



An economic analysis of an elite seed potato farm in Montana
by Joseph Frank Guenther

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Applied Economics
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Abstract:

An elite seed potato farm has been proposed as an improvement to the Montana seed potato industry. The elite farm would provide seed growers in the state with superior elite seedstocks, replacing the stocks that the growers themselves produce. The purpose of this study is to estimate the costs of operating an elite farm and to evaluate whether or not it would be an economic improvement. A computer budget generator program is used to estimate the elite farm's cost of production and economic feasibility.

Results indicate that it would cost less to produce elite seed potatoes on an elite farm than it currently costs seed potato growers to produce such seed on their own commercial seed potato farms. The superior quality of the elite farm seed means that growers could sell PVX-free seed and receive higher prices. As a result, the net farm income of a typical Montana seed grower would increase by more than \$11,000.00 per year. The total potential net benefits to the industry are estimated at \$517,702.00 per year. Brief speculations are made as to why growers have not yet taken advantage of this. A target price scheme is devised to finance the elite farm. By charging \$11.80/cwt for elite seed the initial loan requirements of \$338,800 may be paid off.

Three alternative forms of elite farm organization are explored: a state agency; a cooperative; and a private entrepreneurship. Because of likely bureaucratic inefficiencies and freedom of choice questions, it would seem that the cooperative or private organizational farms have advantages over the state agency farm. Because of economies of size and mutual benefits resulting from an elite farm there are arguments supporting the cooperative organization over a private entrepreneurship. In addition, an existing organization, the Montana Potato Improvement Association, may facilitate forming a cooperative elite seed potato farm. On the other hand, the benefits from an elite farm are sufficiently large to warrant individual action if collective action is not taken. Regardless of the form of organization, personnel at Montana State University may be instrumental in certain aspects of setting up an elite farm.

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SEED POTATO FARM IN MONTANA

by

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A thesis submitted in partial fulfillment
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ABSTRACT

An elite seed potato farm has been proposed as an improvement to the Montana seed potato industry. The elite farm would provide seed growers in the state with superior elite seedstocks, replacing the stocks that the growers themselves produce. The purpose of this study is to estimate the costs of operating an elite farm and to evaluate whether or not it would be an economic improvement. A computer budget generator program is used to estimate the elite farm's cost of production and economic feasibility.

Results indicate that it would cost less to produce elite seed potatoes on an elite farm than it currently costs seed potato growers to produce such seed on their own commercial seed potato farms. The superior quality of the elite farm seed means that growers could sell PVX-free seed and receive higher prices. As a result, the net farm income of a typical Montana seed grower would increase by more than \$11,000.00 per year. The total potential net benefits to the industry are estimated at \$517,702.00 per year. Brief speculations are made as to why growers have not yet taken advantage of this. A target price scheme is devised to finance the elite farm. By charging \$11.80/cwt for elite seed the initial loan requirements of \$338,800 may be paid off.

Three alternative forms of elite farm organization are explored: a state agency; a cooperative; and a private entrepreneurship. Because of likely bureaucratic inefficiencies and freedom of choice questions, it would seem that the cooperative or private organizational farms have advantages over the state agency farm. Because of economies of size and mutual benefits resulting from an elite farm there are arguments supporting the cooperative organization over a private entrepreneurship. In addition, an existing organization, the Montana Potato Improvement Association, may facilitate forming a cooperative elite seed potato farm. On the other hand, the benefits from an elite farm are sufficiently large to warrant individual action if collective action is not taken. Regardless of the form of organization, personnel at Montana State University may be instrumental in certain aspects of setting up an elite farm.

Chapter I

POTATO PRODUCTION IN MONTANA

Potatoes were first cultivated in South America over 2,000 years ago and then subsequently introduced into Europe by the Spaniards. In 1719 potatoes were brought from Ireland into what is now the U.S. and production slowly spread westward.¹ Since at least 1841 potatoes have been cultivated in Montana. Potatoes were an especially important crop during the gold rush era of the late 1800's as they were used to prevent scurvy among miners.²

At present potatoes are an important crop only in certain areas of Montana. The value of the 1973 crop in Lake County, for example, was nearly six million dollars which was about one third of the county's total farm receipts. However, on a statewide basis the crop has been of moderate importance. During the ten year period 1964 to 1973 cash receipts from potatoes represented between 0.4

¹Ora Smith. Potatoes: Production, Storing, Processing. The AVI Publishing Co., Inc.: Westport, Connecticut, 1968.

²James McClellan Hamilton. From Wilderness to Statehood: A History of Montana. Binford & Mort: Portland, Oregon, 1957. p. 350.

and 1.5 percent of the total cash receipts from Montana agricultural commodities.³ Figure 1 shows the geographical distribution of the potato crop in Montana. The areas of production are primarily the mountain valleys of western Montana. Table 1 lists acreage, yield and value for each potato producing county and region in Montana. This study, therefore, involves a crop that is not very important on a statewide basis but is a locally significant commodity.

The potato market, as diagrammed in Figure 2, consists of three distinct submarkets: (1) the tablestock (fresh, unprocessed potatoes) market; (2) the processing market; and (3) the certified seed market. There is a separate group of buyers in each submarket. However, on the selling side potatoes grown on a single farm may, under certain conditions, be sold in two or even all three of the submarkets.⁴ The major restrictions are imposed on those potatoes intended for the certified seed submarket.

³Montana Agricultural Statistics, Volume XV. Montana Department of Agriculture and Statistical Reporting Service - USDA. Helena, Montana, Dec., 1974. p. 10.

⁴John K. Hanes. Organization and Structure of the Red River Valley Potato Industry. Economic Study Report No. 568-3. Department of Agricultural Economics, Institute of Agriculture, University of Minnesota in cooperation with the U.S. Department of Agriculture. Feb. 1969. p. 27.

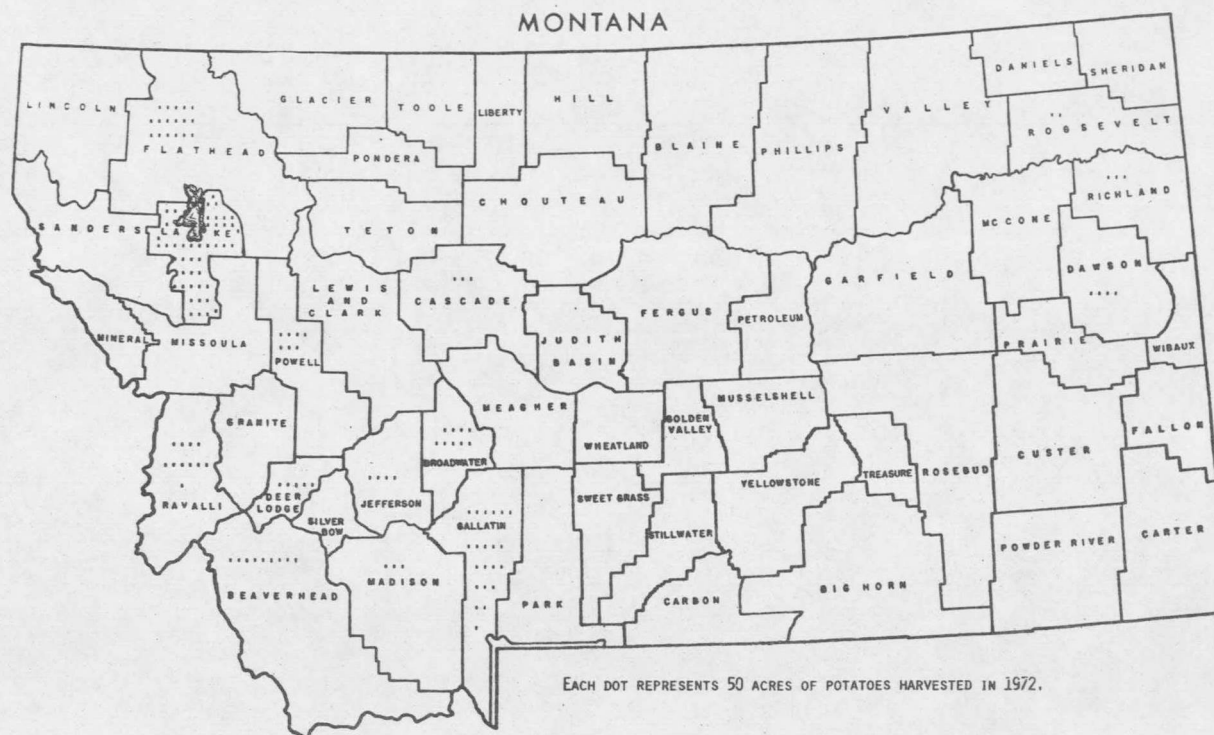


Figure 1. Areas of Potato Production in Montana

TABLE 1

POTATO ACREAGE, YIELD, PRODUCTION AND VALUE BY COUNTIES, 1974

District and County	Acres Harvested	Yield	Value	Acres Harvested	Yield	Value
Deer Lodge	230	220	255,600	150	200	324,000
Flathead	830	250	1,047,900	730	240	1,892,200
Lake	2,230	240	2,702,900	2,250	240	5,832,300
Powell	330	230	383,300	200	180	388,800
Ravalli	530	210	562,100	460	200	993,600
Other Co.	10	180	9,100	30	113	36,700
<u>N. West</u>	4,160	236	4,960,900	3,820	230	9,467,600
<u>N. Central</u>	200	130	131,300	200	138	297,000
Dawson	200	150	151,500	100	180	194,400
Richland	150	150	113,600	150	180	291,600
Roosevelt	100	110	55,600	100	130	140,400
Other	40	100	20,200	20	150	32,400
<u>N. East</u>	490	138	340,900	370	165	658,800
Broadwater	410	200	494,100	360	190	738,700
Cascade	120	160	97,000	120	120	155,500
Other	120	192	116,200	100	171	184,700
<u>Central</u>	650	191	627,300	580	172	1,078,900
Beaverhead	470	220	522,200	430	200	928,800
Gallatin	1,020	250	1,287,900	950	240	2,462,500
Jefferson	180	200	200,000	140	210	317,500
Madison	120	220	133,300	120	230	298,100
Other	60	170	51,500	20	180	38,900
<u>S. West</u>	1,850	235	2,194,900	1,660	226	4,045,800
<u>S. Central</u>	100	104	52,500	100	154	166,300
<u>S. East</u>	50	100	25,200	70	100	75,600
State	7,500	220	8,333,000	6,800	215	15,790,000

Reproduced from: Montana Agricultural Statistics, Volume XV, Montana
Department of Agriculture, Helena, Montana, 1974.

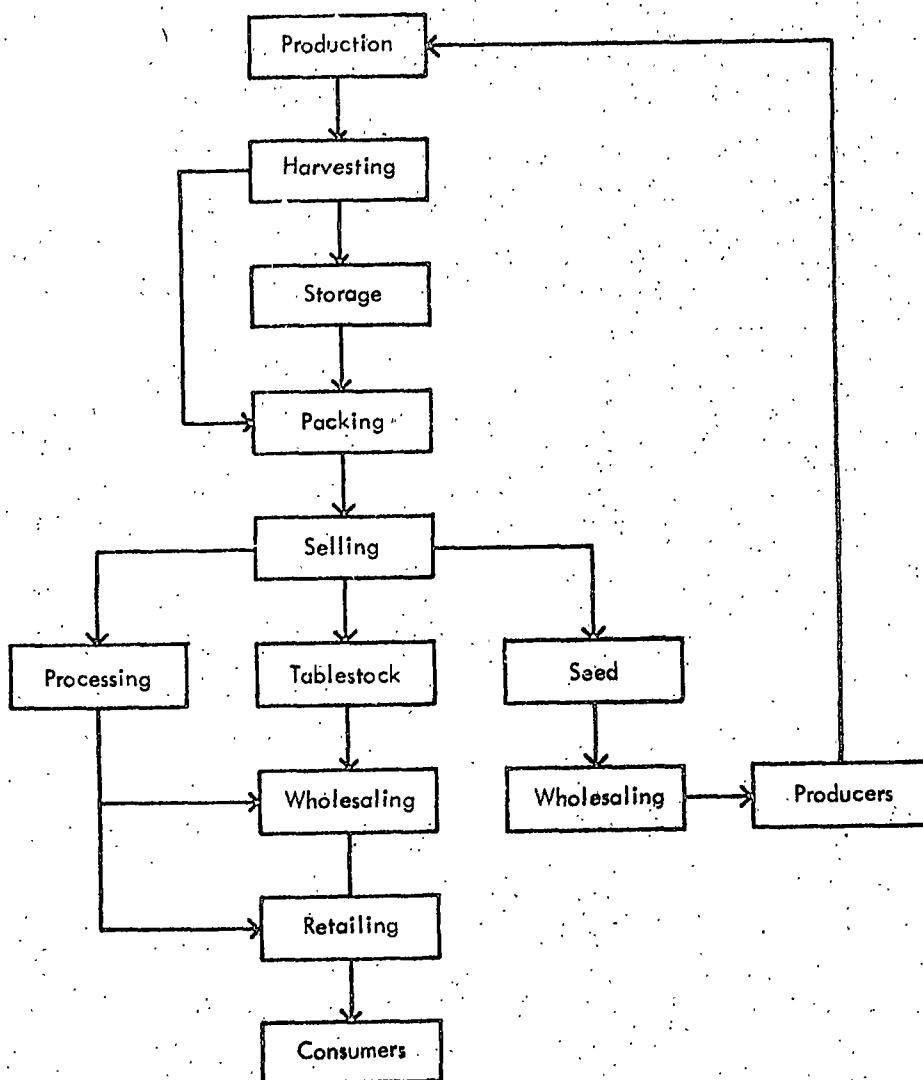


Figure 2. Late Crop Potatoes: production and marketing functions. Reproduced from: Hanes, op. cit., p. 35.

