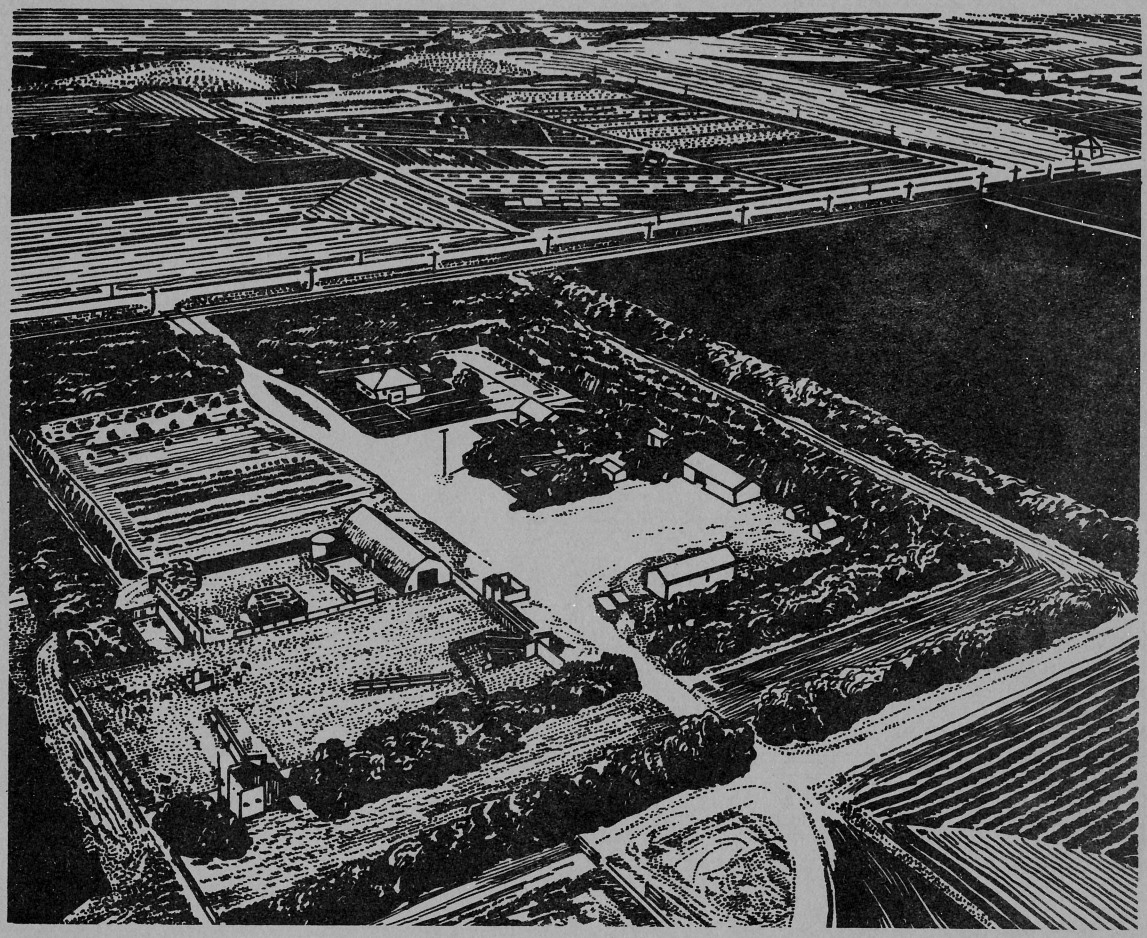
IRRIGATION
IN CENTRAL SASKATCHEWAN



CANADA DEPARTMENT OF AGRICULTURE

IRRIGATION IN CENTRAL SASKATCHEWAN

Prepared by

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Prairie Farm Rehabilitation Administration

Cover picture –

PFRA Pre-Development Farm, Outlook, Sask.

