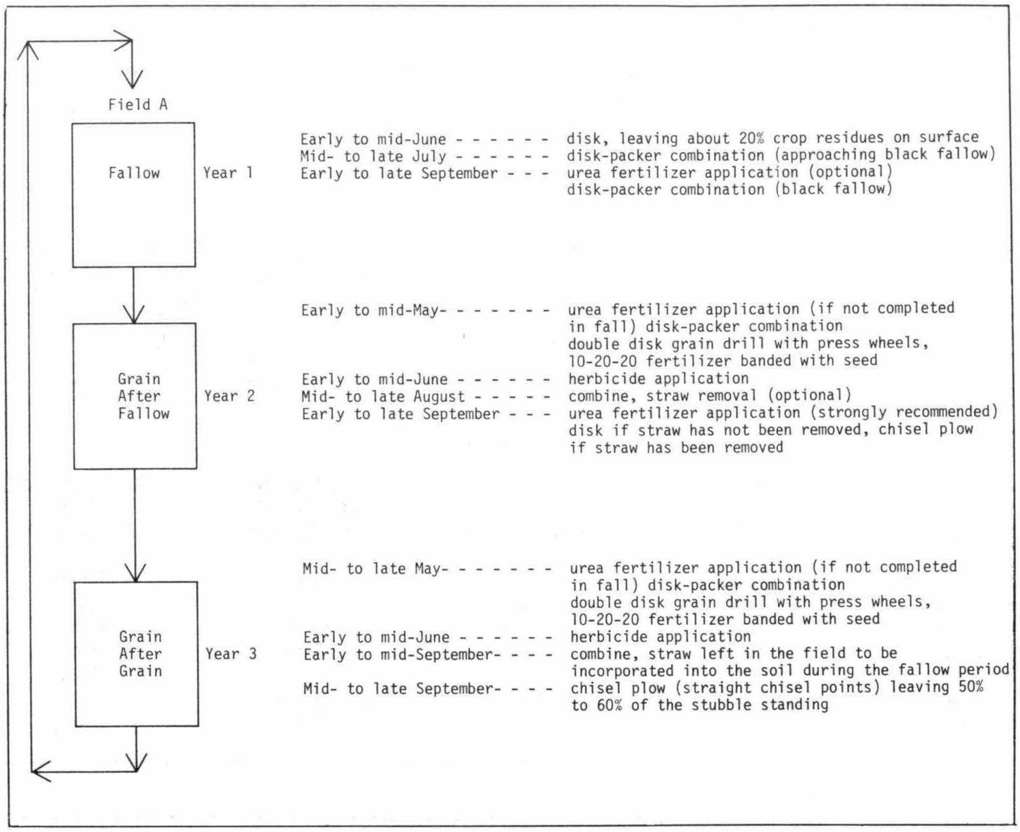

FIGURE 3.4
SCHEDULE OF OPERATIONS
2/3 GRAIN - 1/3 FALLOW

BARLEY VARIETIES

Yields of seven barley varieties that have demonstrated the greatest adaptability to the Delta-Clearwater area are presented in Table 3.1. When grown on summer-fallowed land, these varieties have produced yields averaging 70 bushels per acre over a three-year period. The three highest yielding varieties averaged 76-80 bushels per acre. During this period, yields have been consistent, without major ups and downs due to wet or dry years. This provides some indication that large-scale barley production in the area would have a fairly high degree of stability over a long period of time.

TABLE 3.1: SUMMARY OF BARLEY VARIETY TRIALS, LEE FETT'S FARM, DELTA-CLEARWATER, ALASKA 1973-1975 [a]

VARIETY OR SELECTION	YEAR TESTED 1973	1974	1975	AVERAGE 1973-1975
	—Grain Yield (bushels/acre)—			
Galt	79.0	84.1	65.1	76.4
Otra	92.4	75.0	72.8	80.1
Weal	56.2	67.4	78.3	67.3
Lidal	59.9	62.4	62.5	61.6
Edda	60.2	78.5	64.2	67.6
Olli	54.5	69.6	58.1	60.7
Rovaniemi Sel. (Finnaska)	85.4	68.4	76.1	76.6
AVERAGE	69.8	72.2	68.1	70.0

[a] Varieties selected for this table have shown the greatest adaptation to the Delta-Clearwater area. Each year, grains were grown on summer-fallowed land and fertilizer was applied at the rate of 66 pounds N, 33 pounds P_2O_5 and 33 pounds K_2O per acre.

Some characteristics of these varieties are given in Table 3.2, and recommended planting dates are shown in Figure 3.5. The difference in maturity between the earliest and latest varieties is approximately 10 days. Of the seven varieties, a combination of Galt and Otra offer the best prospects for the Delta-Clearwater area. Galt is a late-maturing Canadian variety which has demonstrated considerable resistance to head shattering and drought. For best performance, Galt should be planted before May 21 and definitely no later than May 24. Later plantings of Galt usually result in drastic reduction in yield, and maturity problems frequently arise. Otra, a very early-maturing Finnish variety, has performed satisfactorily even when the planting season is extended into the first week of June.

FERTILIZER MATERIALS AND RATES

The results of a fertilizer trial conducted on Lee Fett's farm in the Delta-Clearwater area are given in Table 3.3. Response of Galt barley to nitrogen application from urea and ammonium nitrate fertilizers was studied over a two-year period. The results demonstrate clearly how lack of nitrogen limits yield and the effectiveness of urea as a source of nitrogen for barley. Nitrogen supplied as urea, at a rate of 100

TABLE 3.2: CHARACTERISTICS OF BARLEY VARIETIES ADAPTED TO THE DELTA-CLEARWATER AREA.

VARIETY	MATURITY CLASS	RESISTANCE TO HEAD SHATTERING	RESISTANCE TO DROUGHT	RESISTANCE TO STRIPE DISEASE	RESISTANCE TO LODGING
Galt	Late	Good	Good	Good	Good
Otra	Very Early	Fair	Fair	Good	Fair
Weal	Medium	Good	Poor	Good	Good
Lidal	Early	Fair	Fair	Poor	Fair
Edda	Early	Poor	Fair	Poor	Fair
Olli	Very Early	Poor	Fair	Good	Fair
Finnaska	Very Early	Poor	Fair	Poor	Fair

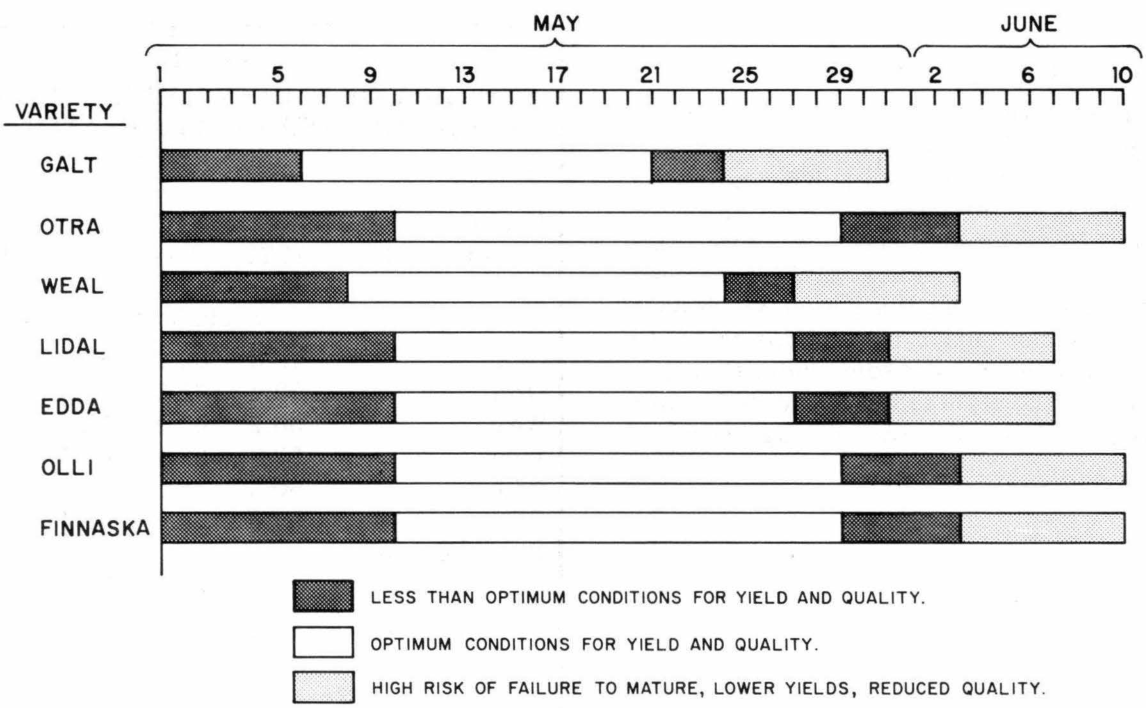

FIGURE 3.5: RECOMMENDED PLANTING DATES FOR BARLEY VARIETIES ADAPTED TO THE DELTA-CLEARWATER AREA.

pounds per acre produced a yield of 63 bushels. A comparison between grain after grain and grain after fallow was made at the 66-pound/acre nitrogen rate. The yield of Galt barley was obtained from variety trials on fallowed land adjacent to the fertilizer study. When barley is grown on previously fallowed land, higher yields are produced and nitrogen fertilizer requirements are lower. Results from fertilizer trials conducted at Fairbanks (data not shown) indicate that yield at each nitrogen level can be increased from 7 to 10 bushels per acre by fall tillage of stubble. For the study conducted on Lee Fett's farm, the stubble was disked under in the spring just prior to planting.

Fertilizer materials and rates for different cropping sequences and management practices are listed in Table 3.4. Phosphorus rates assume that newly cleared soils have received a build-up application of this nutrient as part of the development process.

YIELD ESTIMATES FOR LARGE ACREAGES IN PRODUCTION

For barley grown after summer fallow, yields of 70 bushels or more per acre as obtained in the variety trials (Table 3.1), are high when projected for large acreages in production. During the three-year period of testing, varieties were planted between May 16 and May 21, a period which falls within the range of optimum planting dates. For large farms, planting dates which are less favorable for obtaining these yields would be necessary in order to complete planting of the large acreage. Therefore, a yield range, possibly 40 to 80 bushels per acre, could be expected. Under these conditions, an average yield of 60 bushels per acre is more likely to be obtained.

For barley grown after barley (second-year grain), yields of over 60 bushels per acre were obtained in fertilizer trials (Table 3.3). To compensate for less than optimum planting dates, an average yield of 50 bushels per acre could be expected.

TABLE 3.3:
GALT BARLEY YIELDS IN RESPONSE TO NITROGEN APPLICATION FROM UREA AND AMMONIUM NITRATE FERTILIZER CARRIERS, LEE FETT'S FARM, DELTA-CLEARWATER, ALASKA, 1974-1975.

Nitrogen[a] Rate (lbs N/acre)	Grain after Grain: Urea	Grain after Grain: Ammonium Nitrate	Grain after Fallow[b]
	— Grain Yield (bu/acre) —		
0	20.5	—	—
33	33.0	29.5	—
66	48.5	40.5	74.6
100	63.0	54.0	—

[a] In addition to nitrogen, all treatments received uniform applications of phosphorus (33 lbs. P_2O_5/acre) and potassium (33 lbs K_2O/acre). All fertilizer materials were broadcast and disked in prior to planting.