The production of certified seed is governed by rules and regulations that prohibit substitution of tablestock and processing potatoes into the seed market. Such rules and regulations are usually administered by either a state Department of Agriculture, state approved seed organization, or the State College of Agriculture.⁵ The sale of Montana produced potatoes has become concentrated in the certified seed submarket. The percentage of total Montana potato acreage that was certified seed has steadily increased from 32.5 percent in 1957 to well over 60 percent in the 1970's while the percentage of total U.S. acreage that was certified as seed ranges from 7 to 9 percent, Table 2.

In Montana, the seed certifying agency is the Montana Potato Improvement Association (MPIA) which is state approved and was chartered by the Montana Legislature in 1951. The organization is governed by a Board of Directors consisting of four potato growers and an executive director from Montana State University. The agency has been a financial success, collecting its revenue from growers for

⁵H.M. Darling and H.O. Werner. "Seed Potato Certification." Potatoes: Production, Storing, Processing. Ora Smith, editor. The AVI Publishing Co., Inc.: Westport Connecticut, 1968. Chapter 13.

TABLE 2

MONTANA AND U.S. CERTIFIED SEED

Year	Montana			U.S.		
	Acres Entered for Certification	Acres Passed	Percent Entered for Certification That was Passed	Percent of Total Harvested Acreage That was Certified Seed	Percent of Total Acreage That was Seed	Percent Entered for Certification That was Passed
1957	2,842	2,828	99.5	32.5	8.7	80
1958	3,064	2,844	92.8	34.3	7.6	83
1959	2,983	2,611	87.5	31.5	8.4	81
1960	3,026	2,989	98.8	36.5	8.7	85
1961	3,687				7.2	85
1962	3,264	3,128	95.8	39.6	7.7	86
1963	3,104	3,047	98.2	37.6	7.4	89
1964	3,119	2,869	92.0	36.8	9.0	89
1965	3,682	3,385	91.9	42.3	8.1	87
1966	4,370	3,984	91.2	48.6	7.9	83
1967	4,794	4,513	94.1	54.4	7.7	89
1968	4,620	4,587	99.3	55.3	8.3	88
1969	5,092	4,687	92.0	62.5	7.8	89
1970	5,451	4,788	87.8	61.4	7.4	84
1971	5,821	5,487	94.3	68.6	7.0	83
1972	5,028	4,939	98.2	64.1		85
1973		4,613		66.0		90
1974	5,189	4,611	88.9			
Average			93.8		7.83	85.6

Compiled from: Spudlight, Certified Seed Editions, 1957-1975, a publication of the United Fresh Fruit and Vegetable Association; Montana Agricultural Statistics: The National Potato Council Eighth Annual Statistical Report 1973, Denver, Colorado.

such things as: tag fees, inspection fees, indexing fees, and virus testing fees.

It is the responsibility of the MPIA to set seed standards and to conduct field and bin inspections to ascertain freedom from disease, varietal purity and other conditions that may impair seed value. When a lot of seed potatoes has been grown in accordance with the rules and regulations and has passed inspections and grade requirements, the MPIA grants an official color-coded certification tag and seal. The colors designate various tolerances for defects. Certification means only that the grower has met certain requirements and that the crop met certain standards enforced by the MPIA. Certification does not mean immunity or disease resistance and since the seed may become contaminated after leaving the grower's hands, there is a non-warranty clause on the tags.⁶

Montana has evolved into a seed producing state that provides seed to nearby major potato producing areas such as Idaho and Washington. There are several reasons why. First, the climate and growing conditions of the isolated

⁶Orville W. McCarver. "Potato Certification in Montana." First Annual Washington State Potato Conference. Moses Lake, Washington, 1962.

mountain valleys in Montana are much more conducive to quality seed production than are such areas as eastern Washington.⁷ Second, other potato production areas have a comparative advantage over Montana in growing tablestock and processed potatoes because there are no large processing plants or large population centers in Montana.

In each of the last 13 years Montana prices have exceeded the U.S. average price, Table 3. This is because of the large proportion of seed that is grown in Montana. Seed prices in general and Montana seed prices in particular are usually the highest of the three submarket prices.

One reason for this price difference is that the price must be higher to offset the higher costs of growing seed potatoes. As this study will reveal there are certain costly operations that are necessary for seed production which are not necessary for tablestock or processed potato production.

Another reason is the apparent excess demand for Montana certified seed potatoes. Hanes states that reputation is an important factor to the purchasers of seed

⁷Ken Waud and Nicholas Sandar. "Our Seed Potato Needs." First Annual Washington State Potato Conference, Moses Lake, Washington, 1962.

TABLE 3

POTATO ACREAGE, PRODUCTION, PRICE, TOTAL VALUE AND VALUE PER ACRE

	Acres Harvested	Yield (cwt. per Acre)	Price per cwt.	Value of Production	Value per Acre	Average U.S. Price*
1961	8,000	180	\$ 2.01	\$ 2,894,000	\$ 361.75	\$1.36
1962	7,800	160	2.35	2,933,000	376.03	1.67
1963	7,900	180	2.51	3,569,000	451.77	1.78
1964	7,600	165	6.23	7,812,000	1027.89	3.50
1965	7,800	170	2.89	3,832,000	491.28	2.53
1966	8,000	175	3.00	4,200,000	523.00	2.04
1967	8,400	190	2.59	4,134,000	492.14	1.87
1968	8,100	195	3.95	6,241,000	770.49	2.23
1969	7,000	205	3.77	5,410,000	772.86	2.24
1970	7,500	205	2.83	4,353,000	580.40	2.21
1971	7,800	180	3.15	4,423,000	567.05	1.90
1972	7,500	220	5.05	8,333,000	1111.07	2.55
1973	6,800	215	10.80	15,790,000	2322.06	4.05

Reproduced from: Montana Agricultural Statistics.

*U.S. prices from National Potato Council Eighth Annual Statistical Report 1973, Denver, Colorado.

potatoes.⁸ In Washington, seed lot trials are conducted "to evaluate seed from various sources for their disease content."⁹ Montana seed has usually performed quite well in these trials further enhancing the excellent reputation of Montana seed. Moreover, according to Orville McCarver, MSU Extension Horticulturist, the Montana seed potato industry has not expanded as rapidly as it could have. In the past 15 years while Montana's seed potato tonnage has doubled, potato acreage in Washington has increased five-fold due to the agricultural development of the Columbia River Basin. Washington growers who have traditionally depended upon Montana growers for their seed must go elsewhere.

The Disease Problem

Certified seed potatoes are not necessarily a homogeneous product. All seed that is certified has met certain disease tolerance levels but some lots may contain more disease and defects than others. The ultimate test of seed quality is for the buyer to use the seed to grow a

⁸Hanes, op. cit., p. 77.

⁹Robert E. Thornton. "Washington Seed Lot Trials." Ninth Annual Washington State Potato Conference. 1970.

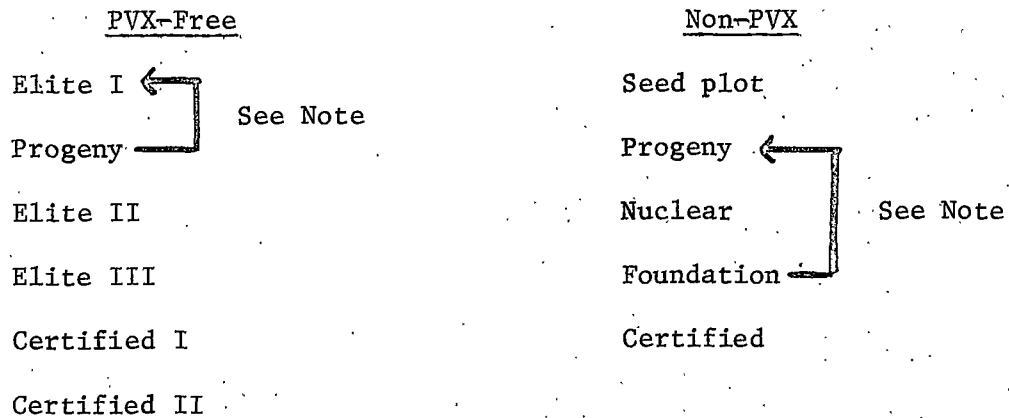
crop. Thus a grower's product may be differentiated on the basis of past performance. A seed grower's past reputation, then, is a factor that buyers depend on. Unlike tablestock and processed growers, seed growers usually make only one sale to a customer per year. Thus, a single year of bad seed production may destroy a grower's reputation and perhaps adversely affect his business in the future.

An obvious goal of seed growers is to produce seed of optimal quality every year. Hanes states that, "the quality of seed is determined by the proper selection of foundation stock and by the whole series of production and storage techniques designed to eliminate seed borne diseases . . ."¹⁰ Seed certification programs provide for a genealogical increase scheme to insure that certified seed acreage is planted with seed of good quality. Generations may be divided roughly into three classes: elite, foundation and certified. Foundation stocks are usually required to plant certified fields and the requirements for this foundation class are stricter than for certified. Restrictions for the elite class are stricter yet as this is the

¹⁰Hanes, op. cit., p. 77.

parent stock for foundation seed. The names and number of seed classes may vary from state to state. Montana currently has two classification systems, Figure 3. The PVX free classes are: Elite I, Elite II, Elite III, Certified I and Certified II, and the non-PVX free classes are: Nuclear, Foundation, and Certified. For purposes of simplification the classification system in this report will contain only elite, foundation, and certified as classes. The Montana classes of Elite I and Nuclear will jointly be referred to as elite seed, which is defined as the stocks used to plant the progenitor(s) of certified seed.

In spite of the required steps for certification, there are many seed potato fields in Montana that contain some potato disease and each year there are some that exceed tolerance levels and fail to pass inspection. There are certain diseases that seem to be more of a problem in Montana than others. Dallas Batchelor, executive-director of the MPIA, believes that blackleg and leafroll are the two diseases that cause the most problems in the state. A third disease, Potato Virus X (PVX), is important in that the MPIA has a separate system of seed classification for it. A description of these three diseases is presented



Note: Greenhouse Indexing Required

Figure 3. Outline of Required Steps in Montana's Seed Potato Program

Reproduced from: Montana 1975 Certified Seed Potato Directory, Montana

Potato Improvement Association, Johnson Hall, Montana

State University, Bozeman, Montana, p. 1.

below giving special attention to how the disease is spread, symptoms, damages caused, and control measures.

Blackleg. Blackleg disease is a worldwide potato problem that is capable of causing great potato losses both in the field and in storage. The disease is caused by the bacterial organism, Erwinia Carotovara. The bacteria overwinter in infected plant debris in the field and in stored tubers. Infection usually begins in the seedpiece, often entering through a wound, and spreads upward.

One of the first apparent symptoms of the disease is a wilting or yellowing of the lower leaves which later spreads to the upper leaves. The chief characteristic of the disease is the black streak which appears on the lower stem near the surface of the soil. The tubers of an infected plant have a soft rot at the stem end and may develop secondary infection and rot entirely. This tuber decay may be delayed and result in a serious loss during storage. Also, the bacteria may rot seed pieces in the ground and attack young sprouts which will result in a poor stand that is not usually attributed to blackleg.¹¹

¹¹M.D. Harrison. "Potato Blackleg: Its Nature and Prospects for Control." Fourteenth Annual Washington State Potato Conference. Moses Lake, Washington. Feb. 6, 1974, p.23.

Three common sources of infection are: (1) infected seed pieces; (2) infection of seed pieces by bacteria in the soil; and (3) infection following the attack of seed pieces by the seed corn maggot.¹² Also mentioned as sources of infection are: contaminated machinery, cutting knives, and nematodes;¹³ and storage facilities.¹⁴ There are factors other than the presence of bacteria that dictate the amount of blackleg that will develop and the stage of plant growth when it will be expressed. The factors are: the number of bacteria in the seedpiece; soil temperature; other microorganisms attacking the seedpiece; soil nutrition; and storage and handling facilities.¹⁵ Because of the variability of these factors the blackleg problem varies in severity from year to year.

Infection is usually favored by high moisture so planting in well drained soils and not irrigating until

¹²M.M. Afanasiev. Potato Diseases and Their Control. Bulletin 329, Cooperative Extension Service, Montana State University, Bozeman, MT, Dec. 1970.

¹³W.A. Hodgson, D.D. Pond, and J. Munro. Diseases and Pests of Potatoes. Publication 1492, revised 1974. Canada Department of Agriculture, Ottawa. p. 16.

¹⁴Harrison, op. cit., p. 26.

¹⁵Harrison, op. cit., p. 25.

plants have emerged are good practices. The seed corn maggot lives in a symbiotic relationship with the blackleg bacteria. Treatment of seedpieces with Captan usually controls the maggot and therefore blackleg as well.¹⁶ Other suggested control measures include: roguing and a proper crop rotation;¹⁷ disinfect cutting knife or plant small whole tubers, if disease is found sell the entire crop off the field and disinfect all equipment and destroy all bags, plant seed that is free from the disease;¹⁸ avoid fertilizer burn, control for insects and other diseases;¹⁹ do not bruise or mishandle seed, warm seed before planting;²⁰ and destroy potato refuse piles to prevent them from becoming a source of inoculum.²¹

¹⁶G.D. Easton, M.E. Nagle, and D.L. Bailey. Potato Seed Piece Treatment. Scientific Paper 3409, College of Agriculture. Washington State University, Pullman, Washington. Project 1709. p. 3.