CANADA DEPARTMENT OF AGRICULTURE

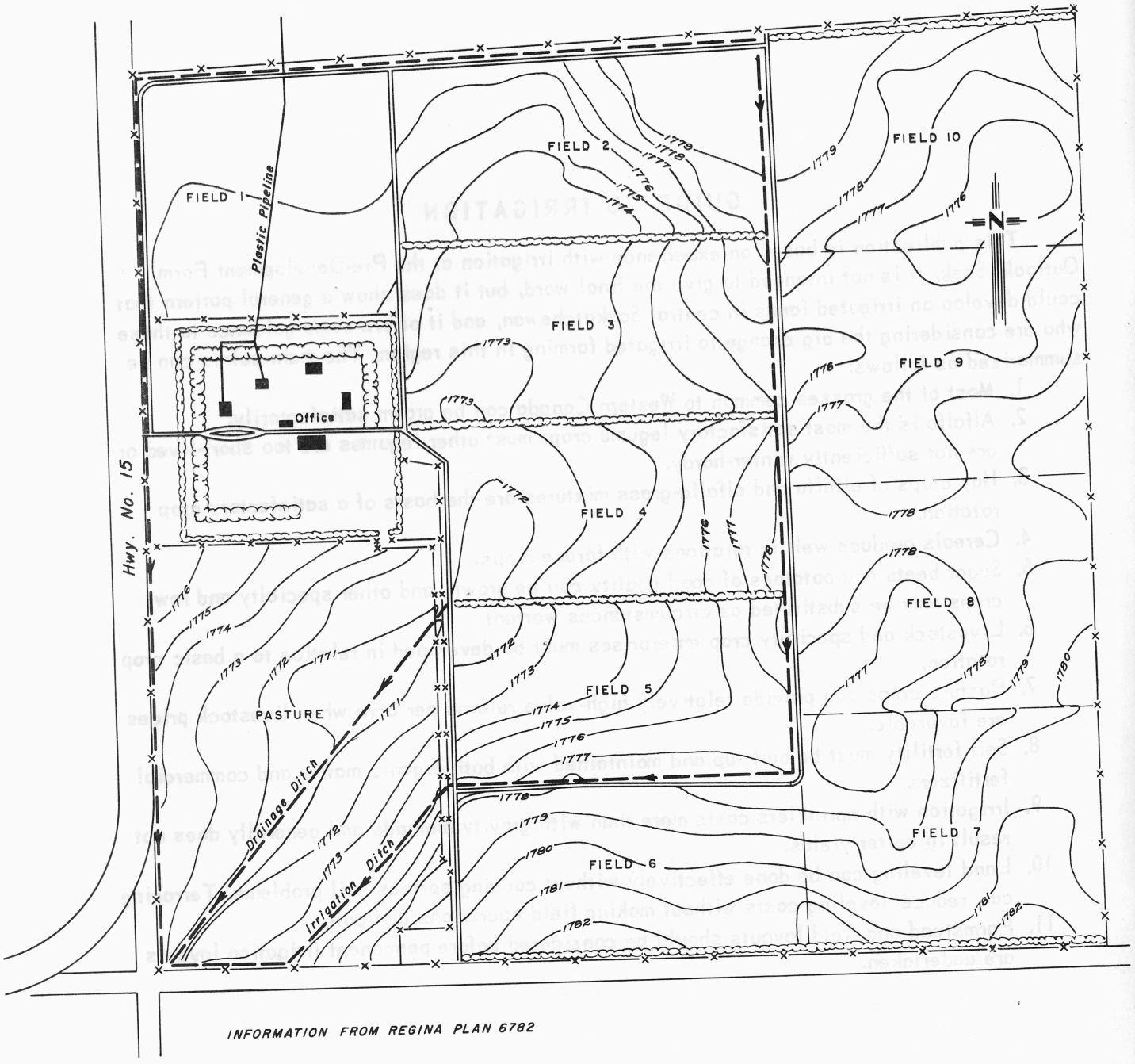
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GUIDE TO IRRIGATION

This publication is based on experience with irrigation at the Pre-Development Farm, Outlook, Sask. It is not intended to give the final word, but it does show a general pattern that could develop on irrigated farms in central Saskatchewan, and it offers some guidance to those who are considering the big change to irrigated farming in this region. The main points can be summarized as follows:

1. Most of the grasses common to Western Canada can be grown satisfactorily.
2. Alfalfa is the most satisfactory legume crop; most other legumes are too short-lived or are not sufficiently winter-hardy.
3. Hay crops of alfalfa and alfalfa-grass mixtures are the basis of a satisfactory crop rotation.
4. Cereals produce well in rotations with forage crops.
5. Sugar beets and potatoes of good quality can be grown, and other specialty and row crops may be substituted as circumstances warrant.
6. Livestock and specialty crop enterprises must be developed in relation to a basic crop rotation.
7. Pasture crops can provide relatively high-value returns per acre when livestock prices are favorable.
8. Soil fertility must be built up and maintained with both organic matter and commercial fertilizers.
9. Irrigation with sprinklers costs more than with gravity methods and generally does not result in better yields.
10. Land leveling can be done effectively without causing serious soil problems. Terracing can reduce leveling costs without making field operations difficult.
11. Farmstead and field layouts should be considered before permanent irrigation layouts are undertaken.