[b] The yield for grain after fallow was extracted from variety trials conducted in an area adjacent to the fertilizer trials and represents an average for 1974 and 1975. Nitrogen was supplied at a rate of 66 lbs per acre from a mixture containing ammonium phosphate and ammonium nitrate.

TABLE 3.4: FERTILIZER MATERIALS AND RATES FOR DIFFERENT CROPPING SEQUENCES AND MANAGEMENT PRACTICES.

Cropping Sequence and Soil Management Practices	Nutrients Required Per Acre (lbs): N[a]	P_2O_5[b]	K_2O	Fertilizer Materials Required Per Acre (lbs): Urea broadcast in fall or spring	10-20-20 banded with seed
Grain after summer fallow	50-66	25	25	83-133	125
Grain after grain; straw removed; fall tillage	70-86	30	30	122-158	150
Grain after grain; straw not removed; fall tillage	80-96	30	30	144-180	150
Grain after grain; straw removed; no fall tillage	80-96	30	30	144-180	150
Grain after grain; straw not removed; no fall tillage; straw turned under with moldboard plow or burned in spring	70-86	30	30	122-158	150

[a] A range of nitrogen levels is given because 2-row malting barleys and 6-row feed barleys have different requirements. The lower nitrogen limit is recommended for 2-row barleys and the upper nitrogen limit is recommended for 6-row barleys.

[b] Phosphate rates assume that newly cleared soils have received a build-up application of this nutrient as part of the development process.

Section 3

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Section 4
Costs of Production

The purpose of this section is to assess the costs of barley production in the Delta-Clearwater area of interior Alaska. To this end, several crop management methods were studied using various equipment components and farm sizes. Management practices used in barley production in regions similar to the Delta-Clearwater area in soil characteristics, topography, and climate were used to broaden the limited data base provided by farming operations in interior Alaska (2, 5, 10, 12). Production costs, equipment performance, and seasonal constraints used in this report are specific to interior Alaska and are based on information from area farm operators and farm produce dealers, or on experimental results from the Agricultural Experiment Station in Fairbanks, or were calculated using standard engineering equations with coefficients adjusted to reflect Alaskan conditions (1, 6, 8, 9). A synthetic life-cycle cost method was used to prepare the budgets (4, 11). Costs presented are based on the most efficient of the agricultural inputs considered for each farm unit size.

MACHINERY AND BUILDINGS

Farming operations used in the production of small grains in Alaska do not differ from those used in other areas similar in soil conditions and topography. However, the shortness of the growing season places severe restrictions on the minimum sizes of machinery complements which can be used for both planting and harvesting. If the farming operation exceeds the optimum capacity of the equipment complement, efficiency and crop quality will be sacrificed. If the farm operation is too small to make use of the equipment capacity, costs will be higher than necessary. The cost estimates presented were developed by matching the farm unit size to the most efficient planting and harvesting machinery complements for that farm. Using the seasonal time constraints illustrated in Figure 4.1, typical machinery

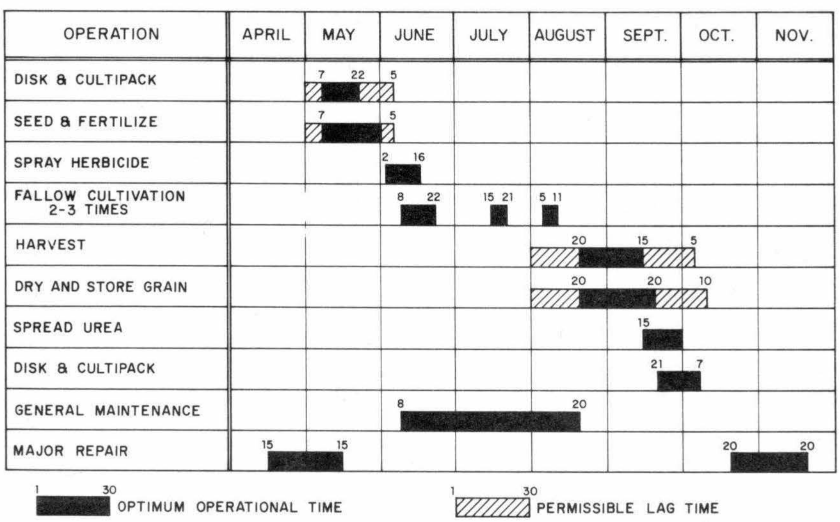

FIGURE 4.1: SEASONAL CONSTRAINTS ON CROP PRODUCTION OPERATIONS

complements were developed for each farm unit for both two- and three-year crop rotations with the objective of performing the farming operations involved in the most efficient manner. Machinery operating efficiencies were obtained from area farmers and farm equipment dealers (3, 7), then checked against standard engineering equations with adjusted coefficients (1). Machinery complements developed for each farm size and annual hours of machine usage are discussed in Appendix D.

Machinery capitalization costs were calculated using 1976 new prices f.o.b. Fairbanks, Alaska (3). Salvage values are based on local averages of 5% of original cost. In most cases, repair costs, preparation and maintenance costs, and fuel costs are based on standard engineering equations with adjusted coefficients. In some instances, particularly with the smaller tractors, combines, and tillage equipment, information obtained from area farmers indicated standard formula estimates were low. In these cases, the costs were adjusted to better reflect area farmers' experience.[a] This was particularly true in the case of repairs. The higher repair cost was attributed to two factors: 1) the farmer's electing to repair machinery rather than replace the machine, and 2) the higher cost of replacement parts and/or custom repair service. To depreciate equipment, the straight-line method was used. Equipment lifetimes were obtained from the Agricultural Engineering Handbook, or, when shorter lifetimes were indicated by local experience, from area farm data. Insurance rates were calculated at $7.00 per $1,000 including operator coverage.[b] Table 4.1 shows new cost, salvage value, and lifetime and annual owner cost of equipment (8).

The Alaskan farmer cannot take advantage of a used-equipment pool from which to purchase machinery. However, by purchasing a large number of pieces of new equipment for a number of farms from a single dealer, quantity discounts may be allowed. During 1976, farm equipment was readily available. It was not considered unreasonable by area equipment dealers to expect an average discount of 25% to 40% of new cost plus shipping on large quantities. Although these figures may change if demands for new equipment increase, some savings should accrue to farmers from large-quantity purchases. The figure of 25% was used to calculate machinery cost reductions. Because the new cost is affected, owner costs of investment and depreciation were lowered accordingly.

[a]Fuel costs were calculated using $.50/gallon for diesel, $.60/gallon gasoline, bulk rate, Fairbanks. Craig Taylor Equipment Co. quotes on repair parts were used. Custom labor was charged at $12.00 per hour excluding overhead and employee benefits. All were at 1976 price levels.

[b]Estimates were obtained from Dawson and Company of Alaska, Inc., Anchorage, Alaska, at 1976 rates.

TABLE 4.1: NEW MACHINERY COSTS AND ANNUAL OWNERSHIP COSTS

	New Cost $	Salvage Value $	Years Life	Annual Ownership Costs Invest. $	Annual Ownership Costs Deprec. $	Insur. $
Tractor, diesel, 100 HP	25,779	1,289	10	812	2,449	95
Tractor, diesel, 125 HP	34,148	1,707	10	1,076	3,244	125
Tractor, 4WD, diesel, 175 HP	51,423	2,571	10	1,620	4,805	188
Tractor, 4WD, diesel, 225 HP	57,885	2,894	10	1,823	5,606	213
Tractor, 4WD, diesel, 335 HP	75,786	3,789	10	2,387	7,340	279
Tandem Disc., 14 ft	3,498	175	8	110	416	11
Tandem Disc., 20 ft	4,967	250	8	157	593	16
Cultipacker, 14 ft	2,000	100	8	63	238	8
Cultipacker, 20 ft	2,840	143	8	90	339	11
Chisel Plow, 14 ft	2,357	118	8	74	280	7
Fertilizer Spreader, 45 ft	4,112	206	10	130	391	15
Grain Drill w/fertilizer applicator, 12 ft	4,533	227	6	143	718	17
Sprayer, 45 ft	3,444	172	10	108	327	13
12T Wagon w/auger & dump	3,703	186	10	117	352	14
2½-T Truck w/hoist bed	15,000	750	9	473	1,583	55
¾-T Pickup	6,000	300	5	189	1,140	22
Front-end Loader	2,585	129	10	81	245	9
Combine, 24-ft header	52,083	2,604	10	1,641	4,948	191
Combine, 20-ft header	31,098	1,555	10	980	2,954	114
Combine, 15-ft header	29,972	1,499	10	944	2,847	110
Combine, 13-ft header	29,766	1,489	10	938	2,830	109

TABLE 4.2: UTILITY BUILDING CONSTRUCTION COSTS AND ANNUAL OWNERSHIP COSTS

	New Cost $	Salvage Value $	Years Life	Annual Ownership Costs Invest. $	Deprec. $	Insur. $
Utility Building,[a] 40' x 40'	40,000	20,000	30	600	667	683
Utility Building,[a] 60' x 60'	60,000	30,000	30	1,200	1,334	1,366
Shop Equipment[b]	10,000	-0-	8	300	1,125	
Office Equipment[b]	1,000	-0-	10	30	100	

[a] Shop — 800 square feet included in utility building. Farm office can be located in the utility building or in the farm home.

[b] Lifetimes of shop and office equipment shown are used for depreciation. All office equipment is depreciated. Small tools valued at $1,000 are considered an operating expense. Therefore, only shop equipment valued at $9,000 is depreciated.

It is a general practice for most farmers in interior Alaska to provide minimal shelter for equipment during the off season. Type and size of shelter varies from farm to farm. For the purpose of estimating cost of shelter, a corrugated steel utility structure (40 ft x 40 ft for farm units up to 1,000 acres and 60 ft x 60 ft for farm units from 1,800 to 3,000 acres), was used. Heating and electricity were assumed to be in operation for three months at the beginning and end of the arming season.

Almost all farm operators in Alaska perform minor repairs on equipment and do all general maintenance and field preparation work. Space was allocated for an 800-ft^2 shop in each utility building. Tool supplies included welding equipment, diesel fuel storage and pumping equipment, and general equipment used for vehicle maintenance. Initial costs of the utility structure, investment, depreciation, and insurance are given in Table 4.2.[c]

An investment cost using a 6% interest rate was included in the budgets for each farm unit. The investment cost was calculated as an average over the equipment or building lifetime using

$$\text{Investment Cost} = \frac{\text{New Cost} + \text{Salvage Value}}{2}(\text{Interest Rate}) \quad (8)$$

The 6% rate is the current charge for intermediate-term loans from the Alaska State Agricultural Revolving Loan Fund.

LABOR

Labor rates include base hourly wage, employee benefits at 25% of base wage, and a housing allowance of $3.00 per hour.[d] Because of the seasonal nature of the farming operation, no vacation allowances are included. An hourly charge has been made for all labor necessary for production of the barley crop. In most cases, all operations could be performed by labor hired for the total production season with the exception of the larger farm units for which additional drivers and operators are needed during planting and harvest. In these instances, no housing allowances are included. The total hourly labor requirement for each operation includes the time the worker spent with a particular piece of equipment, the time spent in preparation of the equipment, time spent at field work, and estimated down time. Although long daylight hours in interior Alaska make 24-hour operation possible, information from farm operators indicated that efficiency drops significantly even when two shifts are used. Therefore, 12 hours was considered the maximum work day. There were no overtime premiums paid for work over an 8-hour day. Wage rates are shown in Table 4.3.