¹⁷Afanasiev, op. cit., p. 28.

¹⁸Hodgson, et al., op. cit., p. 16.

¹⁹A.L. Fredricks and H.N. Metcalf. "Potato Blackleg Disease." American Potato Journal. September 1970. Volume 47, No. 9.

²⁰Easton et al., op. cit., p. 8.

²¹J.C. Walker. Diseases of Vegetable Crops. McGraw-Hill Book Co., Inc., 1959. p. 38.

Leafroll. Leafroll is a virus disease that may be caused by current season infection or by infected seed pieces. Symptoms differ and the types of infection are termed primary and secondary, respectively. Primary symptoms may not appear if infection occurs late in the growing season.²² The symptoms of a plant with primary infection are stiff, pale green upper leaves that have a tendency to roll. Tubers from plants with primary leafroll always produce plants with secondary leafroll. Secondary symptoms appear on the lower leaves when plants are only a few inches high and progress to higher leaves. Leaf margins roll upward and become dry, leathery and thicker than normal. Vines are usually stunted and rattle when shaken.

Leafroll reduces yield because the diseased plants produce tubers fewer in number and smaller in size. Infected tubers often appear normal on the surface but may show net necrosis (a network of brown strands or dead tissue originating from the stem end) when cut open.²³ Tubers

²²Walker. Ibid., p. 381.

²³Hodgson et al., op. cit., p. 33.

will produce long, spindly sprouts even if net necrosis has not developed.²⁴

Insects, especially the green peach aphid, may spread the leafroll virus. Temperature and moisture affect the numbers of the aphid. Oftentimes there are overlapping generations in a growing season. ^{They what?} They may be ^{Martians} found on potatoes in storage and often overwinter on peaches and other fruits in the egg stage. This is especially a problem in the potato growing area near Flathead Lake in northwestern Montana which happens to be a fruit producing region. Usually one application of a systemic insecticide is sufficient but during some seasons supplemental applications of insecticides must be made to control the population of aphids.

Infected seed and aphids appear to be the main sources of leafroll infection. The disease is not spread by seed cutting operations or by picker-type planters.²⁵ Suggested methods of controlling leafroll are: roguing

²⁴Avery E. Rich. "Potato Diseases." Potatoes: Production, Storing, Processing. Ora Smith, editor. The AVI Publishing Co., Inc.: Westport, Connecticut, 1968. Chapter 17.

²⁵Afanasiev, op. cit., p. 35.

throughout the growing season; use disease free seed; control aphids; and grow on fields where prevailing winds won't bring in aphids.²⁶ Early harvesting of seedplots is also recommended.²⁷

Potato Virus X (PVX). Potato virus X has also been known as the "healthy potato virus."²⁸ This name was probably used because an infected plant almost always shows no visible symptoms (i.e., PVX is a latent virus). The presence of symptoms depends on climatic conditions, variety and the strain of the virus.²⁹ Depending also on these conditions the virus may significantly reduce yields.

Nearly all of the potatoes grown in the United States are infected with PVX at the present time. The virus is not transmitted through true seeds so new varieties may not be as heavily infected as the older

²⁶Hodgson et al., op. cit., p. 33.

²⁷Rich, op. cit., p. 420.

²⁸Kenneth M. Smith. Recent Advances in the Study of Plant Viruses. P. Blakiston's Son & Co., Inc.: Philadelphia, PA, 1934. p. 299.

²⁹Afanasiev, op. cit., p. 40.

varieties.³⁰ Other host plants for the virus include tomato, tobacco, pepper, petunia and black nightshade.³¹

The virus is not transmitted by aphids but may be transmitted by grasshoppers. It may spread by sprout-to-sprout contact of tubers in storage and by contact above or below ground by plants in the field. It is brought into an uncontaminated field mainly by contaminated equipment, workers, and animals.³²

Obviously planting PVX free seed stocks and disinfecting equipment and workers are practices that must be employed to control the disease. However, since nearly all potatoes in the United States are infected with PVX a program designed to eradicate the disease from a number of plants and to increase these plants is necessary for control of the virus.

³⁰Rich, op. cit., p. 415.

³¹Walker, op. cit., p. 378.

³²James T. Shepard and Larry E. Claflin. "Critical Analysis of the Principles of Seed Potato Certification." Annual Review of Phytopathology. 1975. Vol. 13, p. 275.

An Elite Seed Potato Farm

In all but one year since 1957 Montana has passed a higher percentage of acres for seed certification than the United States average in spite of very strict tolerance levels (e.g., Montana's 0.25% tolerance for blackleg is the lowest of all states and the 0.25% tolerance for leafroll exceeds only the 0.2% of Washington and Idaho³³). Apparently Montana is in a competitive position in the seed potato industry but that does not mean that there is not room for improvement. The percent of seed that has passed certification has not varied greatly from the average in any of the last 17 years. Moreover, Shepard and Claflin state

Each seed certification program has merit because seedstocks will be improved if any of the principles of certification are implemented. It is doubtful, however, whether any program has developed to the point where disease control is complete or where all existing knowledge has been utilized fully.³⁴

It would seem that disease control in Montana has not progressed much in the past two decades.

³³ Shepard and Claflin. Ibid., p. 275.

³⁴ Shepard and Claflin. Ibid., p.289-290.

Seed improvement programs in some states include isolated seed farms exclusively devoted to the production of elite seedstocks while other states cooperate directly with the growers in producing elite seedstocks.³⁵ The Montana Potato Improvement Association (MPIA) operates under the latter plan. In this section arguments will be presented on behalf of an elite farm for Montana as a means of improving disease control. The term elite farm is used to describe a single farm that would have the right to produce the elite seed for growers in the state.

In the previous section the three potato diseases that cause the most concern in Montana were described. For each disease, planting only disease free seed is recommended as a control measure. An isolated elite farm would be able to produce seedstocks that are relatively more disease free than the elite seed currently produced on private farms. For example, blackleg free starting material may be obtained by taking vegetative cuttings from young potato stems.³⁶ By increasing the starting material under strict growing conditions blackleg free elite seed may be

³⁵ Darling and Werner, op. cit., p. 324.

³⁶ Harrison, op. cit., p. 25.

produced. This practice is not done by commercial growers but would be done by an elite farm. Leafroll-free elite seed should be grown in an area sufficiently isolated from other potato fields to prevent transmission of the disease by aphids. State seed growers may not have sufficient isolation in the field whereas an elite farm would.

Currently the PVX-free program in Montana involves extensive indexing, testing and roguing but not eradication. An eradication program known as "meristem culture," which also eliminates bacteria and virus diseases other than PVX, is currently used in a latent virus-free program in British Columbia.³⁷ This procedure or one similar to it would be used on the elite farm and is briefly described here.

Selected potato tubers or cuttings are grown in a chamber under specified conditions for at least eight weeks after which small buds or stems are removed and transferred to nutrient tubes. After a period of incubation (two to eight weeks) under lights at room temperature the roots and stems reach a length of two to three centimeters and are

³⁷N.S. Wright. "Production of Virus-Free Seed in British Columbia." Seventh Annual Washington State Potato Conference. Moses lake, Washington, 1968.

transferred to soil in a greenhouse. Certain serological tests are then conducted to determine which of the plants are free of PVX and other disease contamination. The healthiest of these plants are selected to propagate PVX-free clones by vegetative cuttings. After the plants are ten to twelve inches tall the tips are removed to promote axillary stem growth. When the stems grow out the tips are removed and planted in sand where they root in about ten days. They are then transplanted in a greenhouse and transplanted again in the field. By this method, in 1967, a single tuber of the White Rose variety was increased to 2,000 rooted cuttings which yielded 4,860 pounds of tubers.

Elite seed in Montana is produced by private growers who index, test, and select the plants that are to be used for elite seed. Greenhouse indexing each year determines that some plants are unacceptable because of disease. The growers do not use the above mentioned practices that would be used on an elite farm because they have not acquired the necessary resources and knowledge. Obviously, the practices described above result in elite seed of better quality than the average elite seed currently produced. An elite farm would be a place to start disease free plants,

increase them and provide superior elite seed to the growers.

There are also arguments, other than quality, to be made in favor of an elite farm. Growers within the state may on rare occasions buy elite seed from other growers if their own stocks become too heavily infected with disease. Petty jealousies among the growers may prevent the buyer from purchasing from another grower who has the best elite seed available at the time. The elite farm could provide an impartial source of elite seed for all eligible growers.

Dallas Batchelor, executive director of the MPIA, says that blackleg has become a serious problem in the state and seed growers have expressed a strong demand for seed material that is free of the disease. Without an elite farm to produce such seed the disease may well continue to be a problem. Proponents of an elite farm say that the farm is needed to prevent the blackleg problem from becoming even more serious and to provide potato research facilities where new varieties, seed treatments, etc., can be tested.

Paul Eastman of the Maine Department of Agriculture said of their elite seed farm,

. . . we needed a farm of our own where we could carry out all the known methods of disease control regardless of cost.³⁸

While some people in Montana may also hold this view, it would seem that the decision to set up such a farm should be based on economic criterion and that costs should indeed be important. It is true that the average overall quality of elite seed would increase and growers wouldn't have to maintain their own elite plots but the costs of the farm must be weighed against these factors. This study is an attempt to determine those costs and the potential net benefits of an elite seed farm.

Objectives

The specific objectives of this study are:

- (1) to determine the cost of producing elite seed potatoes on an elite seed farm in Montana.
- (2) to determine whether or not the elite seed potato farm would be an economic improvement to the Montana seed potato industry in particular and society in general.
- (3) to evaluate alternate means of organizing and financing on elite seed potato farm.

³⁸ Paul J. Eastman. "A Successful Foundation Seed Farm." The American Potato Journal. July 1952. Vol. 29, No. 7, p. 173-174.

Procedure

The first objective will be satisfied by a farm enterprise cost analysis done with the aid of a computer budget generator program. A cost study of certified seed growing will also be done to provide certain data that are appropriate for the elite farm budget. A cost study done in 1970 will also be updated to provide additional data.³⁹ Data obtained from the Wisconsin elite seed potato farm near Three Lakes, Wisconsin and provided by Dr. Henry Darling of the University of Wisconsin are to be utilized as well.

Partial budgeting is used to satisfy the second objective. Data will be provided from the result of the first objective, from seed growers, and from university experts. A social welfare analysis will also be presented in the final chapter.

The third objective consists of making judgments and comparisons. The farm organization section involves a comparison of alternative ways of organizing and is more subjective than the financial plan which presents a means

³⁹M.E. Griffing and W. Thacker. Enterprise Cost of Seed Potatoes. Circular 1116. Cooperative Extension Service and USDA-SCS Cooperating. Bozeman, Montana, 1970.

by which the farm may be paid for. Prescribed courses of action or policy statements will be made as a result of this study.

Chapter II

METHODOLOGY

In this chapter, assumptions on the structure of, methods used to estimate the costs of, and the feasibility of, the elite farm are presented. Farm characteristics that have an impact on the costs of operation are described in developing the budget. This is followed by a description of the technique used to estimate costs of production and a description of the partial budgeting framework.

Characteristics of an Elite Farm

Since there is not currently an elite seed potato farm in Montana, the equipment, operations and other details of a proposed farm must be built on assumptions. It is assumed that a Montana elite seed farm would be patterned after elite farms already in existence. The State of Wisconsin, in 1941, was the first to develop an elite farm for the exclusive purpose of providing seed growers with elite seed potatoes. The farm is located near Three Lakes, Wisconsin and was set up and still operates under the supervision of Dr. Henry Darling, Professor of Plant Pathology at the University of Wisconsin. In 1947, an elite farm was set up in Maine and patterned after the Three Lakes farm with the help of Dr. Darling. An elite

farm is also operated in Idaho. Some information has been obtained from each of these farms. All three of the farms, especially the Wisconsin farm, will be used as models for the proposed Montana farm. While the Montana elite farm is not expected to be an exact duplicate of any of these other elite farms, much of the data collected from them can be used in the cost study.

The required size of the farm is estimated to be approximately 160 acres with 40 acres of elite seed potatoes grown per year and the remainder of the farm planted to other crops in the rotation. The required seed potato acreage was derived from the 1975 Montana Certified Seed Potato Directory. It lists all seed stocks entered for certification which have met field inspection requirements. In 1975 a dichotomized seed classification system was established in Montana. For non-PVX tested seed Nuclear is the first class in the sequence and for PVX tested seed Elite I is the first class. It was assumed that elite seed from the elite farm would replace these two classes of seed. The sum of the acreages of these seed classes in 1975 was 36 acres. This acreage was merely rounded to 40 acres. The Wisconsin seed potato industry was used as a check on these figures. A ratio of the number of acres of

certified seed to the number of acres on the elite farm was equated to a similar ratio for Montana. Solving for acres of Montana elite farm seed, the answers range from 34 acres to 40 acres, depending on the year.

However, in each growing season three different generations of seed would be grown on the farm. The system of geneological increase would be:

- 1st year: Stem cuttings which are derived from the meristem culture procedure;
- 2nd year: Nuclear stock planted from the previous year's stem cuttings; and
- 3rd year: Elite seed from the previous year's nuclear stock.