GENERAL PLAN
EXPERIMENTAL PLOTS

PRE-DEVELOPMENT FARM
OUTLOOK, SASK.

S.W. 1/4 Sec. 15, Twp. 29, Rge. 8, W 3.

FIG. 1

PRE-DEVELOPMENT FARM

Introducing irrigation to a dryland farming area raises questions as to the crops that can be grown and the new farming methods that will have to be adopted. To provide some information in advance of actual irrigation development on the South Saskatchewan River Project, the Canada Department of Agriculture established in 1949 a demonstration farm and experimental area near Outlook, Sask.

The purpose of the Pre-Development Farm is to assess irrigation practices that are accepted in other prairie regions and to develop modifications more suitable for local conditions. The experimental program covers research on crop varieties, fertilizer responses and water requirements in relation to the soil and climate of the proposed irrigation project. The farm operation was undertaken by PFRA and the research program by the Experimental Farm, Swift Current.

Field operations have included the growing of forage, cereal and row crops, irrigation by sprinkler and gravity methods, fertilizer trials, land leveling and the use of forage crops as hay, green feed and pasture for livestock. The cropping, cultural and operational methods were selected to demonstrate more the technical than the economic aspects of irrigation development in the area. Some economic observations have been made, but the picture varies according to local prices or the value placed on farm products. This report is based on experience under the conditions prevailing from 1949 to 1964.

Farm Layout

The Pre-Development Farm contains about 155 acres adjacent to the town of Outlook. It is divided into 10 fields of 10 to 12 acres each, a pasture area of 21 acres, a farmstead of 11 acres, and about 10 acres in ditches, roads and field hedges. Of the 10 fields included in the initial crop rotation, five are irrigated by gravity and five by a sprinkler system. Most of the pasture and farmstead areas can be irrigated by gravity. The farm layout is shown in Figure 1.

The experimental area contains 16 acres and is located immediately west of the farm on the west side of the main highway. Figure 2 shows the topography of this area, which extends to the bank of the river valley.