[c] Estimates for initial costs and salvage value were obtained from Butler Manufacturing Company, Fort Atkinson, Wisconsin.

[d] The housing allowance was estimated by considering total cost of housing provided and amortizing over the lifetime of the housing.

TABLE 4.3: HOURLY WAGE RATES FOR FARM LABOR

Labor Category	Base Wage ($ per hr)	Housing Allowance ($ per hr)	Employee Benefits @ 25% Base ($ per hr)	Total Wage ($ per hr)
Operators				
Full Season	6.00	3.00	1.50	10.50
Harvest Only	6.00	—	1.50	7.50
Planting Only	6.00	—	1.50	7.50
Drivers				
Full Season	6.00	3.00	1.50	10.50
Harvest Only	6.00	—	1.50	7.50
Planting Only	6.00	—	1.50	7.50
Laborers				
Full Season	4.00	3.00	1.00	8.00
Harvest Only	4.00	—	1.00	5.00
Planting Only	4.00	—	1.00	5.00

TABLE 4.4: AMOUNT, TYPE, AND COST OF MATERIALS, SUPPLIES AND SERVICES[a]

Materials Supplies Services	Required	Cost per Hour $	Cost per Year $	Cost per Acre $
FERTILIZER[b]				
1st-Year Crop				
Urea	101 lbs/acre			7.07
10-20-20	125 lbs/acre			15.13
2nd-Year Crop				
Urea	162 lbs/acre			11.34
10-20-20	150 lbs/acre			18.15
SEED[b]	72 lbs/acre			7.92
HERBICIDE[b]				2.50
FARM OFFICE				
Supplies			250.00	
Services			250.00	d
FARM SHOP				
Supplies			1,000.00	d
UTILITY BUILDING				
40' x 40' space				
Repairs			600.00	
Utilities[c]			384.00	d
60' x 60' space				
Repairs			600.00	d
Utilities[c]			864.00	
CUSTOM REPAIR				
180 Hours Total (800-1000 Acres)		12.00	2,160.00	d
360 (Hours Total (1800-3000 Acres)		12.00	4,320.00	

[a]Fertilizer cost estimates were obtained from Collier Carbon on the Kenai Peninsula and Alaska Feed in Fairbanks. M.U.S. in Fairbanks provided utility estimates. It was assumed that seed would be produced in Alaska. Mechanic's labor is assumed to be $12.00 per hour. All are at 1976 price levels.

[b]Does not include application cost.

[c]$.08/ft^2/month for 3 months.

[d]Fixed costs per acre vary as farm unit size changes.

Family members on a family-operated farm will undoubtedly perform some of the crop production tasks. Labor tasks which could fall into this category are: miscellaneous operations, fertilizer and herbicide applications, and seeding. This allocation of tasks to family members could lower the labor cost, although the reduction will probably differ for each farm unit.

MATERIALS, SUPPLIES AND SERVICES

The amount and type of materials, supplies and services used, and per-unit costs of these materials are based on information from area farmers, retailers and wholesalers, and public utilities, as well as experimental results from the Agricultural Experiment Station in Fairbanks. These are shown in Table 4.4. In Table 4.4, allowances have not been made for variations in soil types and conditions within the 64,000-acre development-demonstration project nor for production of seed within the project area. If these allowances are made, adjustments in seed, fertilizers, and herbicides may be possible.

Seed:

If farmers within the development-demonstration project follow the practices of small grain farmers in other areas, they will produce most of their own seed. The seeding rate of 72 lbs per acre allows the farmer a margin of approximately 24 lbs in the event that field conditions are poor for seed germination or that seeds are lost to insects and/or disease organisms (fungi). The seeding rate can be reduced to 48 lbs per acre with no reduction in yield, provided that certain precautions are taken. Successful use of this seeding rate is dependent upon the following:

1. Care should be taken to assure that a good seed bed is prepared prior to planting. When grain follows summer fallow, this presents no problem. Tillage operations carried out during the previous summer should result in a seed bed having good physical condition (tilth) and adequate moisture. However, when grain follows grain, as in the 1/3-fallow system, preparation of good seed beds will depend to a

great extent upon the type and amount of fall tillage. In this case, most, if not all of the crop residues, should be incorporated into the soil following grain harvest to ensure that some decomposition and absorption of moisture occur prior to planting the following spring.

2. For planting, the grain drill should be set so that the seed is placed at a sufficient depth to make contact with moist soil (though not deeper than about 2 inches). Use of grain drills equipped with press wheels will assure that moist soil is firmed up around the seed and will provide favorable conditions for quick uniform germination.
3. A chemical seed treatment (seed protectant) may be advisable to reduce seedling mortality resulting from attack by disease organisms.
4. Lower seeding rates should not be used where weeds are a major problem. During early growth, thinner stands of barley are more subject to yield reduction from weed competition than are heavier stands of barley. Weeds may appear before barley seedlings and crowd the seedlings out before they reach a growth stage where herbicides can be safely applied.

Planting at 48 lbs/per acre would require a maximum of 950 acres for seed production for all project farms. Production costs for the 1,800-acre farm can be used to approximate seed production cost. Using these costs, seed could be produced for $3.00 per bushel.

Herbicide:

Herbicide applications are expected to be less when fallow management systems are used. *If good management practices are used*, such as planting weed-free seed and using proper fallow management, weed problems will be greatly reduced on new lands. It is then anticipated that one application of herbicide will be sufficient. This would reduce herbicide costs to $1.00 per acre.

Fertilizer:

Soil tests indicate that soils in the Delta-Clearwater area have medium levels of potassium in forms available to plants. Potassium levels are such that yield benefits may or may not be obtained from addition of this nutrient when these soils are first cropped. With proper management and cropping systems, the natural potassium-supplying capacity of these soils may be adequate to sustain projected yields for a considerable period of time. Inclusion of summer fallow in the cropping system should extend this period even longer.

Approximately three times more potassium is removed from the soil in barley straw than in barley grain. If only grain is harvested, and the straw returned to the soil, it may be possible to omit potassium from the fertilizer formulation with little or no reduction in yield. In place of 10-20-20 mixed-fertilizer formulations containing potassium, a high-analysis ammonium phosphate fertilizer, such as 11-48-0, could be used. This should be applied as a band application with the seed in amounts sufficient to supply the same rates of phosphorus as previously recommended (Table 3.4). To maintain the recom-

TABLE 3.4: FERTILIZER MATERIALS AND RATES FOR DIFFERENT CROPPING SEQUENCES AND MANAGEMENT PRACTICES.

Cropping Sequence and Soil Management Practices	Nutrients Required Per Acre (lbs)			Fertilizer Materials Required Per Acre (lbs)	
	N[a]	P_2O_5[b]	K_2O	Urea broadcast in fall or spring	10-20-20 banded with seed
Grain after summer fallow	50-66	25	25	83-133	125
Grain after grain; straw removed; fall tillage	70-86	30	30	122-158	150
Grain after grain; straw not removed; fall tillage	80-96	30	30	144-180	150
Grain after grain; straw removed; no fall tillage	80-96	30	30	144-180	150
Grain after grain; straw not removed; no fall tillage; straw turned under with moldboard plow or burned in spring	70-86	30	30	122-158	150

[a] A range of nitrogen levels is given because 2-row malting barleys and 6-row feed barleys have different requirements. The lower nitrogen limit is recommended for 2-row barleys and the upper nitrogen limit is recommended for 6-row barleys.
[b] Phosphate rates assume that newly cleared soils have received a build-up application of this nutrient as part of the development process.

TABLE 4.5: FERTILIZER MATERIALS, RATES FOR DIFFERENT CROPPING SEQUENCES, AND MANAGEMENT PRACTICES ASSUMING POTASSIUM IS NOT REQUIRED.

Cropping Sequences and Soil Management Practices	Nutrients Required Per Acre (lbs)[c]			Fertilizer Materials Required (Lbs Per Acre)[c]	
	N[a]	P_2O_5[b]	K_2O	Urea broadcast in fall or spring	11-48-0 banded with seed
Grain after summer fallow	50-66	25	0	98-134	52
Grain after grain; straw removed; fall tillage	70-86	30	0	140-176	63
Grain after grain; straw not removed; fall tillage	80-96	30	0	163-198	63
Grain after grain; straw removed; no fall tillage	80-96	30	0	163-198	63
Grain after grain; straw not removed; no fall tillage; straw turned under with moldboard plow or burned in spring	70-86	30	0	140-176	63

[a] A range of nitrogen levels is given because 2-row malting barleys and 6-row feed barleys have different requirements. The lower nitrogen limit is recommended for 2-row barleys and the upper nitrogen limit is recommended for 6-row barleys.

[b] Phosphate rates assume that soils have received a build-up application of this nutrient as part of the development process.

[c] Nutrient and fertilizer rates shown include the oxides for both potassium and phosphate.

mended nitrogen rates, slightly higher broadcast applications of urea would be required. Rates of application recommended are given in Table 4.5.

GRAIN DRYING AND STORAGE

A charge for grain drying of $.26 per bushel was calculated using the 1976 rates of Matanuska Maid, Inc. in Palmer, Alaska. This charge reflects current prices paid by Alaskan grain farmers for drying and storage services. The average moisture of incoming grain was assumed to be 21%. This will not be the case in all years. However, this moisture content serves as a reasonable baseline value. Yields per acre of 60 bushel and 55 bushel for two- and three-year rotations, respectively, were used in these computations.

The facilities available at the cooperative include a 450-bushel-per-hour capacity, continuous flow dryer, and aerated and dry storage for 25,000 bushels of grain. To process adequately the approximately 2 million bushels harvested from 64,000 acres in either a 1/2- or 1/3-fallow management system, a drying capacity of 2,000 bushel per hour and storage and put-through capacity of 1 million bushels will be necessary. If this capacity is available in one facility, cost reductions will occur only when full production capability is reached. In this case, estimates indicate that a charge of approximately $.17 per bushel for yields of 55-60 bushel per acre can be anticipated. Cost reductions would also be possible if elevator-storage facilities were constructed in either several stages and/or at several locations. In this manner, a smaller facility operating near capacity could be used during the early years of production. Expansion would occur in stages, keeping step with increases in production. Economies of scale would be realized and reductions in cost of approximately 35% from the $.26 per bushel figure would occur. Comparison with country elevators in other northern states show this to be the case and show the approximate charge of $.17 per bushel adjusted to Alaskan costs of operation to be comparable.

MANAGEMENT

A return to management was included in the production cost estimates. The budgets include an annual sum of $20,000 considered a salary to the farm unit operator. This includes a return to management and an hourly wage for farm labor. The return to management was calculated using the following equation:

Return to Management = $20,000 − Total Wage Paid the Manager for Work Performed in Crop Production

For example, if the farmer-manager performs all the tillage operations and operates a combine during harvest, he might receive a total wage of $6,300 for 600 hours' work.[e] Then $20,000 less the $6,300 or $13,700 would be the return to management. This method of computation assumes the farmer-manager would receive a salary of $20,000, regardless of farm size. It illustrates to the potential farm operator the revenue which must be generated if the intent is to use farm income as the only income to the farm family. Clearly this will result in higher operating costs, particularly for the smaller units which, in reality, are part-time operations.