Acreage allowances must be made for the first two generations. The plant population is decreased to half that of the elite plot for the first two generations because there must be wider spaces between plants to minimize disease spread. Assuming a 30 percent yield increase per plant for the smaller populations, a yield of 130 cwt/acre is estimated for the 1st and 2nd generations as opposed to 200 cwt/acre for the elite plot. Further assuming a plant population of 6000 plants/acre and a seeding rate of 15 cwt/acre for the elite plot, and half that for the first two

generations, a nuclear plot of 4.6 acres and a stem cuttings plot of .27 acres is required for an elite plot of 40 acres. Thus, a total potato acreage of 45.13 is required. However, the elite acreage required is arbitrary. In the early years when not all the growers in the state chose to purchase from the elite farm, a smaller acreage would suffice. Conversely, the farm may have to expand to a greater acreage if the seed potato industry in Montana expands. In this study 40 acres was selected as the potato acreage because it seems to be appropriate for the current size of the Montana seed potato industry. The total farm size of 160 acres is assumed to be sufficient for any necessary expansion.

The elite farm should be well isolated with limited access so that all people and vehicles may be inspected or disinfected before entering. Isolation from other potato fields and fruit orchards is necessary since disease may be carried from them into the uninfected fields by insects. The elite farms in existence are isolated from other potato fields by a number of miles. The Three Lakes Farm is a former 240 acre dairy farm located in a part of northern Wisconsin where there is little crop agriculture of any kind. The farm should also be located on productive light

soil and irrigated for optimal potato production. If potatoes had previously been grown on the site, the crops necessarily should have been superior quality seed potatoes so that the chance of disease carryover is minimal.

A planting practice known as tuber unit planting is employed on other elite farms and would be employed on the Montana farm as well. The seed pieces are planted in units usually consisting of four hills. Each seed piece is cut into four pieces and planted in these units of four with a relatively large space between the units so that all plants from the one seed piece can be easily identified. When a diseased plant or tuber is found, all the plants or tubers that grew from the parent tuber are eliminated.

Crops other than seed potatoes should be grown in rotation on the elite farm. The Wisconsin State Farm follows a three year rotation of: 1st year - seed potatoes; 2nd year - oats and clover; 3rd year - clover. This is a typical rotation in Wisconsin and is followed to eliminate the problems of volunteer potato plants which may be infected, to maintain soil humus and to lessen the incidence of early blight, a fungus disease. The Idaho State Farm fallows the year following potatoes to help eliminate volunteer potato plants and integrates foundation grain and

grass crops in the rotation. A rotation sequence that is typical of Montana certified seed potato growers will be used for this study.

To avoid disease transmission by equipment travel in the fields, weed control should be done by spraying rather than cultivating on elite farms. On the Wisconsin farm potato plantings are made in sixteen foot widths. The sprayer used for insecticides, fungicides and herbicides has an eight foot boom on each side so that the tractor and sprayer may travel in alleyways without touching the potato plants. On the Maine farm, a helicopter is used for spraying in order to eliminate ground equipment travel. The Wisconsin practice will be adopted for the Montana elite farm since it would appear to be less expensive than purchasing or renting a helicopter.

On all elite farms equipment and storage facilities are disinfected. The Maine farm requires all vehicles entering the farm to drive through a moat of disinfectant. In addition, workers are given clean gloves and footwear are disinfected each day. Disinfectant costs are included in this study.

The costs of operating an elite seed farm will be synthesized in part from cost data obtained from private

seed farms. Some of the machinery, buildings, and field operations on the Wisconsin State Farm are the same that would be found on any small seed potato farm in a similar area of Wisconsin. In order to determine the costs of a Montana elite farm, it is assumed that many of the operations are the same as that of a typical certified seed grower in Montana. An enterprise cost report for certified seed potatoes published in 1970 will be updated to provide data for this study.

Information from the Wisconsin State Farm concerning such things as machinery, buildings and operations have been obtained and are to be used as a guideline in deriving a Montana elite farm budget. Briefly, some of the special facilities and equipment to be on the elite farm are a greenhouse, laboratory facilities, and a two-row assist feed potato planter. This type of planter has long since been replaced by a picker arm type planter on nearly all commercial potato farms but it enables tuber unit planting whereas the new type does not. The greenhouse is to be used in obtaining starting material and the laboratory facilities are to be used for disease testing. In addition, equipment size adjustments will have to be made to account for the size of the farm. For example, a large

tractor may be required on a certified seed operation while a smaller tractor would be sufficient for the smaller acreage of the elite farm.

Some of the elite farms are nearly self-supporting and some are not. The Maine farm was purchased and started on a \$100,000 loan in the late 1940's. In 1965 the last payment on this loan was made and the farm has been a financial success without legislative appropriations. The Idaho State Farm, however, receives a budget of about \$70,000 from the State for salaries and some of the operating budget. The organization and support of the Montana elite farm will be discussed in Chapter IV.

The Enterprise Cost Analysis Program

The certified grower's costs of production and the elite farm's costs of production will be calculated with the help of a Farm Enterprise Cost Analysis Computer Program.¹ The

¹Copies of the program and processing information can be obtained from: Montana Cooperative Extension Service, Bozeman, Montana 59715 or Automatic Data Processing Unit, West Regional Technical Service Center, U.S.D.A. Soil Conservation Service, Room 209-701 N.S. Glisian Street, Portland, Oregon 97209.

program was developed for use in the joint data program of the Extension Service and Soil Conservation Service in Montana and is written in Fortran IV language for the IBM 1130 Computer and adapted to the Sigma 7 Computer.

The data required for the computer input consists of the five data sheets described below:

Data Sheet #1 contains background information and assumptions of the farm in general. Such things as total farm size, chemical weed and insect control, shop space, insurance rates, and the market value of the cropland are included in this data sheet.

Data Sheet #2 is the source of operations data. All mechanical operations associated with land preparation, planting, tillage, cultivation, harvesting and hauling are included here. Also included are irrigation operations, labor operations such as roguing out diseased plants, and the amount and cost of any materials used for each operation that has not been entered in Data Sheet #1. If an operation is hired done by a custom operator that cost is also entered here.

Data Sheet #3 provides a complete list of equipment used to carry out the operations shown in Data Sheet #2. Purchase prices and years of expected life are included

for each piece of machinery in order to determine ownership costs. Total hours of use, including non-cropping use of tractors and trucks, must also be computed so that ownership costs may be divided proportionately among the farm enterprises.

Data Sheets #4a and #4b are for providing information about motorized and non-motorized machinery, respectively. The data include items such as fuel price, rate of fuel consumption and repairs per year. These figures are used to compute hourly operating costs.

From this data the enterprise cost program computes per acre costs of farm crop enterprises. Costs are computed for each of the operations required for crop production and include: labor costs, materials and service costs, ownership and machinery operating costs (including interest on operating capital, miscellaneous overhead and management). These costs are computed after the basic operations table has been completed. Real estate costs may also be calculated and tabulated below operations costs to present the entire cost structure for a farm enterprise.

A supplemental tabulation of machinery data also appears in the output. This table lists the machinery used

along with the cost, annual hours of use, performance rates and per hour ownership and operating costs.

The output of this program does not take the form of a comprehensive total farm budget but is rather an enterprise cost analysis to determine costs of production for a particular crop or commodity on the farm.² It is similar to a total budget in that all economic costs are accounted for. However, only the portion of total farm costs that apply to the particular crop are used. For example, if forty percent of the total hours on a tractor are used for the crop being studied, exactly forty percent of that tractor's ownership costs are included in the costs of production for that crop.

It may appear that the program can compute the costs of growing seed potatoes quite well but that the cost of setting up an elite farm is also important to this study. The program has no provision for computing these costs. However, included in the data collected for the program is a list of depreciable assets and real estate necessary for

²For a discussion of complete farm budgets, see Quenemoen, M.E., Complete and Partial Budgets for Farm and Ranch Decisions, Bulletin 1066, Cooperative Extension Service, Montana State University, Bozeman, Jan. 1976 (Reprint).

an investment summary which will be done in the financial analysis section of Chapter IV.

The Partial Budget

The partial budget is used as a tool for accomplishing the second objective of this study. As the name implies, the partial budget involves only parts of the total budget for a farm. It has been stated that, "The partial budget is appropriate when the proposed change is marginal in the sense that the entire farm organization will not be affected."³ The partial budget is used to estimate changes in net farm income and will be used to test the profitability of the proposed elite farm from the viewpoint of certified seed growers. The grower's practice of growing their own elite seed is replaced with the practice of purchasing elite seed from the elite farm.

The partial budget is a simple procedure involving only simple addition and subtraction. However, care must be taken to determine accurate figures for each entry in the budget. The basic form of the partial budget is as follows:⁴

³Emery N. Castle, H. Manning, and Frederick J. Smith. Farm Business Management, The Macmillan Co. 1972, p. 111.

⁴Quenemoen, op. cit., p. 17.

Estimated Change in Annual Net Farm Income
from (some change in the farm plan)

1. Added Costs	3. Added Returns \$ _____
Variable \$ _____	
Prorated _____	
2. Reduced Returns _____	4. Reduced Costs \$ _____
Subtotal A \$ _____	Subtotal B _____
Estimated Change in NFI (B-A) \$ _____	

The added costs include variable and prorated costs. The variable costs could be the additional labor required to operate a new machine while the purchase price of the machine would be prorated over a number of years. The reduced returns would be the returns that are no longer to be received after the change is made. Added returns are the expected additional returns for products sold and services rendered as a result of the change under consideration. Reduced costs is the estimate of the annual costs that will no longer be incurred if the proposed change is made.

The simple arithmetic of the partial budget results in an estimated change in net farm income. If the figure is negative, the change would result in decreased net

profits and if it is positive, net profits would increase by that amount as a result of the change.

Chapter III

DATA AND RESULTS

The preceding chapters have presented an overview of seed potato production in Montana, disease problems that growers face, a description of elite seed farms, and the methodology to be used in accomplishing the objectives of this study. In this chapter the actual data used and the results of analysis are presented.

The chapter is divided into three sections: (1) a total cost budget for commercial seed potato growers; (2) a total cost budget for the proposed Montana elite seed potato farm; and (3) a commercial seed grower's partial budget to determine the effect of an elite farm on his profits.

As mentioned in Chapter II the data required for the Farm Enterprise Cost Analysis program are separated into four areas and collected on four corresponding data sheets. The four areas are: background information, operations data, equipment data, and information on motorized and non-motorized machinery for hourly cost computations.

In the following sections a description of the two respective total budgets will be presented in addition to the data used and the results of the analysis.

The Certified Seed Grower's Budget. A total budget for typical Montana seed growers in Lake County was formulated in order to obtain data for the elite farm budget. Although they are two entirely different enterprises, much of the data from the commercial growers' farms will coincide with the elite farm budget.

The certified grower's budget is actually an updated report of a cost study done in 1970.¹ The same four Lake County seed potato growers that cooperated in the 1970 study cooperated in this study. The author met with the growers (James J. Fleming, Jr., Pablo, LeRoy Lake, Ronan, Walter Mangels, Polson, and Dan Callahan, St. Ignatius) in Ronan on November 12, 1975. Also present at the meeting were G. Edward Bratton, County Extension Agent, Ronan and Orville W. McCarver, Montana State University Extension Horticulturist.

The data collection procedure was to place the data sheets on an overhead projector and have those present at the meeting discuss each successive entry until mutual

¹M.E. Griffing and W. Thacker. Enterprise Cost of Seed Potatoes, Circular 1116 Cooperative Extension Service and SCS-USDA Cooperating, Bozeman, Montana 1970.

agreement was reached on a typical figure. In some instances when it was difficult to reach agreement an average was taken. The data collected from 1970 were occasionally used as a guideline.

Data sheets #2 and #3 contain operations and machinery data and are reproduced in Tables 3-1 and 3-2. The data sheets contain information on the seed potato crop only, even though information for the other crops was obtained at the meeting as well. Machinery ownership costs are, of course, calculated for percentage of total use required for the potato crop.

The objective of the total budget study is to use the cost program to calculate per acre costs of growing seed potatoes. The resulting cost data are presented in Tables 3-3 and 3-4.

Each operation required for the production of seed potatoes is listed in chronological order. For each operation the per acre costs are calculated and include: (1) ownership and operating costs for the tractor and/or implement used in the operation. (2) labor costs; (3) materials and service costs. The subtotal for direct operating cost is \$919.47 per acre.

TABLE 3-1

CERTIFIED GROWERS OPERATIONS DATA

Operations Data

Line No.	Operations	Tractor Size	Implement Size	No. Acres Covered	No. Hours Required	Total Amount and Cost of Materials
1	Chisel/Harrow 3x	100 HP	15'	270	40	
2	Disk	100 HP	14'	90	10	
3	Plow	100 HP	5x16"	90	20	
4	Disk/Harrow/Eptam	100 HP		90	20	
5	Mulcher	100 HP		90	12	
6	Cut Potatoes			90	105	\$6.50/cwt seed
7	Plant	75 HP	2 row	90	105	Fert. 16-16-16
8	Harrow	75 HP		45	6	Ex. labor - 2 men
9	Cultivate	75 HP	2 row	90	20	
10	Hill	75 HP	2 row	90	18	
11	Irrigate 5x	75 HP		90	90	
12	Roguing 4x			90		\$25/A
13	Inspection Fees			90		\$17.50/A
14	Vine Kill Custom 2x			18		\$13.50/A Custom
15	Windrow	75 HP	2 row	45	64	Ex. labor - 1 man
16	Harvest	100 HP	2 row	45	64	Ex. labor - 3 men
17	Haul 3 trucks			90	64	Ex. labor - 3 men
18	Unload			90	64	Ex. labor - 2 men
19	Storage			90		Electricity
						\$100/mo
20	Sort and Handle			90	190	10 men

TABLE 3-2

CERTIFIED GROWERS MACHINERY DATA

Machinery Data

Machine No.	Implements ^{1/}	Size	Cost	Trade-in Value	Planned Years Of Use	Total Hours Of Use
1	Tractor	100 HP	\$20,000	\$2,000	7	400
2	Tractor	70 HP	16,000	1,600	7	650
3	Tractor, used	50 HP	2,000	200	10	100
4	Chisel	15'	2,500	250	10	40
5	Disk	14'	4,000	400	10	76
6	Moldboard Plow	5x16"	4,000	400	10	47
7	Packer		700	70	10	47
8	Mulcher		3,000	300	10	12
9	Harrow	15'	300	30	10	112
10	Planter	2 row	5,000	500	10	105
11	Potato Cutter		4,000	400	10	105
12	Cultivator	2 row	1,600	160	10	38
13	Sprayer		900	90	10	8
14	Irrigation System	3 wheel	20,000	2,000	20	2,700
15	Honda 90		650	65	5	25
16	Windrower	2 row	7,500	750	5	64
17	Potato Harvester	2 row	20,000	2,000	5	64
18	Spudnik		8,200	820	10	125
19	Potato Grader		10,000	1,000	15	125
20	Conveyor	10'	1,000	100	10	190
21	Bin Loader		11,000	1,100	10	190
22	Pickup Truck	1/2 T	6,000	600	7	350
23	Truck w/box	2 T	14,500	1,450	10	215
24	Truck w/box, used	2 T	7,000	700	7	110
25	Truck w/box, used	2 T	7,000	700	7	110

^{1/}N = new, and U = used.