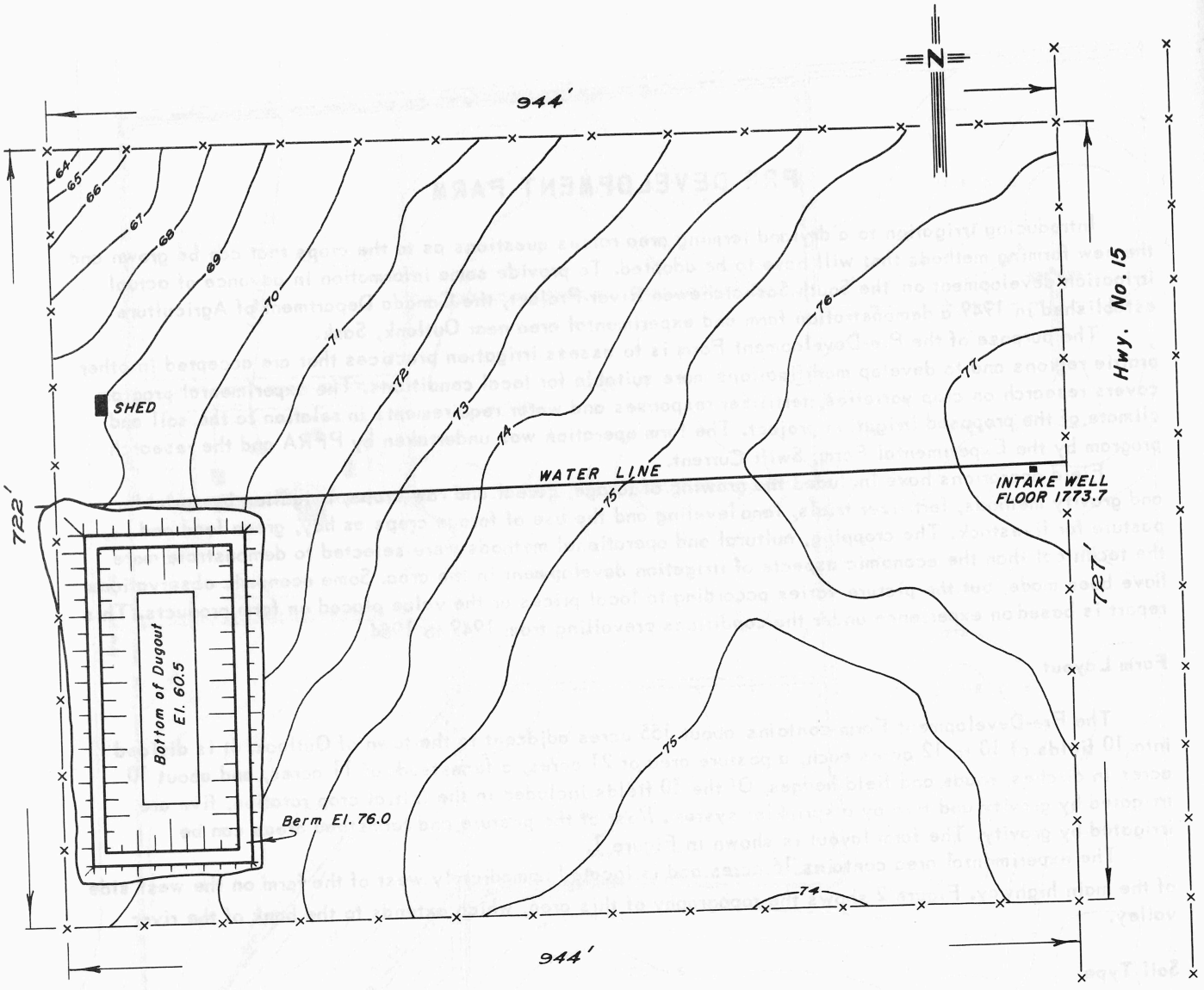
Soil Type

The soil in both areas is generally described as sandy loam, mostly of the Bradwell association. A narrow strip along the south side of the farm is more sandy and similar to the Asquith association. Most of the area had been affected by wind erosion during the dry years before it was developed for irrigation.

The Asquith soils vary in texture from fine sandy loam to light loam, and have very little structure and tend to become very compact below the surface. Because of excessive drainage these soils have a low water-holding capacity, and their fertility is generally low. The Bradwell soils are similar in texture but have a better structure, hold more moisture and are more fertile. Their drainage characteristics are generally adequate and soluble salts are not a problem except in poorly drained areas. The Elstow association, which occurs in other parts of the project, represents soils of heavier texture with good structure and adequate drainage, except on the heavier phases.

Water Supply

Irrigation water from the South Saskatchewan River is supplied to both the farm and experimental areas by an electrically-driven centrifugal pump through 12-inch steel pipe. The pipeline carries water up the river bank, through the experimental area, and discharges it into a gravity ditch that distributes it to the



INFORMATION FROM REGINA PLAN 7113

GENERAL PLAN
EXPERIMENTAL PLOTS

PRE-DEVELOPMENT FARM
OUTLOOK, SASK.

In E ½ Sec. 16, Twp. 29, Rge. 8, W3.

FIG. 2

farm fields. The experimental area can be irrigated either by sprinkler or gravity methods, but six fields on the farm must have sprinklers as they are higher than the gravity supply ditch.

The maximum output of the pump system from the river is about 3 cubic feet per second, or 1,125 gallons per minute, which is adequate except in periods of heavy demand for irrigation. A small reservoir was provided in the experimental area to supplement the pipeline supply at the peak demand. The capacity of the reservoir has been increased to six acre-feet.

CROPS AND CROPPING PRACTICES

Rotations

One of the major changes that must be considered in establishing an irrigated farm is crop rotation. Summerfallow is eliminated to intensify the use of irrigated land, and this also results in more general use of chemicals for weed control.

The basic crop rotation on the Pre-Development Farm was a 10-year program on about 115 acres (the remaining area was pasture, farmstead, ditches and shelterbelts). Following six years in alfalfa or a hay mixture, a field was plowed in the fall and seeded to wheat the following spring. After harvest, the field was given an application of barnyard manure in preparation for potatoes. The potatoes were followed by oats and barley, and then reseeded to hay in the spring. During the year of establishment the hay yield was light, but the next five years yielded fair to good returns.