To reflect size of operation, an alternate method of computing a return to management can be used. The 3,000-acre unit with the 1/3-fallow management system can be regarded as a full-time operation. One-third of the farmer-manager's time is spent in labor directly related to grain production. Two-thirds of his time is spent in management of the farm unit. This same division of time can be applied to all farm units. The result will be that smaller units will show a smaller return to management. The revenue necessary to cover production and owner cost will be lower but the farmer-manager will need some outside income to cover his living costs. Table 4.6 shows these returns to management.

OPERATING CAPITAL, INSURANCE, TAXES, AND LAND LEASE

Capital outlay for operating supplies and expenses is generally large for small-grain production operations. It was assumed the farmer would borrow all operating capital other than that needed for grain drying and storage services. This would include wages; cost of machinery operation; and cost of fertilizer, seed, and herbicides. The budgets developed include interest on this operating capital at 9% for six months beginning at the start of the growing season.

The budgets developed for this report do not include charges for real or personal property taxes or crop insurance. At the present time, there are no personal property taxes levied in the Delta-Clearwater area. Until an estimate of millage rates is available and some indication is given of when and if such a tax will be imposed, this charge will not be included. No real property tax is levied during the lease period. Crop insurance has never been written in Alaska, and statistics from particular crop successes and failures are insufficient to determine insurance rates. Until a historical data bank enables rates to be estimated and crop insurance implemented, there can be no charges included for crop insurance.

Lease fees of $15.96 and $13.30 per harvested acre for the 1/2- and 1/3-fallow crop management systems, respectively, have been included in the budgets. The charge is the same for all farm units. The lease fee is not charged until the first year of crop production (the third year after project start-up). The lease fee is based on the premise that the farmer will pay back all costs of clearing the acreage which he will farm. The lease fee during the first ten years of crop production includes only the interest, at 6% over 40 years, on the clearing cost of $133 per acre. In the tenth year, the fee will increase to $19.32 for the 1/2-fallow units and $14.49 for the 1/3-fallow unit. This will include principal and interest, at 6% over 40 years, on the clearing cost. An additional charge for surveying, initial fertilizers, and clearing of state-controlled lands used during the initial land preparation could be levied as an owner cost.

FARM BUDGETS

Costs of producing one acre of barley using two- and three-year crop rotations on farm units ranging in size from 800 to 3,000 acres were computed using the base data discussed in the preceding paragraphs. The number of harvested acres provided the cost base. These detailed budgets are given in Appendix A. In the operating cost category, under equipment and farm transportation costs, repair, maintenance, field preparation, fuel, and labor are included. The details of these costs are given in Appendix B. The miscellaneous cost category includes office and shop supplies, utilities and repairs for buildings, accounting services, and custom repair services. Under owner costs, the equipment and building categories include investment cost, depreciation, and insurance.

TABLE 4.6: RETURNS TO MANAGEMENT

Farm Size (acres)	Farmer-Mgr. Labor $		Mgt. Return $		Cost Per Acre $	
	Portion Fallowed					
	1/2	1/3	1/2	1/3	1/2	1/3
800	2,004	3,864	3,627	6,994	9.07	13.12
1,000	2,670	4,152	4,833	7,515	9.67	11.27
1,800	4,961	5,312	8,979	9,562	9.98	7.93
2,200	5,656	6,011	10,237	10,880	9.31	7.38
2,600	5,024	6,761	9,093	12,231	6.99	7.02
3,000	5,735	7,120	10,380	12,880	6.92	6.44

[e] $10.50 per hour including base wage, housing allowance, and employee benefits.

TABLE 4.7: ESTIMATED COSTS OF PRODUCING ONE ACRE OF BARLEY (3,000 ACRES)

	1/2 Fallow Tractors: 335, 175 HP Combine: Two 20-Foot			1/3 Fallow Tractors: 335, 175 HP Combine: Two 24-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$14.11			$11.81		
b. Fertilizer	15.74			19.52		
c. Seed	3.00			3.00		
d. Herbicide	1.00			1.00		
Total Planting & Tillage		$33.85			$35.33	
2. Harvest Equipment		5.59			5.77	
3. Farm Transportation		8.61			7.58	
4. Miscellaneous		4.88			3.66	
5. Grain Drying		10.14			9.29	
6. Interest @ 9%		2.53			2.39	
Total Operating			$ 65.60			$ 64.02
OWNER COSTS						
1. Equipment		$18.67			$18.19	
2. Buildings		1.55			1.21	
3. Land Lease		15.96			11.97	
4. Management Return		6.92			6.44	
Total Owner			$ 43.10			$ 89.57
Total Cost			$108.70			$101.83

Cost/bu (Estimated production of 60 bu/acre) =$1.81

Cost/bu (Estimated production of 55 bu/acre) = $1.85

TABLE 4.8a: SUMMARY OF COST ADJUSTMENTS SHOWING OPERATING, OWNER, AND TOTAL COSTS PER ACRE

FARM UNIT (SIZE ACRES)

PRODUCTION COST ($ PER ACRE)	800 $/acre		1,000 $/acre		1,800 $/acre		2,200 $/acre		2,600 $/acre		3,000 $/acre	
1/2 Fallow												
OPERATING COST	109.71		100.50		103.23		94.28		95.94		89.91	
35% drying reduction	(5.46)		(5.46)		(5.46)		(5.46)		(5.46)		(5.46)	
	104.25		95.04		97.77		88.82		90.48		84.45	
Farm family labor	(8.71)		(7.29)		(5.86)		(5.12)		(5.85)		(5.31)	
reduction	95.54		87.75		91.91		83.70		84.63		79.14	
Seed reduction	(4.92)		(4.92)		(4.92)		(4.92)		(4.92)		(4.92)	
	90.62		82.83		86.99		78.78		79.71		74.22	
Herbicide reduction	(1.50)		(1.50)		(1.50)		(1.50)		(1.50)		(1.50)	
	89.12		81.33		85.49		77.28		78.21		72.72	
Fertilizer reduction	(6.46)		(6.46)		(6.46)		(6.46)		(6.46)		(6.46)	
	82.66		74.87		79.03		70.48		71.75		66.26	
Adjustment in borrowed operating capital @ 9%	(.79)		(.75)		(.67)		(.67)		(.69)		(.67)	
Total Operating Cost		81.87		74.12		78.36		69.81		71.06		65.59
OWNER COST	118.20		96.47		73.37		62.37		57.88		51.92	
25% machinery reduction	(13.49)		(10.81)		(9.54)		(7.82)		(7.16)		(6.23)	
	104.71		85.66		63.83		54.55		50.72		45.69	
Reduction in return to management	(35.92)		(24.99)		(6.73)		(3.73)		(4.53)		(2.59)	
Total Owner Costs		68.79		60.67		57.10		50.82		46.19		43.10
TOTAL COST		150.66		134.79		135.46		120.63		117.25		108.69
Reduced cost per bushel Yield = 60 bu/acre		2.51		2.25		2.26		2.01		1.95		1.81

TABLE 4.8b: SUMMARY OF COST ADJUSTMENTS SHOWING OPERATING, OWNER, AND TOTAL COSTS PER ACRE

PRODUCTION COST ($ PER ACRE)	FARM UNIT SIZE (ACRES) 800 $/acre	1,000 $/acre	1,800 $/acre	2,200 $/acre	2,600 $/acre	3,000 $/acre
1/3 Fallow						
OPERATING COST	110.19	100.50	98.93	93.31	92.82	90.44
35% drying reduction	(5.01)	(5.01)	(5.01)	(5.01)	(5.01)	(5.01)
	102.73	93.49	91.47	85.85	87.81	82.98
Farm family labor	(6.33)	(5.39)	(4.63)	(4.09)	(4.64)	(4.24)
reduction	96.40	88.10	86.84	81.76	88.17	78.74
Seed reduction	(4.92)	(4.92)	(4.92)	(4.92)	(4.92)	(4.92)
	91.48	83.18	81.92	76.84	78.25	73.82
Herbicide reduction	(1.50)	(1.50)	(1.50)	(1.50)	(1.50)	(1.50)
	89.98	81.68	80.42	75.34	76.75	72.32
Fertilizer reduction	(9.97)	(9.97)	(9.97)	(9.97)	(9.97)	(9.97)
	80.01	71.71	70.45	65.37	66.78	62.35
Adjustment in borrowed operating capital @ 9%	(.88)	(.82)	(.79)	(.67)	(.80)	(.78)
Total Operating Cost	81.58	73.34	72.11	67.05	65.98	64.02
OWNER COST	89.57	72.92	55.50	49.15	46.58	43.87
25% machinery reduction	(10.94)	(8.63)	(7.32)	(6.52)	(6.41)	(6.06)
	78.63	64.29	48.18	42.68	40.17	37.81
Reduction in return to management	(18.05)	(12.49)	(4.31	(2.11)	(.58)	(0)
Total Owner Costs	60.58	51.80	43.87	40.52	39.59	37.81
TOTAL COST	142.16	125.14	115.98	107.57	105.57	101.83
Reduced cost per bushel Yield = 55 bu/acre	2.58	2.28	2.11	1.96	1.91	1.85

The production costs shown in Appendix A, Tables A.1 through A.6, do not include possible adjustments which may occur through quantity discounts on machinery, economies of scale in the drying operation, adjustments in labor costs, alternate returns to management, and alternate crop management practices. For illustrative purposes, Table 4.7 presents the budgets for a 3,000-acre unit using 1/2- and 1/3-fallow management as if all cost adjustments occurred simultaneously. It is quite possible that the individual farmer-operator, through good management practices, may be able to still further reduce costs from those illustrated in this segment. Table 4.8 (a and b) shows details of all cost adjustments which were made for each farm unit size.

Section 4

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Section 5
Yield, Cost, and Price Consideration

The continued operation of any business is dependent upon an economic return which will cover the costs of production. In the case of barley production, the price received per bushel must equal or exceed the operating cost necessary to produce the crop if farming operations are to continue. If returns fall below operating costs for several consecutive years, and if predictions for future years do not indicate either increasing price or yields, or do not indicate decreasing costs of production, the farmer will be forced to cease production. In extreme cases, proceedings for declaration of bankruptcy may be initiated. The decision point at which returns equal operating costs of production is referred to as the shut-down point. On the other hand, if returns exceed operating costs, the farmer will apply the excess portion of the returns to owner costs. It is not necessary to cover total owner costs in every year of operation in order to maintain production. If returns are high enough to cover both operating and owner costs, the farmer will break even, that is, total costs will equal total revenue. If returns exceed total costs, the farmer will have realized an economic profit.

Each farmer in the Delta project will be faced with two major problems: 1) generation of sufficient revenue to cover production costs, and 2) management of cash flow so that sufficient capital is available to pay supply bills, meet payrolls, and make payments when they are due. This is particularly true in the beginning years of crop production when yields on new lands may not be as high as those in later years.

This section presents returns from barley production at several yield and price levels. Cash flow is discussed with consideration given to the early production years during which yields from crops on new soils will be lower and to succeeding years in which soil conditions will have stabilized.