TABLE 3-3

SEED POTATOES - COST PER ACRE, RONAN, MONT.

Line No.	Operations	Machine No.	Total Hours Per Acre Per Year	Tractor Owner-ship	Costs Oper-ating	Implement Owner-ship	Costs Oper-ating	Labor Costs	Material & Service Costs	Total Costs Per Acre
1	Chisel w/Harrow 3x	1,4,9	.148	1.52	.61	1.61	.56	.37	.00	4.67
2	Disk	1,5	.111	1.14	.45	.98	.12	.28	.00	2.97
3	Plow	1,6,7	.222	2.28	.91	3.71	.87	.56	.00	8.33
4	Apply Eptam/Disk/Har	1,5,9	.222	2.28	.91	2.05	.24	.56	8.00	14.04
5	Pack-Mulch	1,8	.600	6.16	2.45	10.74	.64	1.50	.00	21.49
6	Cut Potatoes	11	1.167			7.42	.56	2.92	.00	10.90
7	Plant	2,10,23	1.167	5.91	2.63	22.43	6.76	2.92	10.00	50.65
8	Seed 20cwt x 6.50		.000					.00	130.00	130.00
9	Fert 800 lb 16-16-16		.000					.00	68.00	68.00
10	Extra Labor		1.167					2.92	.00	2.92
11	Harrow	2,9	.133	.67	.30	.06	.01	.33	.00	1.37
12	Cultivate	2,12	.222	1.12	.50	1.56	.44	.56	.00	4.18
13	Hill	2,12	.200	1.01	.45	1.41	.39	.50	.00	3.76
14	Irrigate 5x	14	30.000			28.20	3.00	5.00	6.25	42.45
15	Roguing 4x		.000					.00	25.00	25.00
16	Inspection Fees		.000					.00	17.50	17.50
17	Vine-Kill Custom 2x		.000					.00	2.70	2.70
18	Windrow	2,16	1.422	7.20	3.20	43.00	8.89	3.55	.00	65.84
19	Harvest	1,17	1.422	14.60	5.82	114.67	53.32	3.55	.00	191.96
20	Extra Labor 3 men		4.266					10.66	.00	10.66
21	Haul, 2 trucks, 2 men	0,23,24	1.422	.00	.00	34.63	13.49	10.67	.00	58.79
22	Extra truck	25	1.422			18.60	7.96	3.55	.00	30.11
23	Unload-bin loader	21	1.422			13.75	1.12	3.55	.00	18.42
24	Extra labor 2 men		2.844					7.11	.00	7.11
25	Storage 5 mos.		.000					8.32	5.55	13.87
26	Sort & handle		.000					.00	.00	.00
27	Spudnik	18	1.390			15.23	1.67	3.47	.00	20.37
28	Grade	0,19,20	1.390	.00	.00	16.68	2.93	3.47	.00	23.08
29	Load on truck	21	1.390			13.44	1.10	3.47	.00	18.01

Table 3-3 (continued)

Line No.	Operations	Machine No.	Total Hours Per Acre Per Year	Tractor Owner-ship	Costs Oper-ating	Implement Owner-ship	Costs Oper-ating	Labor Costs	Material & Service Costs	Total Costs Per Acre
30	Extra Labor		13.900					34.75	.00	34.75
31	Marketing Costs		.000					.00	7.00	7.00
32	Honda	15	.063			.42	.09	.16	.00	.67
33	Pickup truck	22	.875			3.08	2.63	2.19	.00	7.90
34	Subtotals			43.89	18.23	353.67	106.79	116.89	280.00	919.47
35	Interest on operating capital (line 34 less ownership costs), 10.00 pct of 521.91 for 1/2 year									26.10
36	Miscellaneous Overhead, 5 pct of line 34									45.97
37	Management, 10 pct of gross return per acre (1125.00)									112.50
38	Total Operation Costs									\$1104.04

REAL ESTATE COSTS PER ACRE

Line No.	Item	Market Value (Dollars)	Depreciation (PCT)	(Dollars)	Interest (PCT)	(Dollars)	Taxes (Dollars)	Water (Dollars)	Insurance (Dollars)	Total Costs Per Acre (Dollars)
39	Land	1000.00			9.0	90.00	4.00	5.25		99.25
40	Buildings	620.00	3.0	18.60	9.0	55.80	3.00		2.50	79.90
41	Subtotals	1620.00		18.60		145.80	7.00	5.25	2.50	179.15
42	Total Cost Per Acre									\$1283.19

NOTE:

Labor wage rate 2.50/hr. Irrigation labor 5.00/acre; Insect Control, Disiston at planting time, 10.00/acre; Gross Return per acre, 250 cwt x 4.50/cwt; Overhead includes tools, dues, social security, etc.; Real Estate costs include opportunity and ownership costs for capital invested in real estate; Insurance includes fire, extended coverage and liability; Marketing costs include growers' conventions, travel costs, etc.; Salvage value is ten per cent of cost.

TABLE 3-4

MACHINERY DATA-SEED POTATOES, RONAN, MONT.

Machine No.	Machine	Size	Cost	Annual Use (Hrs)	Performance Rate (Hr/)	Ownership Cost/Hr	Operating Cost/Hr
1	Tractor, D	100 HP	20000.	400.	--	10.27	4.09
2	Tractor, D	75 HP	16000.	650.	--	5.06	2.25
3	Tractor (used)	50 HP	2000.	100.	--	3.34	2.91
4	Chisel	15 ft	2500.	40.	.148	10.44	3.75
5	Disk	14 ft	4000.	76.	.181	8.79	1.05
6	Moldboard Plow	5-16	4000.	47.	.224	14.22	3.83
7	Plow Packer		700.	47.	.224	2.49	.11
8	Packer-Mulcher		3000.	28.	.133	17.90	1.07
9	Harrow	15 ft	300.	112.	.174	.45	.04
10	Planter	2 row	5000.	105.	1.167	7.95	1.90
11	Potato Cutter		4000.	105.	1.167	6.36	.48
12	Cultivator	2 row	1600.	38.	.211	7.03	1.97
13	Sprayer		900.	8.	.100	18.79	6.25
14	Irr. Syst-Wheel Move	3 wheel	20000.	2700.	30.000	.94	.10
15	Honda 90		650.	25.	.062	6.71	1.36
16	Windrower	2 row	7500.	64.	1.422	30.24	6.25
17	Harvester	2 row	20000.	64.	1.422	80.64	37.50
18	Spudnik		8200.	125.	1.389	10.96	1.20
19	Potato Grader		10000.	125.	1.389	11.12	2.00
20	Conveyor	10 ft	1000.	190.	2.111	.88	.11
21	Bin Loader		11000.	190.	2.111	9.67	.79
22	Pickup Truck	1/2 T	6000.	350.	.875	3.52	3.01
23	Truck	2 T	14500.	215.	.537	11.27	3.89
24	Truck, used	2 T	7000.	110.	.275	13.08	5.60
25	Truck, used	2 T	7000.	110.	.000	13.08	5.60

NOTE: Fuel and Oil costs - diesel 0.36/Gal; Gas 0.549/Gal, Oil 3.00/Gal; Irr Hrs. shown represent pump-hrs.

In addition to direct operating cost, total operations cost includes: interest on operating capital, miscellaneous overhead and management. These additions result in a total operations cost of \$1104.04 per acre.

When all economic costs (e.g., real estate costs) are included, the total cost of production is \$1283.19 per acre. The expected gross revenue is \$1125 (250 cwt x \$4.50/cwt) which covers operating cost but not the total cost per acre when real estate costs are included.² It is interesting to note that in the 1970 cost study the gross revenue did not even cover the total operating cost but in this study those costs were more than covered.

The purpose of this cost study was to determine certain machinery, operations and performance data which can be used in the elite seed farm budget.

The Elite Farm Budget

In this section the Montana elite seed potato farm is synthesized and the operating budget calculated. The commercial seed growers enterprise is used as a starting

²This revenue estimate is based on an average yield of 250 cwt. Given the input levels used in budgeting the costs one would expect a higher yield. Thus, this is a conservative revenue estimate.

base with changes made to suit the elite farm characteristics described in Chapter II.

The proposed elite farm grows about 40 acres of elite seed per year while the commercial farm grows 90 acres of potatoes. The elite farm therefore may use smaller equipment such as was used in the commercial farm study of five years ago. The 1970 study is used in the elite farm budget formulation for such things as tractor size and hours of operating time per acre.

It is important to note that some machinery cost figures were not obtained directly from any one source. For example, a four-bottom plow was used in both the 1970 study and the elite budget. The cost of such a plow was doubled for this study since a comparison of 1975 equipment to 1970 equipment shows that most costs did indeed double.

Specific changes made for the elite farm on data sheet #1 are:

- (1) total farm size 160 acres, 40 acres elite seed potatoes;
- (5) potato crop yield - 200 cwt/acre;
- (6) normal prices - \$11.80/cwt;
- (7) seeding rate - 15 cwt/A, \$10.00/cwt;

(9) chemical insect control,

Monitor supplement in summer (3 times) chemical
cost \$17/A/application;

(13) grain storage - 2,000 bu; and

(17) insurance \$600/year.

The total farm size was discussed in Chapter II.

Crop yield was reduced from 250 cwt/A to 200 cwt/A for several reasons. The elite farm maintains wider spaces between plants because of tuber unit planting, rogues more intensively thus destroying plants which might ordinarily be left to grow, and maintains alley ways in the field so that the ground sprayer doesn't touch any of the plants.

Determination of the normal selling price of elite seed will be discussed in Chapter IV. To avoid a problem of circularity, the price of the seed planted is a surrogate estimate for the costs of producing this seed on the farm. The seeding rate was reduced because the potato plants must be less dense as discussed above.

A supplemental summer insect control program was incorporated into the elite enterprise. This is more of a precautionary measure than a necessity. Three spray applications per summer was a figure recommended by Orville

McCarver. The remaining changes on data sheet #1 were the result of the decrease in farm size.

Data sheets #2 and 3 are presented in Tables 3-5 and 3-6. Data sheets #1, #4a and #4b which involve background information and machinery operating costs are not included. The major changes in operations and machinery are pointed out and discussed below.

The machinery data were compiled from a list of machinery that is used on the Wisconsin elite seed potato farm. This list as well as other information for this study was obtained in a visit to the Wisconsin farm in September, 1975. Dr. Henry Darling, professor in the Department of Plant Pathology at the University of Wisconsin, donated a day of his time in helping the author collect the data.

Dr. Darling suggested that two medium sized tractors would suffice for a farm of this size so tractors of 75 HP and 50 HP appear on the list. Since the field operations used in Montana must be retained in the enterprise, some machinery that isn't present on the Wisconsin farm is included in this list. Two examples of this are the chisel and the harrow.

TABLE 3-5

ELITE FARM OPERATIONS DATA

Line No.	Operations	Tractor Size	Implement Size	No. Acres Covered	No. Hours Required	Total Amount and Cost of Materials
1	Chisel/Harrow 3x	75 HP	12'	120	30	
2	Disk	75 HP	12'	40	8	
3	Plow	75 HP	12'	40	30	
4	Disk/Harrow/Eptam	75 HP	12'	40	12	Eptam \$8.00
5	Mulcher	75 HP		40	6	
6	Cut Potatoes			40	80	Extra labor 3 men
7	Plant	75 HP	2 row	40	80	Seed \$10, fer. 16-16-16, 3 men
8	Harrow	50 HP	15'	20	6	
9	Cultivate	50 HP	2 row	40	15	
10	Hill	50 HP	2 row	40	12	
11	Disinfect equip & whse					\$50
12	Irrigate 5x			40	40	
13	Roguing			40	100	
14	Spray for insects 3x	50 HP	16 row	120	12	\$17/A x 3 = \$51/A
15	Vine kill			8		\$13.50/A custom
16	Harvest	75 HP	2 row	40	60	Extra labor 4 men
17	Haul			40	60	
18	Unload			40	60	
19	Storage			40		\$80/mo electricity
20	Sort & Handle			40	120	Extra labor 1 man bags, tags, etc. 40¢ x 200 = \$80

TABLE 3-6

ELITE FARM MACHINERY DATA

Machine No.	Implements	Size	Cost	Trade-in Value	Planned Years Of Use	Total Hours Of Use
1	Tractor	75 HP	16000	1600	7	350
2	Tractor, used	50 HP	2000	200	10	150
3	Chisel	12'	2400	240	10	30
4	Disk	12'	3500	350	10	44
5	Plow	4xl6	3000	300	10	66
6	Packer		700	70	10	66
7	Mulcher		300	300	10	24
8	Harrow	15'	300	30	10	84
9	Planter (assist feed)	2 row	5000	500	10	80
10	Cultivator	2 row	1600	160	10	27
11	Sprayer	16 row	2000	200	10	20
12	Irr. System		15000	1500	20	1200
13	Harvester	2 row	20000	2000	10	60
14	Spudnik		8200	820	10	120
15	Grader		10000	1000	10	120
16	Conveyors (2)	10'	2000	200	10	180
17	Scales		350	35	10	120
18	Car loader		350	35	10	120
19	Sack piler		900	90	10	120
20	Bin loader		10000	1100	10	180
21	1 1/2 T truck w/box, used	1 1/2 T	5500	550	7	140
22	1 1/2 T truck w/box, used	1 1/2 T	5500	550	7	60
23	Pickup truck	1/2 T	6000	600	7	300

The windrower was omitted from this list because it is not used on the Wisconsin farm and also because of the small acreage involved. Other than fewer and smaller trucks the remainder of the machinery is the same that was necessary for the sorting and handling operation in 1970. Commercial seed growers are currently shipping their potatoes in 100 lb. burlap sacks. Since the state elite seed farm would sell its seed in small lots, the packaging equipment is necessary. Estimates for 1975 packaging equipment ownership costs were obtained from the growers at Ronan.