This rotation could be varied by using other cereal and row crops. A cereal usually follows a forage stand in order to dispose of the roots, which would interfere with a row crop. These cereal crops produce sufficient grain for livestock enterprises or can be used as cash crops. Hay stands do not usually continue to produce well after five or six years.

Irrigated pastures do not fit into the main rotation, as a continuing pasture program requires different grass mixtures and a rotation that permits breaking and reseeding at regular intervals in order to maintain good production.

Irrigation farming allows more intensive production from the soil than is possible with dry farming. Increased production requires both commercial chemical and organic fertilizers and more attention to the physical structure of the soil. Since the cost of irrigation is high, it requires consistent production of crops that are not directly competing with dryland crops for markets. The sequence of crops should provide a balanced program so that succeeding crops will benefit from the built-up fertility and give maximum returns per acre from year to year.

A satisfactory crop rotation may be somewhat different for each farm, but some basic characteristics are common to every rotation:

1. The rotation must include crops that can be processed on the farm or marketed successfully to give maximum returns.
2. Some of the crops must help to maintain soil fertility and improve productivity.
3. Reasonable production must be assured every year, with few exceptions.
4. The sequence of crops must be such that one does not interfere with the next, and permits control of insect pests and plant diseases.
5. The crops must complement other farm enterprises to make the best use of available labor and capital.

A number of forage and cereal crops have been grown in test plots, but the farm rotation has been confined to alfalfa, alfalfa-grass mixtures, wheat, oats, barley and potatoes. Several pasture mixtures have been used for natural grazing by cattle.

Alfalfa was found to be the most satisfactory legume, with high yields whether sown alone or in a mixture with grass. Ladak and Rambler appeared to be the best of the varieties tested. Seeding without a companion crop produced healthier and higher yielding crops with fair weed control. Siberian



Figure 3 — Natural grazing for yearling bulls at Outlook.



Figure 4 — Wheat crop at the Pre-Development Farm, 1955.

Figure 5 — Irrigation test plots at Outlook.



red clover is well adapted to the area, but short-lived, usually drying out after the second year. Other legumes do not seem to be sufficiently winter-hardy.

Grasses that can be grown satisfactorily under irrigation in Saskatchewan include intermediate wheatgrass, slender wheatgrass, tall wheatgrass, crested wheatgrass, reed canarygrass, Russian wild rye, brome and timothy. For longer-term hay production, brome, crested wheatgrass and reed canarygrass are most satisfactory. Russian wild rye has produced fairly well as a hay crop, but it is better as pasture. Intermediate and slender wheatgrass produced the highest yields, but they are relatively short-lived and would be suitable where land is to be left in grass for only a few years. Grass sown alone does not yield as well, nor does it persist as long as when alfalfa is grown with it.

The common cereal crops have yielded well and produced total dry matter yields comparable to forage crops. When used in a rotation, they can provide reasonably good cash returns per acre.

The row crops grown were potatoes, silage corn, sunflowers and sugar beets. Potato yields varied considerably and higher average yields should be possible. Netted Gem potatoes have produced good late crops, but Pontiac and Norland, which are earlier varieties, gave slightly higher yields in plot tests. Corn and sunflower production was satisfactory, but they were grown for only two years and significant average yields have not been established. Sugar beets produced well in test plots and had a good sugar content.

Pasture

Successful pasture production depends on grass-legume mixtures that maintain growth throughout the pasture season. Adequate fertilizing and rigid management are essential. Pasture mixtures of brome-alfalfa and intermediate wheatgrass-alfalfa appear to provide the best production through spring and summer, and reed canarygrass-alfalfa produces well during the season. Creeping red fescue is useful in a pasture that will be grazed naturally, but is of limited value for mechanical grazing. Russian wild rye is useful as a summer and fall grass, and crested wheatgrass is most useful for early spring grazing.

Some legume with the grass is desirable, and bloat has not been a problem with brome-alfalfa mixtures when alfalfa does not exceed 50 percent of the mixture. Grasses that do not grow readily in hot weather may tend to unbalance the grass-legume ratio, and during hot periods the increased proportion of legume may increase the danger of bloat. Grass-legume ratios and yields may also be altered by varying the proportions of nitrogen and phosphorus in the fertilizer.