BARLEY PRICE VS. YIELD AND PRODUCTION COST

It is of interest to consider at what farm-gate price levels the farmer can remain in operation and/or make a profit from his grain crop. Figure 5.1 illustrates production costs for each farm unit size and farm-gate prices varying from $1.50 per bushel to $3.00 per bushel for the 1/3-fallow management system. All but the smallest units will cover operating costs at all price levels. However, only the larger units will be above the break-even level at prices under $2.00 per bushel for barley at the farm gate.

An alternate method of displaying the break-even and shut-down points is to consider either an increase or decrease in yield at a fixed price. Figure 5.2 illustrates the yields required to either break even or operate at shut-down with a fixed price per bushel of $2.00 and $2.50. The implication is that the farmer-manager will apply the total revenue received to operating costs and the surplus, if any, to owner costs. If the costs of production remain as those shown in Section 4, the figures indicate the yield which could be sustained per acre while still continuing operations.

EARLY PRODUCTION YEARS

Yields during the first two years will be below the 60 and 55 bushels per acre expected in subsequent years. Fertilizer application in these years should be higher, but can decrease in the third year. During the first three production years, no herbicide will be needed if clean seed is used. Table 5.1 indicates estimated yields and expected cost differences resulting from changes in fertilization and herbicide application.

As can be seen from Table 5.1, not only will yields be lower in the first two years, but production costs will be higher. If the farmer were faced with having to decide either to continue operating or to shut down, he may opt to shut down unless he has

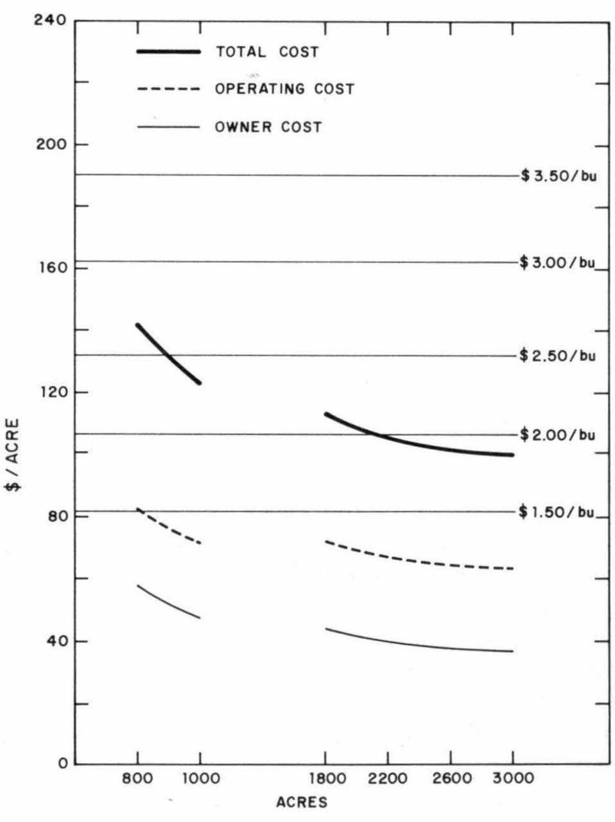

FIGURE 5.1: PRODUCTION COSTS AND FARM-GATE PRICES.

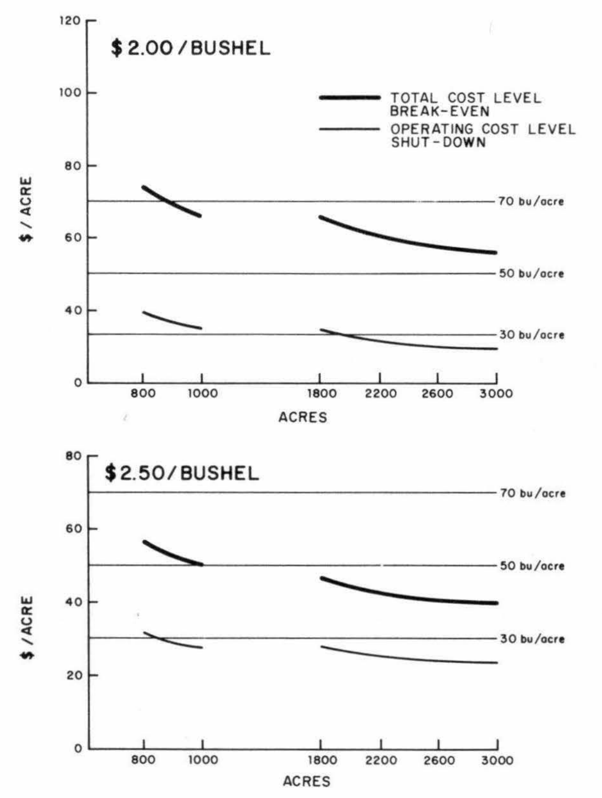

FIGURE 5.2: BREAK-EVEN AND SHUT-DOWN YIELDS IN BUSHELS PER ACRE USING FIXED FARM-GATE PRICES OF $2.00 AND $2.50/BUSHEL.

TABLE 5.1: EXPECTED YIELDS AND FERTILIZER LEVELS FOR START-UP YEARS, AND EXPECTED COST CHANGES

Crop Production Years	Crop Management System	Yields Bushel Per Acre	Fertilizer Levels Lbs/Acre	Change In Fertilizer Cost Per Acre	Change In Herbicide Cost Per Acre	Total Change In Cost Per Acre
1	All acreage in crops[a]	40	urea: 225 lbs[b] 11-48-0: 125 lbs[b]	+7.63 (over 1/2 fallow) +4.70 (over 1/3 fallow)	-1.00	+6.63 +3.70
2[c]	1/2 fallow 1/3 fallow	50 50	urea: 181 lbs 11-48-0: 63 lbs	+6.12	-1.00	+5.12
3	1/2 fallow	60	urea: 116 lbs 11-48-0: 52 lbs	-0-	-1.00	-1.00
	1/3 fallow	55	urea: 181 lbs 11-48-0: 63 lbs	-0-	-1.00	-1.00

[a] Lower yield in part due to exceeding the limits on the planting season and possible late harvest.

[b] Exceeds 100+ pounds of N requirement and assumes newly cleared soils received a build-up application of phosphorus.

[c] Both crops planted in 1/2- or 1/3-fallow systems will be second-year crops.

sufficient equity capital to withstand this early period. Without this equity capital base this decision may be made more rapidly by the owners of large farm units. It is of value, therefore, to consider the income to the larger farm units over a longer period of time.

To illustrate how farm income could be managed to provide a positive return during and after the early years of production, the 3,000-acre unit will be used. Cash flow will be considered over an eight-year period, the average lifetime of the production equipment. Grain prices will be fixed at $2.00 and $2.50 per bushel. It will be assumed that the farmer is willing to operate with only a $10,000 salary which would include remuneration for farm labor and a small return to management. Table 5.2 illustrates the returns which could be expected over the eight-year period. Depreciation costs have been included. Although they are not cash costs, they are a part of the farming expense.

TABLE 5.2: TOTAL CUMULATIVE AND YEARLY RETURNS TO CASH COST PLUS DEPRECIATION FOR A 3,000-ACRE FARM USING 1/2 OR 1/3 FALLOW MANAGEMENT[a]

MANAGEMENT SYSTEM	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8	
	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3
	$		$		$		$		$		$		$		$	
					@ $2.00 per bushel											
Return to cash cost @ $2.00/bu	(49)[b]	(49)	17	43	56	63	55	61	55	61	55	61	55	61	55	61
Less depreciation expense	28	33	28	33	28	33	28	33	28	33	28	33	28	33	28	33
Return to cash plus depreciation	(77)	(82)	(11)	10	28	30	27	28	27	28	27	28	27	28	27	28
Cumulative Return	(77)	(82)	(88)	(72)	(60)	(42)	(33)	(14)	(6)	14	21	42	48	70	75	98
					@ $2.50 per bushel											
Return to cash cost @ $2.50/bu	11	11	55	93	71	118	100	116	100	116	100	116	100	116	100	116
Less depreciation expense	28	33	28	33	28	33	28	33	28	33	28	33	28	33	28	33
Return to cash plus depreciation	(17)	(22)	27	60	43	85	72	83	72	83	72	83	72	83	72	83
Cumulative Return	(17)	(22)	10	38	53	123	125	206	197	289	269	372	341	455	413	538

[a] Returns shown are for all acreage harvested.

[b] ( ) denotes a negative return.

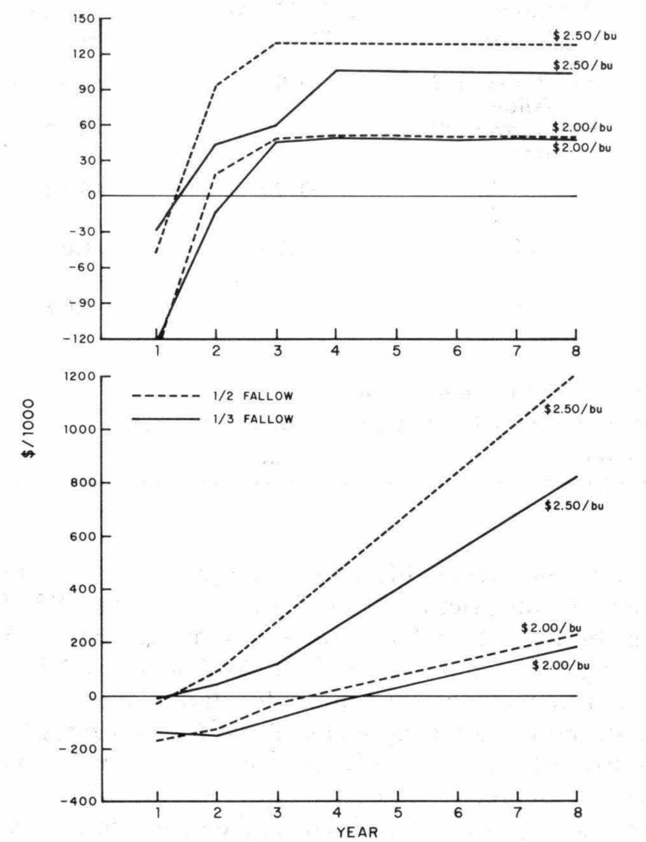

FIGURE 5.3: CASH FLOW, YEARLY (UPPER GRAPH) AND CUMULATIVE (LOWER GRAPH)

As can be seen from Table 5.2, by the sixth year the farm will show a positive return at a price of $2.00 per bushel of $21,000 using the 1/2-fallow management system and a positive return of $14,000 in year five using the 1/3-fallow system. At a price of $2.50 per bushel, there will be no negative returns after the first year. By year two, the 1/2-fallow management system will show a cumulative positive return of $10,000 and the 1/3-fallow system a cumulative positive return of $38,000. Figure 5.3 illustrates both the yearly and the cumulative cash flow over the eight-year period. When a longer period of operation is considered, average costs and returns are quite favorable for the 3,000-acre unit using either management system.

Section 6
Final Thoughts

This report, using ten specific assumptions and the best available data sources, presents the agronomic data and cost analyses for an agricultural development-demonstration project in interior Alaska. Although the analyses suggest an efficient means of allocating resources on project farms, there is no guarantee that problems will not occur as the development is implemented. It is most important for the agency or group responsible for the development-demonstration to exercise a flexible approach in managing the project.