For the operations data of the elite farm, most of the 1975 commercial seed grower's data were used. However, the tractor and implement size in most cases is smaller. Since tractor and implement sizes were decreased, hours of operating time per acre must be changed also. Some of the hour figures were taken from the 1970 study and some were estimated.

One of the major differences in the elite farm is the cutting and planting operation. The seed tubers are cut by hand rather than by a seed cutting machine. Each tuber is cut in four sections, but not all the way through. The four sections must remain together until planting.

The man riding the planter breaks the tubers into four pieces and drops them into consecutive holes in the machine. By leaving the fifth hole empty the crop is planted in tuber units. This operation is obviously more time consuming than the conventional method of planting. Dr. Darling states that five to six acres may be planted per day by this method. Therefore, with a ten to twelve hour day, two hours is required to plant one acre of potatoes.

The roguing cost was arbitrarily increased from \$25.00 to \$35.00 because the elite farm should ostensibly practice more intensive roguing. Spraying for insects is another cost that the elite farm must bear to be extra cautious about disease.

The cost calculations for the elite farm are presented in Table 3-7. Some adjustments are necessary to complete cost determination. Line 35 which represents the management cost is eliminated since there is no private entrepreneur in this case. However, there are some additional costs that don't appear in the program that must be added in. These costs are: one full-time foreman at \$13,000/year; one-fourth-time supervisor at \$6,000/year; and \$1,000 travel expenses. These figures were arrived at during a discussion with Orville McCarver. Dividing this

TABLE 3-7

ELITE SEED POTATO FARM-COSTS PER ACRE

Line No.	Operations	Machine No.	Total Hours Per Acre Per Year	Tractor Owner-ship	Costs Oper-ating	Implement Owner-ship	Costs Oper-ating	Labor & Service Costs	Material & Service Costs	Total Costs Per Acre
1	Chisel w/Harrow 3x	1,3,8	.250	2.35	.81	3.35	1.26	.62	.00	8.39
2	Disk	1,4	.200	1.88	.65	2.66	.36	.50	.00	6.05
3	Plow	1,5,6	.750	7.04	2.44	7.02	1.76	1.87	.00	30.13
4	Apply Eptam/Disk/Har	1,4,8	.300	2.82	.98	4.17	.56	.75	8.00	17.28
5	Pack-Mulch	1,7	.150	1.41	.49	3.13	.19	.37	.00	5.59
6	Cut Potatoes, 3 men		2.000					20.00	.00	20.00
7	Plant	1,9,21	2.000	18.78	6.50	37.02	14.10	5.00	10.00	91.40
8	Seed 18 cwt x 10.00		.000					.00	144.00	180.00
9	Fert 800 lb 16-16-16		.000					.00	68.00	68.00
10	Extra Labor, 3 men		.000					15.00	.00	15.00
11	Harrow	2,8	.300	.67	.64	.18	.02	.75	.00	2.26
12	Cultivate	2,10	.375	.84	.79	3.71	1.04	.94	.00	7.32
13	Hill	2,10	.333	.74	.71	3.30	.93	.83	.00	6.51
14	Irrigate 5x	12	30.000			47.40	4.50	5.00	6.25	63.15
15	Disinfect equip & whse		.000					.00	1.25	1.25
16	Roguing		.000					.00	35.00	35.00
17	Spray for insects 3x	2,11	.100	.22	.21	1.67	.25	.25	51.00	53.60
18	Vine kill 2x		.00					.00	2.70	2.70
19	Harvest	1,13,21	1.500	14.08	4.87	95.62	56.82	3.75	.00	175.14
20	Extra Truck	22	1.500			28.26	10.45	3.75	.00	42.46
21	Unload	0,16,20	1.500	.00	.00	18.10	1.57	3.75	.00	23.42
22	Extra Labor 4 men		.000					15.00	.00	15.00
23	Storage (5 mos.)		.000					.00	5.55	5.55
24	Sort and Handle		.000					.00	.00	.00
25	Spuđnik	14	3.000			34.23	3.75	7.50	.00	45.48
26	Grade, bag, tag	19	3.000			3.75	.99	7.50	80.00	92.24
27	Weigh	17	3.000			1.47	.00	7.50	.00	8.97
28	Pile Sacks	19	3.000			3.75	.99	7.50	.00	12.94

Table 3-7 (continued)

Line No.	Operations	Machine No.	Total Hours Per Acre Per Year	Tractor Owner-ship	Costs Oper-ating	Implement Owner-ship	Costs Oper-ating	Labor Costs	Material & Service Costs	Total Costs Per Acre
29	Extra labor, 1 man		.000					7.50	.00	7.50
30	Load on trucks	16	1.250			2.32	.27	3.12	.00	5.71
31	Pickup truck	23	.900			3.70	2.87	2.25	.00	8.82
32	Subtotals			50.83	19.09	304.81	102.68	121.00	460.50	1046.16
33	Interest on operating capital. (Line 32 less ownership costs), 10.00 pct of 703.27 for 1/2 year									35.16
34	Miscellaneous Overhead, 5 pct of line 32									52.95
35	Total Operation Costs									\$1134.27

REAL ESTATE COSTS PER ACRE

Line No.	Item	Market Value (Dollars)	Depreciation (Pct)	(Dollars)	Interest (Pct)	(Dollars)	Taxes (Dollars)	Water (Dollars)	Insurance (Dollars)	Total Costs Per Acre (Dollars)
37	Land	1000.00			9.0	90.00	4.00	5.25		99.25
38	Buildings	1139.00	3.0	34.17	9.0	102.51	3.00		2.50	142.18
39	Subtotals	2139.00		34.17		192.51	7.00	5.25	2.50	241.43
40	Total Cost Per Acre									\$1375.70

NOTE: Labor wage rate 2.50/hr. Irr labor 5.00/hr.; Insect control, Disiston at Planting 10/acre. Monitor in summer 3x 17/acre per application; Overhead includes tools, dues, social security, etc.; Real estate costs include opportunity and ownership costs for capital invested in real estate; Insurance includes fire, extended coverage, and liability; Salvage value is ten per cent of cost.

\$20,000 by 40 acres, the cost is \$500.00 per year. With this addition the total cost per acre is \$1875.70. In order to determine the cost per hundredweight of salable elite seed potatoes the total cost (\$1875.70) is divided by the yield of salable elite seed tubers (200 cwt/A) to give a cost per hundredweight of \$9.38. This cost, however, will be modified in Chapter IV for the cost of capital required for the initial investment.

The elite farm machinery data are presented in Table 3-8.

The Partial Budget

The simple arithmetic of the partial budget is used in this section to determine what effect the elite seed farm would have on the profits of the typical commercial seed grower. The format of the budget was described in Chapter II. The budget appears in Table 3-9 and is simply a tabulation of the monetary changes in the seed grower's operation.

The price that growers would receive for their certified seed potatoes was increased by \$0.50. An agreement on this price increase was reached in discussion with Orville McCarver, MSU Extension Horticulturist. It was

TABLE 3-8

MACHINERY DATA-ELITE SEED POTATO FARM

Machine No.	Machine	Size	Cost	Annual Use (Hrs)	Performance Rate (Hr/A)	Ownership Cost/Hr	Operating Cost/Hr
1	Tractor, D	75 HP	16000.	350.	--	9.39	3.25
2	Tractor, Used	50 HP	2000.	150.	--	2.23	2.12
3	Chisel	12'	2300.	30.	.250	12.81	5.00
4	Disk	12'	3500.	44.	.157	13.29	1.82
5	Moldboard Plow	4-16	3000.	66.	.412	7.59	2.27
6	Plow Packer		700.	66.	.412	1.77	.08
7	Pack-Mulcher		3000.	24.	.150	20.88	1.25
8	Harrow	15'	300.	84.	.233	.60	.06
9	Planter, Assist Feed		5000.	80.	2.000	10.44	2.50
10	Cultivator	2 row	1600.	27.	.337	9.90	2.78
11	Sprayer	16 row	2000.	20.	.100	16.70	2.50
12	Irr. System		15000.	1200.	30.000	1.58	.15
13	Harvestor	2 row	20000.	60.	1.500	55.68	33.33
14	Spudnik		8200.	120.	3.000	11.41	1.25
15	Grader		10000.	120.	3.000	13.92	2.08
16	Conveyors (2)		2000.	180.	4.500	1.86	.22
17	Scales		350.	120.	3.000	.49	.00
18	Car Loader		350.	120.	3.000	.49	.17
19	Sack Piler		900.	120.	3.000	1.25	.33
20	Bin Loader		11000.	180.	4.500	10.21	.83
21	Truck, Used	1 1/2 T	5500.	140.	.000	8.07	4.55
22	Truck, Used	1 1/2 T	5500.	60.	.375	18.84	6.97
23	Pickup truck		6000.	300.	1.875	4.11	3.19

Note: Fuel and oil costs - diesel 0.36/Gal.; Gas 0.549/Gal. oil 3.00/Gal.; Irr hrs shown represent pump-hrs.

TABLE 3-9

PARTIAL BUDGET

Certified Seed Growers Currently Selling Non-PVX Free Seed

Estimated change in net farm income from having an Elite Seed Farm.

1. Additional Receipts

Change in revenue from seed potatoes sold
 250 cw/A @ \$5.00/cwt rather than \$4.50/cwt. Thus,
 90 A x 250 cwt/A x \$0.50/A \$11,250.00

2. Reduced Costs

The expense of growing a .56 acre elite seed plot

harvest labor	\$336.00	
bags	336.00	
indexing fees	362.40	
normal operating cost	283.24	1,317.64

3. Subtotal \$12,567.64

4. Additional Costs

Cost of buying elite seed for 6 acre foundation plot

15 cwt/A x 6 A x \$11.80	1,062.00
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5. Reduced receipts

none

6. Subtotal 1,062.00

7. Estimated change in net farm income

(subtotal 3 - subtotal 6)	\$11,505.64
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assumed that the elite seed farm would produce seed that was completely free of PVX. It was further assumed that as a result of this PVX-free elite seed provided by the farm, all seed growers in Montana would be able to produce and sell certified PVX-free seed. The grower in the budget is one who previously could not produce PVX-free seed.

According to Mr. McCarver, Montana certified PVX-free seed sells for a price premium of between one-half dollar and one dollar. A price elasticity of demand study was not done but it is assumed that the demand for certified PVX-free seed is fairly elastic because of the excess demand from the state of Washington. Nevertheless, with an increased supply of Montana certified PVX-free seed, *ceterus parabus*, its price may decline somewhat. Hence, the lower bound of the price range quoted by McCarver was used.

This partial budget was designed for the typical commercial seed grower although there is probably not a single operation in Montana exactly like it. This typical operation grows and sells 90 acres of certified seed each year and is exactly the same as the operation in the initial total budget except for its source of seed. Since there is not an elite farm from which to purchase elite

seed this typical grower chooses to grow his own seed source. This source is derived from an elite seed plot and a foundation seed plot maintained by the grower each year.

Using the estimate that the tubers from one acre of seed potatoes will plant fifteen acres of potatoes in the following year the size of each seed plot may be determined. A foundation seed plot of six acres would therefore produce the amount of seed required to plant 90 acres. However, accounting for wider spacing, intensive roguing and greenhouse rejection, an elite seed plot of .56 acres is necessary to provide seed to plant the foundation field.

The cost of maintaining this elite seed plot is the next item in the partial budget. It is entered under Reduced Costs because that enterprise will no longer be necessary when the grower purchases elite seed from the elite farm. The foundation field remains unchanged because in either situation the grower increases his seed source before planting the certified fields.

The harvest operation for the elite plot consists of digging each hill of potatoes by hand keeping the tubers from each hill in a separate bag. It was estimated by Mr. McCarver and verified by Walter Mangles, a Lake County seed potato grower that two men working together can

harvest about 50 hills of potatoes per hour. In a one acre plot of elite seed there are approximately 6000 hills of potatoes. To harvest one acre would require 240 man-hours. At the wage rate of \$2.50/hour the harvest labor cost is \$600.00 and for .56 acres it is \$336.00. The cost of bags for the hand digging operation is estimated at 10¢ apiece or \$336.00 for .56 acres.