MONO-CROP PRODUCTION

The crop management system suggested for the 64,000-acre development-demonstration project was based on a single crop, barley. Barley, because of its ability to grow to maturity at cool temperatures and its short growing-season requirement, must be considered the grain representing the best compromise of biological adaptation and economic desirability for culture in this far-north environment (2). In addition, barley is considered an excellent new-lands crop. However, oats, wheat, and rye should not be excluded from consideration.

Most oat varieties generally have a longer growing season requirement than barley. They will grow to maturity in cool weather, however, and can be used as a dual-purpose crop as forage (immature) or grain (mature). Hard spring wheats have shown the best adaptation to Alaska, but at present, existing varieties have a narrower range of adaptation than barley or oats. With modern plant-breeding techniques, varieties can be tailored to a particular environment. This may make wheat an important grain crop to Alaska. Rye can be grown successfully in many areas of Alaska but has a major limitation in its susceptibility to ergot disease. It should be regarded as a minor crop from the standpoint of commercial production.

There is little or no difference in crop management or production cost for the four grains: barley, oats, wheat and rye. If the decision is made to include any of these grains other than barley in the production-demonstration project, the cost/agronomic assessment presented in this report would be virtually unchanged.

A fourth crop which shows promise for commercial production is rapeseed grown for the oil content of its seed. At present, Canada is the world's largest rapeseed producer. Crop management systems which are now used for rapeseed production include a rotation with barley in a 1/3-fallow scheme (1). Details for the potential of rapeseed as a commercial crop for Alaska will not be addressed here except to state that preliminary research results indicate it should be given equal consideration with barley as an export crop.

YIELDS

Yield projections used in this report are feasible under good management situations. It should be noted, however, that factors beyond the farmer's control, such as weather, available moisture, and disease will affect actual production, and a series of poor crop years will have adverse impact on returns to the farmer. It is doubtful that a risk analysis would reveal great differences between production of grains in Alaska and in other world grain-producing areas.

FARM SIZE

The size of the farming operation has direct bearing on the cost of production. Indications are that larger farms have a better chance of remaining in business when grain prices are low. A plan for having both small and large farm sizes may result in a turnover in small farms during the early years of production unless farm income is supplemented with off-farm earnings. However, if small farms are combined with other land holdings in the Delta area, or if an alternative crop or commodity is produced and marketed, small farm units may be viable.

CASH FLOW

The data presented in this report indicate that large barley farms can generate enough revenue to cover cash costs during the development period. However, if farmers entering into production are not aware of the problem of cash flow management, the failure rate will be high.

Section 6

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Appendices

Appendix A:	Budgets for the 800- to 3,000-Acre Farm Units Using Base Data Costs
Appendix B:	Equipment Inventory and Associated Costs, Including Costs for Materials, Fuel, and Labor
Appendix C:	Procedure for Updating Cost Estimates
Appendix D:	Equipment Complements and Projected Annual Usages

Appendix A
Budgets for the 800-to 3,000-Acre Farm Units Using Base Data Costs

Table A.1 shows the estimated cost of producing an acre of barley using 1/2- and 1/3-fallow crop management on an 800-acre farm unit. Both operating and owner costs were higher for the 1/2-fallow case for which operating costs amounted to $109.71 per acre and total costs were $227.91 per acre. Using the 1/3-fallow method, operating costs were $110.19 and owner costs $89.57 for a total of $199.76 per acre. Yields averaging 60 bushel per acre for a first-year crop after fallow can be expected in interior Alaska, while yields for a second-year crop after fallow can be expected to drop to 50 bushels per acre. Thus for the 1/2-fallow system, cost per bushel, at 60 bushels per acre, was $3.80. Using a 1/3-fallow management system and maintaining an average yield of 55 bushels per acre, the cost per bushel was $3.63 for a difference of $.17 per bushel.

When farm unit size is increased to 1,000 acres, little difference is noted in operating costs between 1/2 and 1/3 fallow as shown in Table A.2. Operating costs for the 1/2-fallow system were $100.50 and for the 1/3-fallow system $100.95 per acre. Owner costs dropped as did total costs showing a total cost per bushel of $3.28 for the 1/2-fallow system and $3.16 for the 1/3-fallow.

An increase in farm unit size to 1,800 acres necessitated an increase in size and type of equipment complements. Operating costs for the 1/2-fallow system at $103.23 per acre were above those for the 1,000-acre unit at $100.50 per acre as shown in Table A.3. Operating costs for the 1/3-fallow system were approximately the same as those for the 1,000-acre unit at $98.93 per acre. Owner costs decreased for the 1,800-acre unit as did total cost, showing $176.50 and $154.43 for 1/2- and 1/3-fallow, respectively.

TABLE A.1: ESTIMATED COSTS FOR PRODUCING ONE ACRE OF BARLEY (800 ACRES)

	1/2 Fallow Tractors: 175, 100 HP Combine: One 13-Foot			1/3 Fallow Tractors: 175, 125 HP Combine: One 13-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$28.72			$26.50		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$61.34			$66.47	
2. Harvest Equipment		7.59			5.78	
3. Farm Transportation		9.41			7.95	
4. Miscellaneous		11.72			11.68	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		4.05			4.06	
Total Operating			$109.71			$110.19
OWNER COSTS						
1. Equipment		$53.98			$43.77	
2. Buildings		3.27			2.66	
3. Land Lease		15.96			11.97	
4. Management Return		44.99			31.17	
Total Owner			$118.20			$ 89.57
Total Cost			$227.91			$199.76
	Cost/bu (Estimated production of 60 bu/acre) = $3.80			Cost/bu (Estimated production of 55 bu/acre) = $3.63		

TABLE A.2: ESTIMATED COSTS FOR PRODUCING ONE ACRE OF BARLEY (1,000 ACRES)

	1/2 Fallow Tractors: 175, 100 HP Combine: One 13-Foot			1/3 Fallow Tractors: 175, 125 HP Combine: One 13-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$24.81			$23.87		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$57.43			$63.78	
2. Harvest Equipment		6.62			5.52	
3. Farm Transportation		7.81			6.68	
4. Miscellaneous		9.38			7.04	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		3.66			3.63	
Total Operating			$100.50			$100.95
OWNER COSTS						
1. Equipment		$43.24			$34.53	
2. Buildings		2.61			2.66	
3. Land Lease		15.96			11.97	
4. Management Return		34.66			23.76	
Total Owner			$ 96.47			$ 72.92
Total Cost			$196.97			$173.87
	Cost/bu (Estimated production of 60 bu/acre) = $3.28			Cost/bu (Estimated production of 55 bu/acre) = $3.16		

TABLE A.3: ESTIMATED COSTS OF PRODUCING ONE ACRE OF BARLEY (1,800 ACRES)

	1/2 Fallow Tractors: 225, 175 HP Combine: Two 13-Foot			1/3 Fallow Tractors: 225, 225 HP Combine: Two 15-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$22.76			$18.67		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$55.38			$58.78	
2. Harvest Equipment		9.13			5.78	
3. Farm Transportation		11.19			10.43	
4. Miscellaneous		8.16			6.10	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		3.77			3.54	
Total Operating			$103.23			$ 98.93
OWNER COSTS						
1. Equipment		$38.16			$29.29	
2. Buildings		2.54			2.00	
3. Land Lease		15.96			11.97	
4. Management Return		16.71			12.24	
Total Owner			$ 73.37			$ 55.50
Total Cost			$176.60			$154.43
	Cost/bu (Estimated production of 60 bu/acre) = $2.94			Cost/bu (Estimated production of 55 bu/acre) = $2.81		

TABLE A.4: ESTIMATED COSTS OF PRODUCING ONE ACRE OF BARLEY (2,200 ACRES)

	1/2 Fallow Tractors: 225, 175 HP Combine: Two 13-Foot			1/3 Fallow Tractors: 225, 225 HP Combine: Two 15-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$19.40			$16.58		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$52.02			$56.49	
2. Harvest Equipment		7.54			5.61	
3. Farm Transportation		9.07			8.62	
4. Miscellaneous		6.66			4.99	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		3.39			3.30	
Total Operating			$ 94.28			$ 93.31
OWNER COSTS						
1. Equipment		$31.29			$26.06	
2. Buildings		2.08			1.63	
3. Land Lease		15.96			11.97	
4. Management Return		13.04			9.49	
Total Owner			$ 62.37			$ 49.15
Total Cost			$156.65			$142.26

Cost/bu (Estimated production of 60 bu/acre) = $2.61 (1/2 Fallow)

Cost/bu (Estimated production of 55 bu/acre) = $2.59 (1/3 Fallow)

TABLE A.5: ESTIMATED COSTS OF PRODUCING ONE ACRE OF BARLEY (2,600 ACRES)

	1/2 Fallow Tractors: 335, 175 HP Combine: Two 20-Foot			1/3 Fallow Tractors: 225, 225 HP Combine: Two 20-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$22.31			$17.23		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$54.93			$57.14	
2. Harvest Equipment		6.44			5.21	
3. Farm Transportation		9.88			8.65	
4. Miscellaneous		5.63			4.24	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		3.46			3.28	
Total Operating			$ 95.94			$ 92.82
OWNER COSTS						
1. Equipment		$28.64			$25.62	
2. Buildings		1.76			1.39	
3. Land Lease		15.96			11.97	
4. Management Return		11.52			7.60	
Total Owner			$ 57.88			$ 46.58
Total Cost			$153.82			$139.40

Cost/bu (Estimated production of 60 bu/acre) = $2.56 (1/2 Fallow)

Cost/bu (Estimated production of 55 bu/acre) = $2.53 (1/3 Fallow)

TABLE A.6: ESTIMATED COSTS OF PRODUCING ONE ACRE OF BARLEY (3,000 ACRES)

	1/2 Fallow Tractors: 335, 175 HP Combine: Two 20-Foot			1/3 Fallow Tractors: 335, 175 HP Combine: Two 24-Foot		
OPERATING COSTS						
1. Planting & Tillage						
a. Equipment	$19.42			$16.05		
b. Fertilizer	22.20			29.49		
c. Seed	7.92			7.92		
d. Herbicide	2.50			2.50		
Total Planting & Tillage		$52.04			$55.96	
2. Harvest Equipment		5.59			5.77	
3. Farm Transportation		8.61			7.58	
4. Miscellaneous		4.88			3.66	
5. Grain Drying		15.60			14.30	
6. Interest @ 9%		3.20			3.17	
Total Operating			$ 89.91			$ 90.44
OWNER COSTS						
1. Equipment		$24.90			$24.25	
2. Buildings		1.55			1.21	
3. Land Lease		15.96			11.97	
4. Management Return		9.51			6.44	
Total Owner			$ 51.92			$ 43.87
Total Cost			$141.83			$134.31
	Cost/bu (Estimated production of 60 bu/acre) = $2.36			Cost/bu (Estimated production of 55 bu/acre) = $2.44		

APPENDIX A, CONTINUED

As farm unit size continues to increase, costs per acre decrease, as illustrated in Tables A.4, A.5, and A.6, with one exception, the 2,600-acre unit. An increase in size of the main tractor unit in the 1/2-fallow system causes operating costs to remain approximately the same as those for the 2,200-acre, 1/2-fallow unit. A low cost of $134.27 was reached at the 3,000-acre unit as shown in Table A.6, with a per-bushel cost difference of $.08 between the 1/2- and 1/3-fallow systems.

Operating, owner, and total costs of production for one acre of barley are summarized in Figure A.1. The cost differences between the two- and three-year crop rotation systems are illustrated in Figure A.2.

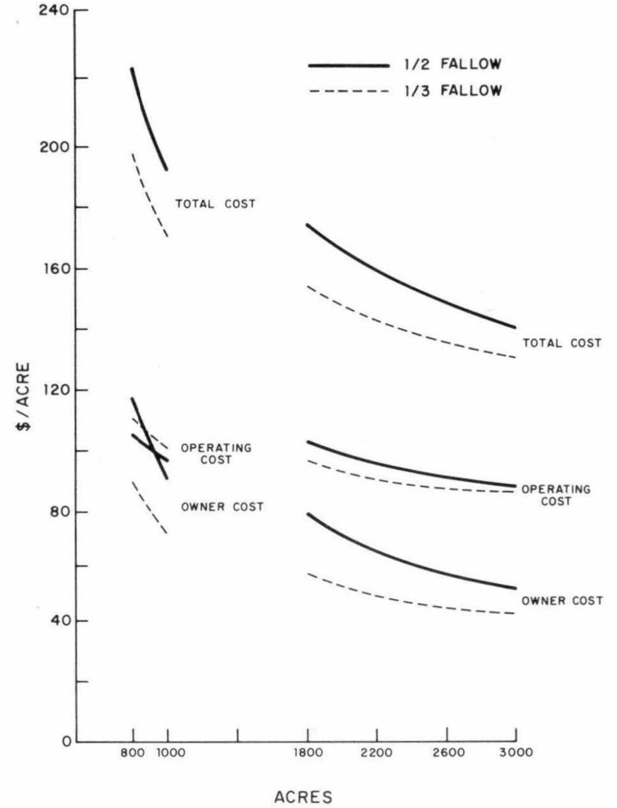

FIGURE A1: BASEDATA PRODUCTION COSTS FOR ONE ACRE OF BARLEY.

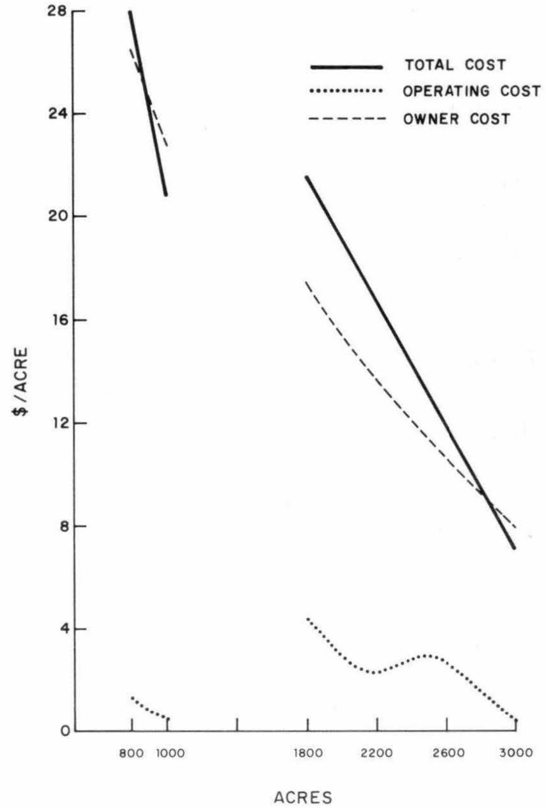

FIGURE A2: COST DIFFERENCES IN 1/2 AND 1/3 FALLOW

Appendix B

Equipment Inventory and Associated Costs, Including Costs for Materials, Fuel, and Labor

TABLE B.1: EQUIPMENT INVENTORY AND COSTS PER ACRE INCLUDING REPAIRS, PREPARATION, AND MAINTENANCE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA

EQUIPMENT	800		1,000		1,800		2,200		2,600		3,000	
	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3	1/2	1/3
	$		$		$		$		$		$	
335 HP 4WD Diesel Tractor									2.55		2.18	1.59
225 HP 4WD Diesel Tractor					2.70	1.93	2.20	1.60		1.39		
225 HP 4WD Diesel Tractor						2.08		1.73		1.57		
175 HP 4WD Diesel Tractor	4.83	3.65	3.97	2.94	2.29		1.91		1.68		1.47	1.24
150 HP Diesel Tractor		2.78										
100 HP Diesel Tractor	2.89		2.38	2.26								
20 ft Disc and Cultipacker	.89	.71	.71	.56	.39	.33	.33		.29		.25	
42 ft Disc and Cultipacker					.83		.70	.55	.59	.46	.51	.38
36 ft Tandem Disc	.45			.36		.20						
42 ft Tandem Disc								.47		.29		.25
14 ft Chisel Plow	.22		.18		.11		.09			.08		
28 ft Chisel Plow												.14
45 ft Fertilizer Spreader—Dry	.35	.26	.31	.20	.16	.11	.13	.09	.11	.08	.10	.07
45 ft Herbicide Sprayer	.46	.35	.41	.28	.21	.15	.17	.13	.14	.11	.12	.10
20 ft Grain Drill w/Fertilizer Attach.		1.24		.99	.71	.55	.58	.45	.49	.38	.42	
24 ft Grain Drill w/Fertilizer Attach.	1.25		1.12									
36 ft Grain Drill w/Fertilizer Attach.												.62
1 - 13 ft Combine	4.59	3.44	4.13	2.77								
2 - 13 ft Combines					4.07		3.32					
2 - 15 ft Combines						3.04		2.49				
2 - 20 ft Combines									2.92	2.20	2.53	
2 - 24 ft Combines												3.16
Front End Loader	.41	.32	.37	.25	.18	.14	.15	.12	.13	.10	.11	.09
1 - 2½-T Truck (Diesel)	.32	.27	.25	.21								
2 - 2½-T Trucks (Diesel)					.26	.21	.21	.18				
3 - 2½-T Trucks (Diesel)									.27	.22	.24	.20
1 - 1½-T Wagons w/Auger and Dump	.48	.37	.39	.29								
2 - 1½-T Wagons w/Auger and Dump					.43	.32	.35	.26				
3 - 1½-T Wagons w/Auger and Dump									.43	.24	.39	.22
TOTAL	16.47	14.06	13.04	11.29	12.23	9.17	10.05	8.16	9.47	7.11	8.32	8.05

TABLE B.2: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (800 ACRES)

OPERATION	1/2 Fallow Mach. Time Per Acre	 Fuel Cost $/acre	 Labor Cost	 Material Cost	1/3 Fallow Mach. Time Per Acre	 Fuel Cost $/acre	 Labor Cost	 Material Cost
20' Disc & Cultipack	.195	.34	1.03		.130	.68	2.04	
20' Tandem Disc					.097	.17	.51	
45' Fertilizer Spreader	.040	.12	.45	7.07	.041	.18	.33	10.40
20' Grain Drill					.101	.46	.81	16.64[a] 7.92
24' Grain Drill	.080	.44	.64	15.13[a] 7.92				
45' Herbicide Sprayer	.090	.47	.68	2.50	.086	.38	.69	2.50
1-13' Combine	.175	.39	2.63		.176	.39	2.95	
14' Chisel Plow					.128	.58	1.34	
1 ea. 2½-T Truck 12-T Wagon		.55	5.25			.41	4.92	
¾-T Pickup		2.81				2.11		
Front End Loader		1.21	1.76			.74	1.32	
Miscellaneous Operations	.750	3.56	6.94		.562	2.21	4.50	
Building Utilities		.96				.72		
Shop Equipment				2.50				1.88
Office Supplies/Services				1.25				.94
Custom Repairs			5.40				4.05	
TOTAL COST		10.85	24.78	36.37		9.03	23.46	40.28

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

TABLE B.3: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (1,000 ACRES)

OPERATION	1/2 Fallow Mach. Time Per Acre	 Fuel Cost $/acre	 Labor Cost	 Material Cost	1/3 Fallow Mach. Time Per Acre	 Fuel Cost $/acre	 Labor Cost	 Material Cost
20' Disc & Cultipack	.195	.34	1.03		.130	.68	2.04	
20' Tandem Disc					.096	.17	.51	
45' Fertilizer Spreader	.040	.12	.45	7.07	.041	.20	.29	10.40
20' Grain Drill					.101	.46	.81	16.64[a] 7.92
24' Grain Drill	.080	.44	.61	15.13[a] 7.92				
45' Herbicide Sprayer	.090	.47	.68	2.50	.086	.47	.69	2.50
1-13' Combine	.175	.39	2.10		.176	.39	2.36	
14' Chisel Plow					.128	.74	1.34	
1 ea. 2½-T Truck 12-T Wagon		.62	4.20			.54	3.95	
¾-T Pickup		2.25				1.69		
Front End Loader		1.21	1.76			.71	1.32	
Miscellaneous Operations	.600	2.85	5.55		.500	1.96	3.60	
Building Utilities		.77				.58		
Shop Equipment				2.22				1.67
Office Supplies/Services				1.11				.83
Custom Repairs			4.80				3.60	
TOTAL COST		9.56	21.21	35.95		8.57	20.49	39.96

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

TABLE B.4: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (1,800 ACRES)

OPERATION	1/2 Fallow				1/3 Fallow			
	Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost $/acre	Material Cost	Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost $/acre	Material Cost
20' Disc & Cultipack	.162	.35	.85		.105	.69	1.66	
42' Disc & Cultipack	.185	1.06	1.95					
20' Tandem Disc					.078	.16	.41	
45' Fertilizer Spreader	.036	.14	.37	7.07	.035	.14	.28	10.40
20' Grain Drill	.101	.29	.81	15.13[a]	.083	.33	.67	14.75[a]
				7.92				7.92
45' Herbicide Sprayer	.085	.25	.68	2.50	.085	.34	.68	2.50
2-13' Combines	.179	.39	4.67					
2-15' Combines					.108	.24	2.50	
14' Chisel Plow					.107	.42	1.12	
2 ea. 2½-T Truck 12-T Wagons		.36	9.10			.36	8.76	
¾-T Pickup		1.04				.78		
Front End Loader		.74	1.78			.67	1.33	
Miscellaneous Operations	.556	1.94	4.00		.377	1.55	3.00	
Building Utilities		.96				.72		
Shop Equipment				1.11				.83
Office Supplies/Services				.56				.42
Custom Repairs			4.80				3.60	
TOTAL COST		7.52	29.01	34.29		6.40	24.01	36.82

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

TABLE B.5: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (2,200 ACRES)