Currently, to qualify for the Montana Elite I seed class each plant must be indexed and tested for disease. In the summer this consists of collecting a leaf sample from each plant which is then tested for PVX. The fee for this test is 3¢ per leaf. Then to detect other disease symptoms or weakness one small tuber from each hill is grown in a MSU greenhouse during the winter. The growers use the results to determine which potatoes are to be replanted and which are not. The fee for this test is 6¢ per tuber. A southern indexing fee is also included. The test is not mandatory but many growers choose to have a sample of 400 tubers sent to California to be grown and checked for disease during the winter. The cost per tuber varies each year depending upon operating costs. In 1976 this fee was set at 15¢ per tuber plus a small shipping

charge. The total indexing fee for the .56 acre plot is \$362.40.

It is assumed that the remainder of the operating costs (e.g., disking, plowing, irrigating) are the same as the costs of growing certified seed potatoes. The total budget for the commercial seed grower is modified to estimate these costs. Some of the modifications are; the roguing must be more intensive so the costs of roguing are doubled; the harvesting costs are omitted; and the loading costs are omitted. The resulting per acre costs are \$505.78. For the .56 acre plot this cost is \$283.24.

Thus, the costs of growing Elite I seed is estimated to be \$1317.64 for .56 acres. Dividing by the yield of usable elite tubers will give the costs of producing the seed. Mr. McCarver estimates that as a result of the indexing tests, an average of 20 percent of all elite tubers must be discarded. Thus reducing the yield by 20 percent a cost of \$14.71/cwt is estimated for the .56 acre plot.

Since elite seed is very rarely sold, no organized market exists. Elite seed prices are nebulous but Mr. McCarver states that \$25.00/cwt for Elite I seed is a good estimate. Although the costs of production figure is \$10.29 below that it does not necessarily mean that the

cost estimate is too low. Apparently those growers who sell elite seed are able to exercise some market power. When a grower needs to buy some elite seed he often needs it desperately (e.g., his stocks have become too infected to replant) if he is to continue in the seed business. In addition, the supply is very limited both in terms of quantity and the number of suppliers. As a result, sellers of elite seed are able to charge this and perhaps even a higher price.

The cost of purchasing elite seed from the elite farm is entered in line 4. The cost of this seed is \$11.80/cwt which is well above the costs of production of \$9.38/cwt calculated in the elite farm budget section. The higher price is used to recover the capital costs of setting up the farm. A detailed discussion of this appears in Chapter IV.

There is a significant difference in the cost of producing elite seed on commercial farms as compared to the elite farm. One reason for this is that the potatoes are not harvested by hand on the elite farm. This is because the rigorous indexing routine that must be paid by private growers is not necessary on the elite farm. As mentioned previously, the seed on the elite farm is

increased directly from meristem cuttings resulting in disease free tubers. The cost of this operation has been included in the foreman's and the supervisor's salaries in the elite budget. The elite farm may also choose to do some indexing and testing; however, it is assumed that these costs are also included in the salaries.

The commercial growers do not use meristem cuttings. They must index their elite stocks to eliminate those tubers that are infected with disease. The cost of doing this represents a substantial proportion of the total costs of production. By dividing the yield of the .56 acre plot into the indexing fees, a cost of \$4.04/cwt is calculated. This indexing cost represents more than 34 percent of the total costs of production.

The entry for Reduced Receipts in line 5 is 0. This partial budget is for the farmer whose operation doesn't include selling elite seed potatoes. There are, however, some growers that do sell elite seed who would have an entry in the Reduced Receipts section. This problem is discussed further in Chapter IV.

The partial budget for this model grower indicates that his net farm income would increase by more than \$11,000 per year if an elite farm were built. This is

because the additional revenue he would gain from selling PVX-free seed together with the reduced cost of growing an elite plot outweigh the increased costs of buying elite seed from the elite farm.

There is another type of grower that must also be mentioned. This grower's budget is the same as the typical grower's except that his seed currently qualifies as PVX-free. In a partial budget for him there would be no entry in Additional Receipts. The only two entries would be the total Reduced Costs of \$1317.64 and the additional costs of \$1062.00. Thus, even for this type of grower the elite farm could increase his net farm income by \$255.64.

It should be mentioned that transportation costs have not been included in the cost of elite seed for the partial budget. This would be a variable whose value depends on the buyer's distance from the elite farm. Presumably the elite farm would be located in Western Montana or in some other part of the state that is not extremely distant to the seed growers. Therefore, it is assumed that the price of the elite seed including the transportation costs is also substantially less than the private grower's cost of production.

With such a large increase in net farm income available through an elite farm, the reader may wonder why growers haven't taken advantage of the situation. One can only speculate as to the reasons why there is presently no elite farm in Montana. The major proportion of the increase in net farm income is attributed to the price premium for PVX-free seed. Growers, in fact, are aware of this premium and many of them attempt to produce PVX-free seed under the current indexing program. A very few growers are successful and may not be interested in an elite farm because of the low expected benefits to them. Those that are unsuccessful may not be knowledgeable enough about potato diseases to build an elite farm. In addition under the inherent risks of potato production growers may be reluctant to search for isolated land suitable for an elite farm, to attempt to hire a competent plant pathologist, and to purchase the necessary buildings and equipment. Also whereas an elite farm producing for many growers may be feasible, one producing for only a few growers may not be. It is not the elite farm itself, but rather the individual farms that would purchase the PVX-free elite seed, that is so profitable. The value of information seems to be an important factor in this.

situation. Many of the growers themselves don't understand PVX and don't realize that an elite farm could control the disease. Persons with money to invest in an elite farm who are outsiders to the potato industry may have never heard of PVX and are almost certainly not aware of the possible profits to be made in the traditionally risky potato business.

Chapter IV

ANALYSIS AND CONCLUSIONS

In this chapter further economic analysis is used to explore the feasibility of an elite seed farm. Thus far, the costs of growing elite seed potatoes on an elite farm and the effect of such a farm on grower returns have been estimated. Additional areas to be analyzed in this chapter are: economic efficiency and alternative means of organizing and financing an elite farm.

Economic Efficiency

An economist cannot legitimately make public policy recommendations unless he can say that one policy is better for the welfare of society than another policy. There have been several criteria proposed to test whether a change in policy is an improvement. Vilfredo Pareto in his 1909 book, Manual D'Economie Politique, put forth what is perhaps the best known criterion, now commonly known as Pareto-optimality. An often-stated interpretation is,¹ "An allocation is Pareto-optimal if production and distribution cannot be reorganized to increase the utility of one or more individuals without decreasing the

¹James M. Henderson and Richard E. Quandt. Micro-economic Theory: A Mathematical Approach, McGraw-Hill, Inc., 1971, p. 255.

utility of others." Therefore, a policy which benefits some people and harms others is not within the scope of the Pareto criterion.

The elite seed farm would obviously benefit some people as evidenced by the partial budget in Chapter III. However, there are certain growers that may be harmed. Not all growers are the same as the typical one used for the partial budget. There may be some seed potato growers that grow more elite seed than they themselves plant. Thus they have additional seed to sell to others who may not grow all that they want to plant or may not grow any elite seed at all. According to Orville McCarver elite seed may command a price of \$25/cwt which is well above the costs of production. Organizing a single elite farm may prevent individuals from selling elite seed. Thus, such a change is likely to result in net losses for some individuals. Because of these losses the Pareto criterion must be replaced by a less restrictive criterion for analyzing welfare changes.

Another criterion, formulated by Nicholas Kaldor, states that, "a change is an improvement if the people who gain from the change evaluate their gains at a higher dollar

figure that the losers attach to their losses."² A drawback of this criterion is that all things of value cannot easily be measured in terms of monetary units. However, the Kaldor criterion can be applied to the analysis of this study.

In order to analyze the elite farm situation under this criterion, elite seed currently grown by individuals is divided into two subsets; elite seed that is replanted by the grower; and elite seed that is sold to other growers. The gainers and losers can easily be identified in this dichotomized market.

First of all those growers who grow and plant their own elite seed would benefit by obtaining elite seed at a lesser cost. In Chapter III it was estimated that the costs to the grower of producing elite seed is \$14.71/cwt. The target price (to be explained later in this chapter) of elite seed from the elite farm is \$11.80. Thus, this type of grower would gain \$2.91 on each hundredweight of elite seed that he buys.

²Edwin Mansfield. Microeconomics, Theory and Applications, W.W. Norton & Co., Inc., 1970, p. 434.

Similarly those growers who upon rare occasions must purchase their elite seed are also gainers. Assuming that they pay \$25.00/cwt now and could buy from the elite farm for \$11.80 they stand to gain \$13.20/cwt.

The possible losers are those growers who currently sell elite seed. They would lose the amount of profit that they make on this elite seed. Subtracting the costs of production, \$14.71/cwt, from the sale price, \$25.00, results in a profit of \$10.29/cwt that would be lost. However, the 1975 Montana Certified Seed Potato Directory lists no growers who grow only Elite I or Nuclear seed (the first generations in PVX and non-PVX genealogical seed increase schemes, respectively, and referred to in this study simply as elite seed). This means that if a grower sells elite seed he also uses some of it himself. Thus, just as other growers, he stands to gain \$2.91 per each hundredweight of elite seed that he uses. Thus, one would have to be selling over 28 percent of his elite seed production to be classified as a net loser. It is extremely doubtful that such is the practice of any grower.

Thus, if the net result accruing to the two types of growers indicates a net gain that is all that is necessary to support the policy as an improvement. The losses of

growers who lose \$10.29/cwt are more than offset by the buyers who gain \$13.20 on each of these units. In addition the losses are most likely offset by the elite seed that the growers use themselves. Thus, the elite farm is an improvement according to the Kaldor criterion.

Even without the Kaldor analysis, it is apparent that the elite farm would benefit society in general as well as seed potato growers in particular. With the elite farm a product superior to the one it replaces is produced. In addition it costs less or takes a lesser amount of resources to produce it. Not only would the buyers of elite seed experience gains in profit but capital, labor, and management resources would be released to produce other goods.

Financing the Elite Farm

The next problem in this study is to investigate means by which the cost of setting up an elite farm may be financed. First, the total cash requirements for starting the farm must be calculated. As mentioned previously, the approximate farm size should be a quarter section. The price of an acre of irrigated potato land is estimated to be \$1000. Thus, the outlay for land alone is \$160,000.

The building expenditures would be as follows: potato storage - \$25,000; greenhouse - \$12,000; machine storage and shop space - \$17,500. The total cost of buildings is \$54,500. The potato machinery requirements were listed previously and sum to \$124,300. It assumed that non-potato equipment is paid for by the other crops in the rotation. However, the potato enterprise pays for the entire land cost.

The total required initial investment is the sum of these three figures, \$338,800. It should be noted that this is quite probably the maximum figure in 1975 dollars. It may be that the land could be donated to the farm by the state or that the land may be cheaper because of the necessary isolation.

Moreover, some of the necessary buildings may already be present on the farm or some of the required machinery may be leased or purchased as used equipment rather than new.

The exact capital requirements can not be known at this time so the high estimate of \$338.800 is used. It is

assumed that the farm will be self-supporting and the costs of the loan must be paid.

A sort of tax on the price of elite seed will be used to recover the capital costs. The idea is to charge enough for elite seed to cover operating costs and to pay the investment cost over a number of years. The price of elite seed, in this analysis, is flexible. The price is to be a mean target price and may vary to allow for year to year variations in elite farm volume of sales and general potato market conditions.

A brief overview of the capital budgeting-amortization framework is presented for this analysis. The present value of a stream of income for a discrete time flow can be shown as

$$P.V. = \frac{a_1}{(1+i)} + \frac{a_2}{(1+i)^2} + \dots + \frac{a_n}{(1+i)^n}$$

where:

P.V. = the present value

a_1 = the income accumulated at the end of time period one

a_2 = the income accumulated at the end of time period two

•
•
•

a_n = the income accumulated at the end of time period n

n = the total number of time periods

i = the rate of interest

Simplifying:

$$PV = \sum_{t=1}^n \frac{a_t}{(1+i)^t}$$

where t is the time period and a_t is the income accumulated at the end of that time period.

Now suppose that $a_t = a$ for each time period $t = 1, 2, \dots, n$ (i.e., a is constant). The equation then may be solved for ' a ' to obtain

$$a = \frac{i (1+i)^n}{(1+i)^n - 1} PV$$

The amortized payment per period " a " is a combination of interest and principal repayment. Since it is constant across all periods the interest payment is high in early years and low in later years. The principal payment, of course, varies inversely with the interest payment.

Amortization tables have been constructed for the amortization factors, $\frac{i (1+i)^n}{(1+i)^n - 1}$, for a wide range of

interest rates, i , and time periods, n . The amortization framework is designed to answer the question, "What is the future series of end-of-period payments that will just recover a present sum [PV] over n periods with compound interest i ?"³

In application to this study the present value is the loan requirement necessary to build the elite seed farm. The end-of-period payments are what is required per year to pay back the amortized loan. This payment must be substituted for the interest on investment figures in the elite farm budget.

In the budget costs of tractors and machinery include such things as depreciation, taxes, and recovering the cost of investment. The amortization calculations have been done by the computer program for all the machinery and are thus included in the costs of production.

The years of life for each machine was used as the payback period. No such payback was input into the program for buildings and land so amortization calculations were not done for real estate.

³George A. Taylor. Managerial and Engineering Economy, D. Van Nostrand Co., Inc., Princeton, New Jersey, 1968, p. 26.

There is a problem in deciding the length of time to recover the costs of investment. If the period is too short, seed growers may balk at the high price of elite seed. On the other hand, there may be problems in obtaining a loan for an excessively long period. After a certain amount of such speculation, the period of 30 years was chosen as the payback period for land and buildings.

During the first two growing seasons, the farm may not make any potato sales because of the genealogical increase scheme. Due to the small potato acreage on the farm for the first two seasons, larger acreages of other crops are planted. It is assumed that with the potato enterprise paying the land costs in the future, the other crops will return enough to pay the initial potato plot costs. The farm is purchased during the spring and potato revenue is not collected until three years later. Thus, interest accrues for three years before any loan payments are made. The initial loan requirement of \$214,500 is increased to \$277,777.50. Amortizing this loan at nine per cent interest for thirty years results in a yearly payment requirement of \$27,038.86 or \$675.97 per acre for each of the 40 acres of elite seed. By adding this to the elite farm budget and subtracting the real estate interest of

\$192.51 initially included in the budget, a total cost of \$2359.16 per acre is derived. The per hundredweight cost is \$11.80.

Thus, \$11.80 is the target price if the farm is to be completely self-supporting. The price should be allowed to vary somewhat from year to year depending on such factors as yield but for the given assumptions this price will pay back the loan.

It may be that the land required for the elite farm need not be purchased. The Idaho elite seed farm, for example, is located on state land that was obtained on a 99 year lease free of charge. If the state of Montana has some land that it would provide free of charge the target price would be reduced substantially. This target price could be even less if some buildings or machinery could be obtained in a like manner. While donated land or equipment would influence the feasibility of the farm it would not affect economic efficiency.

Such a contribution need not imply that the state have ownership or absolute control over the farm. The state may, of course, be reluctant to contribute if it doesn't have control but that is a question to throw into

the political arena. The social welfare implications of the previous section may help in making this decision.

Organization of the Elite Farm

It has been shown that an elite seed farm would be an economically feasible operation. However, nothing has been said about the organization of the farm. Although existing elite farms are similar in organization there are many possible forms.

Official elite seed potato farms are owned and operated by the University of Idaho in Idaho, by Cornell University in New York, by the University of Wisconsin in Wisconsin, and by the State Department of Agriculture in Maine. All four of these state farms are funded in part by seed sales and in part by state funds administered by the state university. The percent of operational costs covered by seed sales ranges from 65 percent for New York to 95 percent for Maine.⁴

The organization of an elite farm in Montana need not be a carbon copy of any of the state farms currently

⁴E.D. Jones and K.W. Knutson. "Sources of Financial Support for Seed Potato Certification Programs and Official Foundation Seed Potato Farms in the United States and Canada." American Potato Journal, Volume 53, Number 1, January 1976.

in existence. In fact, there are some drawbacks in the state-controlled and state-subsidized form of organization. First of all, based upon the cost and returns determined in this study, a government subsidy is not necessary. That is, since the elite farm could produce elite seed for less than the private growers' cost of production, the farm could employ the target price strategy and be entirely self-supporting. Second, a government operated business enterprise may realize higher costs of production than a private enterprise. Ahlbrandt states that, "A bureaucratic producer, maximizing a complex set of goals and objectives, may not be motivated to utilize the least cost production techniques . . ."⁵ Third, a government farm might restrict seed potato growers' freedom of choice unless provisions are made whereby they would not have to purchase their elite seed from the state farm but could maintain their own elite plots or purchase from some other source. Moreover, since the elite farm would presumably offer a superior product and since none of the existing

⁵Roger Ahlbrandt. "Efficiency in the Provision of Fire Services," Public Choice, Volume XVI, Fall, 1973, p. 14.

elite farms charge enough for seed to cover their operational costs, there may be rationing problems. The quantity demanded at the set price may exceed the quantity supplied. This has been the case in Wisconsin and Maine. The method by which the elite seed is allocated has been criticized by seed growers in both of these states.

Based upon the cost data presented in this study, the elite farm may well be feasible under other forms of organization. One may ask, "Why not simply inform growers of the practices and costs necessary for the operation of the proposed elite farm and let private enterprise take over? Surely if there is a profit to be made someone will attempt to make it."

Presumably, a private entrepreneur could purchase the necessary equipment, hire a well-qualified manager and produce elite seed of optimal quality just as well as a government organization could. The private enterprise form of organization would probably not realize the previously mentioned drawbacks associated with the government form of organization. The private firm could be more efficient than the government firm and subsidies would not be necessary. Moreover freedom of choice and rationing problems

could be reduced by contracting and because the growers would have other alternatives available to them.

However, if more than one entrepreneur chose to operate an elite farm, economic efficiency may suffer. There are definite economies of size for potato production which indicates that an elite farm may be a natural monopoly. Wright⁶ states that for Michigan potato farms, per acre costs decrease as farm size increases from 20 acres of potatoes to 100 acres and that there is a similar relationship for potato farms in Maine and Idaho. If several private entrepreneurs were to build elite farms, none of them could be of the optimal size.

Because of the large costs of entry, it is unlikely that several or even one entrepreneur would choose to build an elite farm without first being assured of an adequate demand for their product. Of course, this problem may be solved by advance contracting between entrepreneur and the seed growers.

Given the present size of the seed potato industry in Montana, a single elite farm would be more efficient

⁶Karl T. Wright. "Some Economic Considerations on the Future of Potatoes in the Upper Peninsula, Michigan State University Agricultural Economics Report Number 111, August 1968, p. 34 and 43.

than several elite farms. There may be, however, problems associated with a private entrepreneur setting up an elite farm and contracting with his peers in the seed potato business. An initial time lag allowance for genealogical increase may mean that growers would balk at contracting for more than one year in advance with an individual fellow grower. Bank financing, however, might be used to avoid this problem.

Another possible form of organization is a group of seed growers that would operate an elite farm collectively or as a cooperative. The cooperative form of organization may, like the individual entrepreneur, be able to avoid some of the drawbacks inherent in a government operated farm. However, because of economies of size, a cooperative venture involving only a small number of patrons may not be feasible unless it were to contract with others outside the organization.

Helmberger and Hoos⁷ define a cooperative to be ". . . a non-profit institution guided by the principle of service at cost for the benefit of patrons." With the

⁷Peter Helmberger and Sidney Hoos. "Cooperative Enterprise and Organization Theory," Journal of Farm Economics, Volume XLIV, No. 2, May 1962.

purchasers of elite seed considered as the patrons, this definition seems to describe a viable form of organization for the elite farm.

Marvin Schaars lists the following as a criteria to determine whether or not an organization is a cooperative:

1. Does the organization provide economic benefits to member patrons?
2. Is the company essentially a non-profit enterprise? That is, is it to benefit users of its services rather than to make profits for the organization or for the members as investors?
3. Is the organization controlled by the people who use it? Generally every member is given a single vote irrespective of the volume of business he transacts with the firm or how much stock he owns. Sometimes control is based on the volume of business he conducts with the company (patronage voting).
4. Is the organization centered around the mutual interest of its members, that is, around a common bond of interest?⁸

⁸Marvin A. Schaars. Cooperatives, Principles and Practices, University of Wisconsin Extension Circular No. A1457, 1971, p. 7.

For the proposed elite farm the answers to questions 1 and 4 are a definite 'yes'. The organization would provide economic benefits to seed growers as evidenced by the partial budget analysis and the Kaldor criterion analysis. The organization would be centered around the common interest of obtaining the best possible elite seed that is free from PVX as well as other diseases.

In answer to question number 2 the firm could be a non-profit enterprise and still produce and sell a product that is less expensive than the current one. The target price analysis in the last section is designed to be a non-profit price.

To satisfy number 3 the organization could definitely be controlled by the people who use it. It may be easier to organize the potential patrons if the MPIA were to take the initiative in setting up the state farm. The MPIA may simply choose to set up a cooperative elite farm under its own direction. If such were the case the difficulties in organization, incorporation, membership drives, and selecting a Board of Directors could be reduced. In fact, the cooperative would have an already organized membership and Board of Directors - that of the MPIA.

Schaars tells us, "the management of a cooperative is composed of three separate and distinct groups: members, directors, and managerial staff."⁹ Potential members and directors of the elite farm have already been determined. The management may be readily available as well. Included in the elite farm budget is a 1/4 time supervisor and full-time foreman. This supervisor should be well-qualified to advise and carry out operations concerning the plant pathology aspects of the operation. The foreman could assist the supervisor in the technical operations as well as carry out the normal production operations. Since the Board of Directors would include knowledgeable potato growers, it is expected that it could participate in many management decisions. However, since the Board is composed of busy farmers who are not plant pathologists the supervisor should, in effect, be the sole hired manager.

There are, of course, other forms of organization that may be feasible. For example, a regional rather than a state elite farm seems to be a reasonable alternative. The Montana seed potato industry may cooperate with seed

⁹Schaars. Ibid.

growers in other states to support a single elite farm. States in the general vicinity of Montana that produce a substantial volume of seed potatoes include Idaho, Colorado, Nebraska, North Dakota, Minnesota, and Wisconsin. Since Idaho and Wisconsin currently have state operated elite farms perhaps they could be expanded to supply growers in Montana with elite seed. Another possibility would be for Montana to operate an elite farm in conjunction with one or more of the other states. However, an analysis of the feasibility of a regional elite farm is not within the scope of this study. Shipping costs would, of course, be a factor that might affect feasibility.

The purpose of this discussion concerning organization was not to describe in detail how the farm should be set up. It was merely to briefly present several alternative forms of organization that appear to be economically suitable for the elite farm.

Summary

The purpose of this study was to determine on the basis of economic criterion whether or not a Montana state elite seed potato farm would enhance the welfare of the state seed potato industry and the state itself. The

results of this study indicate that such an elite farm would indeed be an improvement over the status quo. How this conclusion was arrived at is outlined below.

The first step in this study was to determine elite seed potato costs of production. Information was obtained from certified seed growers with the intent of using some of this data in determining the costs of production for the elite farm. From this and from other data sources, such as the Wisconsin State Seed Potato Farm, a total budget was synthesized for the elite farm. A computer budget generator program was used to calculate per acre costs. The costs included all economic costs such as interest on money invested in real estate. Dividing by yield gives a cost of \$9.38/cwt. This cost was increased to \$11.80/cwt when the costs of an amortized loan were included.

The cost of growing elite seed on the commercial seed potato farms was also estimated. Information from the elite farm budget, University experts, and some private growers was used in this estimate. The cost of production for this method of growing elite seed came to \$14.71/cwt.

A partial budget was constructed to determine what effect the elite farm would have on a typical grower's returns. The result of the budget indicated that this type

of grower could expect to gain over \$11,000 per year. In subsequent analysis it was determined that growers other than the typical ones would also benefit from the elite farm.

Potential benefits may also be estimated on an industry wide basis. A savings of \$2.91 was calculated for each hundredweight of elite seed produced on an elite farm. Multiplying this times a yield of 200 cwt/acre for each of the 36 acres of elite seed grown in 1975, a savings of \$20,952.00 is realized. In addition, assuming that the 3974 acres of non-PVX certified seed produced in 1975 would qualify as PVX-free, a premium of \$496,750.00 (3974 acres x 250 cwt/acre x \$0.50/cwt) is derived. Thus, as a result of the proposed elite farm, a potential net benefit of \$517,702.00 is estimated to accrue to the Montana seed potato industry. With such large monetary benefits possible, an elite seed potato farm should be an attractive investment not only to seed potato growers but to persons outside the industry as well. There should be no problem in obtaining financing and the State Legislature need not be asked for appropriations to build an elite farm.

A study of social welfare and efficiency was done to support the recommendation of building an elite farm.

The Kaldor criterion was used in this case and showed that an elite farm would definitely be a social improvement.

The remainder of the study was devoted to outlining alternative means of financing and organizing the farm. The initial required capital was \$338,800. Of this \$124,300 was machinery investment which was included in calculating the costs of production and \$214,500 was real estate cost which was to be paid off in an amortized loan of 30 years. The loan cost was added to the costs of production from the elite farm budget to arrive at a cost of \$11.80/cwt. This would then be the break-even target price in a non-profit organization. Subsequently, alternative forms of organization that appear to be economically feasible were described.

It should be noted that in this study a conservative estimate was used for the benefits of the elite farm and that cost estimates tended to be high in most instances. Since the elite farm is feasible under these biases, it would certainly be feasible if the biases were removed.

An extreme example of the high costs estimates is that the potato enterprise is to pay the entire cost of land. It was assumed that revenue from the other crops

in the rotation would exactly cover their variable costs of production but would contribute nothing to the cost of paying back the initial real estate loan. In reality, the revenue from these other crops would most likely contribute to real estate costs. Therefore, the target price for elite seed derived in this study may be higher than necessary.

A major benefit of an elite farm was also omitted. Presently growers replant their own stocks which may be infected to a small degree with diseases such as blackleg and leafroll. They attempt to rogue out all infected plants but are not 100 percent successful. For each infected plant that is not discovered perhaps fifteen infected plants will be present the following year. As a result some fields exceed disease tolerance levels each year and are rejected for certification. Obviously, with disease free seed from an elite farm the probability of rejection is decreased. This decreased probability of rejection may be transformed in to additional revenue benefits that were not included in this study.

The actual target price for elite farm seed may be less than or greater than the estimate price of \$11.80/cwt because of the high cost estimates and the form of

organization which the farm may take. However, the major advantage of an elite farm is the opportunity for growers to sell PVX-free seed. Even if the elite farm sold for a higher price the premiums collected for PVX-free seed would outweigh the additional costs of a somewhat higher price for elite seed.

The information concerning an elite farm appears to be of considerable value to the Montana seed potato industry. A program designed to convey this information to Montana seed potato growers and other individuals in the industry certainly seems to be a reasonable recommendation.

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