OPERATION	1/2 Fallow				1/3 Fallow			
	Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost $/acre	Material Cost	Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost $/acre	Material Cost
20' Disc & Cultipack								
20' Disc & Cultipack	.248	1.41	2.62		.082	.64	1.28	
42' Tandem Disc					.031	.16	.32	
45' Fertilizer Spreader	.036	.14	.37	7.07	.036	.14	.28	10.40
20' Grain Drill	.101	.29	.81	15.13[a]	.085	.33	.67	16.64[a]
				7.92				7.92
45' Herbicide Sprayer	.085	.25	.68	2.50	.087	.34	.68	2.50
2-13' Combines	.179	.39	3.83					
2-15' Combines					.110	.24	2.88	
14' Chisel Plow					.089	.44	1.14	
2 ea. 2½-T Truck 12-T Wagons		.29	7.37			.36	7.18	
¾-T Pickup		.85				.64		
Front End Loader		.60	1.44			.55	1.09	
Miscellaneous Operations	.455	1.51	3.26		.315	1.28	2.46	
Building Utilities		.79				.59		
Shop Equipment				.90				.68
Office Supplies/Services				.45				.34
Custom Repairs			3.93				2.94	
TOTAL COST		6.52	24.31	33.97		5.71	20.92	38.48

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

TABLE B.6: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (2,600 ACRES)

OPERATION	1/2 Fallow Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost	Material Cost	1/3 Fallow Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost	Material Cost
20' Disc & Cultipack								
28'/42' Disc & Cultipack	.202	1.27	2.12		.113	.56	1.18	
42' Tandem Disc					.058	.16	.30	
45' Fertilizer Spreader	.035	.32	.36	7.07	.036	.14	.28	10.40
20' Grain Drill	.101	.29	.81	15.13[a] 7.92	.084	.34	.67	16.64[a] 7.92
45' Herbicide Sprayer	.086	.25	.68	2.50	.087	.35	.69	2.50
2-20' Combines	.087	.29	3.23		.075	.29	2.72	
14' Chisel Plow						.42	1.12	
3 ea. 2½-T Truck		.38	8.08			.38	7.28	
¾-T Pickup		.72				.54		
Front End Loader		.74	2.03			.76	1.52	
Miscellaneous Operations	.500	2.53	4.00		.376	1.56	3.00	
Building Utilities		.66				.50		
Shop Equipment				.77				.58
Office Supplies/Services				.38				.29
Custom Repairs			3.32				2.49	
TOTAL COST		7.16	24.63	33.77		6.00	21.25	38.33

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

TABLE B.7: MATERIALS, FUEL, AND LABOR COSTS PER ACRE USED IN CALCULATING THE FARM BUDGETS FOR BARLEY PRODUCTION IN THE DELTA-CLEARWATER AREA (3,000 ACRES)

OPERATION	1/2 Fallow Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost	Material Cost	1/3 Fallow Mach. Time Per Acre	Fuel Cost $/acre	Labor Cost	Material Cost
20' Disc & Cultipack								
42' Disc & Cultipack	.195	1.49	2.04		.096	.62	1.00	
42' Tandem Disc					.037	.14	.19	
45' Fertilizer Spreader	.035	.32	.36	7.07	.043	.12	.34	10.40
20' Grain Drill	.101	.29	.81	15.13[a] 7.92				
36' Grain Drill					.057	.31	.46	16.64[a] 7.92
45' Herbicide Sprayer	.086	.25	.68	2.50	.105	.30	.84	2.50
2-20' Combines		.25	2.81					
2-24' Combines	.087				.072	.24	2.37	
28' Chisel Plow					.112	.50	1.18	
3 ea. 2½-T Truck 12-T Wagons		.33	7.03			.38	6.32	
¾-T Pickup		.63				.47		
Front End Loader		.64	1.77			.48	1.33	
Miscellaneous Operations	.434	2.21	3.46		.326	1.39	2.60	
Building Utilities		.58				.43		
Shop Equipment				.67				.50
Office Supplies/Services				.33				.25
Custom Repairs			2.88				2.16	
TOTAL COST		6.99	21.84	33.62		5.38	18.79	38.21

[a]Upper figure indicates the cost of 20-10-10; lower figure, the cost of seed.

Appendix C
Procedure for Updating Cost Estimates

Because prices and charges of the various production inputs are constantly changing, and because it may be desirable to particularize these cost estimates, generalized budgets are presented to facilitate each of these objectives. Costs have been categorized as owner costs and operating costs. Owner costs, incurred whether or not a crop is produced, include investment charges, depreciation, land lease charges, and return to management. Operating costs are those incurred only when a crop is produced, specifically: supplies, material, equipment charges, labor, and services.

Appendix B, Table B.1, presents the machinery complements used in this study along with repair, maintenance and field preparation costs per acre. Tables B.2 through B.7 present the fuel, labor and material costs per acre for all farm unit sizes. These costs have been transferred to the respective tables in Appendix A. For example, Table A.6 includes all owner costs and operating costs taken from Table B.2 in Appendix B.

OPERATING COSTS

Costs which are appropriate to a particular farming operation can be substituted for those costs listed in Tables B.2 through B.7, Appendix B. For example, in Table B.2, the labor cost for operation of a 20-foot tandem disc may be \$.29 per acre rather than \$.51. This \$.29 cost is substituted and the new total labor cost is transferred to Table A.6 in Appendix A.

OWNER COSTS

Items such as depreciation and investment cost will need revision if the initial cost of equipment or buildings changes or if interest rates change. The derivation of these costs has been explained in Section 4 of the report body. This should be reviewed before revisions are made.

Appendix D

Equipment Complements and Projected Annual Usages

TABLE D.1: EQUIPMENT COMPLEMENTS USED TO DEVELOP BUDGETS FOR EACH FARM UNIT

Farm Unit (Acres)	Equipment Complements 1/2 Fallow	 1/3 Fallow
800 and 1,000	175 HP 4WD Diesel Tractor 20' Cultipacker and Disk 45' Fertilizer Spreader 100 HP Diesel Tractor 45' Herbicide Sprayer 20' Press Wheel Grain Drill w/Fertilizer Front End Loader 1-13' Combines 1-2½ Diesel Truck 1-12T Wagon with Auger and Dump	175 HP 4WD Diesel Tractor 20' Cultipacker and Disk 20' Tandem Disk 150 HP Diesel Tractor 20' Press Wheel Grain Drill w/Fertilizer 45' Herbicide Sprayer 45' Fertilizer Spreader 14' Chisel Plow Front End Loader 1-13' Combine 1-2½T Diesel Truck 1-12T Wagon with Auger and Dump
1,800	225 HP 4WD Diesel Tractor 42' Cultipacker and Disk 45' Fertilizer Spreader 175 HP 4WD Diesel Tractor 45' Herbicide Sprayer 24' Press Wheel Grain Drill w/Fertilizer Front End Loader 2-13' Combines 2-2½T Diesel Trucks 2-12T Wagons with Auger and Dump	225 HP 4WD Diesel Tractor 20' Cultipacker and Disk 20' Tandem Disk 225 HP 4WD Diesel Tractor 24' Press Wheel Grain Drill w/Fertilizer 45' Herbicide Sprayer 45' Fertilizer Spreader 14' Chisel Plow Front End Loader 2-15' Combines 2-2½T Diesel Trucks 2-12T Wagons with Auger and Dump
2,200	225 HP 4WD Diesel Tractor 42' Cultipacker and Disk 45' Fertilizer Spreader 175 HP 4WD Diesel Tractor 45' Herbicide Sprayer 24' Press Wheel Grain Drill w/Fertilizer Front End Loader 2-13" Combines 2-2½T Diesel Trucks 2-12T Wagons with Auger and Dump	225 HP 4WD Diesel Tractor 42' Cultipacker and Disk 42' Tandem Disk 225 HP 4WD Diesel Tractor 24' Press Wheel Grain Drill w/Fertilizer 45' Herbicide Sprayer 45' Fertilizer Spreader 14' Chisel Plow Front End Loader 2-15' Combines 2-2½T Diesel Trucks 2-12T Wagons with Auger and Dump

TABLE D.1: CONTINUED

Farm Unit (Acres)	Equipment Complements 1/2 Fallow	Equipment Complements 1/3 Fallow
2,600	335 HP 4WD Diesel Tractor 42' Cultipacker and Disk 45' Fertilizer Spreader 175 HP 4WD Diesel Tractor 45' Herbicide Sprayer 24' Press Wheel Grain Drill w/Fertilizer Front End Loader 2-20' Combines 2-2½T Diesel Trucks 3-12T Wagons with Auger and Dump	225 HP 4WD Diesel Tractor 42' Cultipacker and Disk 42' Tandem Disk 225 HP 4WD Diesel Tractor 24' Press Wheel Grain Drill w/Fertilizer 45' Herbicide Sprayer 45' Fertilizer Spreader 14' Chisel Plow Front End Loader 2-20' Combines 2-2½T Diesel Trucks 3-12T Wagons with Auger and Dump
3,000	335 HP 4WD Diesel Tractor 42' Cultipacker and Disk 45' Fertilizer Spreader 175 HP 4WD Diesel Tractor 45' Herbicide Sprayer 24' Press Wheel Grain Drill w/Fertilizer Front End Loader 2-20' Combines 2-2½T Diesel Trucks 3-12T Wagons with Auger and Dump	335 HP 4WD Diesel Tractor 42' Cultipacker and Disk 42' Tandem Disk 225 HP 4WD Diesel Tractor 36' Press Wheel Grain Drill w/Fertilizer 45' Fertilizer Spreader 45' Herbicide Sprayer 28' Chisel Plow Front End Loader 2-24' Combines 3-2½T Diesel Trucks 3-12T Wagons with Auger and Dump

TABLE D.2: ANNUAL USE OF TRACTORS, COMBINES AND TRUCKS FOR EACH FARM UNIT

	Farm Unit and Equipment[a]	Hours Per Year	
		1/2 Fallow	1/3 Fallow
1.	800 Acres		
	175 HP 4WD Diesel	324	280
	125 HP Diesel	—	428
	100 HP Diesel	304	—
	13-Foot Combine	70	94
	1-2½T Truck	294	263
2.	1,000 Acres		
	175 HP 4WD Diesel	368	310
	125 HP Diesel	—	492
	100 HP Diesel	344	—
	13-Foot Combine	88	118
	1-2½T Truck	297	323
3.	1,800 Acres		
	225 HP 4WD Diesel	407	463
	225 HP 4WD Diesel	—	798
	175 HP 4WD Diesel	593	—
	2-13-Foot Combines	159	—
	2-15-Foot Combines	—	130
	2-2½T Trucks	297	396
4.	2,200 Acres		
	225 HP 4WD Diesel	426	451
	225 HP 4WD Diesel	—	882
	175 HP 4WD Diesel	631	—
	2-13-Foot Combines	194	—
	2-15-Foot Combines	—	158
	2-2½T Trucks	392	523
5.	2,600 Acres		
	335 HP 4WD Diesel	632	—
	225 HP 4WD Diesel	—	572
	225 HP 4WD Diesel	—	1,200
	175 HP 4WD Diesel	899	—
	2-20-Foot Combines	113	150
	2-2½T Trucks	521	508
	3-2½T Trucks	—	—
6.	3,000 Acres		
	335 HP 4WD Diesel	669	555
	175 HP 4WD Diesel	936	1,262
	2-20-Foot Combines	130	—
	2-24-Foot Combines	—	144
	3-2½T Trucks	722	587

[a] Tractor horsepowers are given as PTO HP. The equivalent drawbar (db) horsepowers are:

335 PTO HP = 262 db HP
225 PTO HP = 178 db HP
175 PTO HP = 150 db HP
150 PTO HP = 125 db HP
100 PTO HP = 80 db HP