Irrigated pastures appear to offer possibilities of high returns per acre with a minimum labor and equipment cost. Pasture on lighter soils can be grazed by the animals without much damage to the grass in wet weather, but on heavy soils it may be seriously damaged by tramping when wet. Mechanical or zero grazing may be a more efficient method of using forage, but it requires a bigger investment in equipment. The forage is cut and hauled to the livestock at regular feeding periods and it provides higher field production compared with natural grazing.

Fertility and Fertilizer Response

The Bradwell and Asquith soil associations are generally low in organic matter and fertility. Application of barnyard manure, plowing in green manure crops, growing legumes and grass, and use of chemical fertilizer have significantly increased crop yields and improved the character of the soil.

Table 1 shows some comparable effects of fertilizer on various crops in the experimental rotations and plots. Yields are on a dry weight basis.

Ammonium phosphate at 50 to 100 pounds per acre has markedly increased yields of cereal crops in the year of application and had a definite residual effect on subsequent cereal and hay crops. Alfalfa responded well to barnyard manure at 10 tons per acre and to ammonium phosphate at 100 to 200 pounds, but there was little response of alfalfa to nitrogen alone.

Chemical fertilizers applied in spring or fall produced similar results. Nitrogen applications to grass-alfalfa mixtures tended to increase the percentage of grass in the mixtures. Highest yields of both potatoes and sugar beets were obtained with heavy applications of combined nitrogen-phosphate fertilizers. There may be a benefit to potato yields in adding potash.

Table 1 – Effect of Fertilizers on Yields of Grain and Legumes in Crop Rotations, Outlook Experimental Plots, 1956-60

Crop rotation	Fertilizer		Fertilized yield/acre		Unfertilized yield/acre	
	lb./acre	formula	bushels	tons	bushels	tons
Oats	100	11-48-0	113.0		94.6	
Wheat	residual fertilizer		49.3		39.9	
Alfalfa	100	11-48-0		3.29		1.81
Alfalfa	residual fertilizer			2.88		1.55
Alfalfa	100	11-48-0		2.99		1.63
Continuous oats	50	11-48-0	97.8		67.8	
Alfalfa	manure 10 tons/acre			4.21		3.07
Alfalfa	100	11-48-0		4.40		3.07
Alfalfa	200	16-20-0		4.09		3.07
Alfalfa	100	33.5- 0-0		3.03		3.07
Alfalfa-brome	100	11-48-0		3.04		2.16
Alfalfa-brome	200	16-20-0		3.60		2.16
Alfalfa-brome	100	33.5- 0-0		2.84		2.16
Alfalfa-brome	200 - 100 - 0*			4.16		2.95
Alfalfa-brome	200 - 200 - 0*			4.45		2.95
Sugar beets	120	33.5- 0-0		12.90		11.60
Sugar beets	125	16-20-0		13.00		11.60
Sugar beets	100	11-48-0		14.40		11.60
Potatoes	50 - 100 - 0*			11.10		8.50
Potatoes	100 - 50 - 0*			10.80		8.50
Potatoes	100 - 200 - 0*			12.20		8.50

*Specially prepared fertilizers (pounds of nitrogen-phosphorus-potassium)

There is considerable opportunity for increasing production of most crops by applying suitable fertilizers. A 50 percent increase in yield over non-fertilized crops is common, and greater increases may be possible on lighter soils with good farming and irrigation practices.

Crop Yields

Table 2 shows crop yields in different years to indicate the variations that may be expected. Table 1 shows variations in yields in relation to fertilizer applications.

These crop yields are a basis for estimating revenue either at prevailing market prices or at values related to other farm enterprises.

Cropping Costs

The costs of producing crops will vary for each farm, depending on labor efficiency, machinery use, general management and cash expenditures. Cost budgeting on two fields, one irrigated by gravity (flood) and the other by pressure systems (sprinkler) is shown in Table 3.

Actual costs and yields have been used to arrive at a figure for machine hours and cost per unit. Machine costs were taken at 1964 values and depreciated at a rate related to actual farm experience. The operation and maintenance of machines were also taken into consideration. Investment and taxes were charged at 6.2 percent of total land investment. Labor was charged at $1.50 per hour. For details of budgeting machine and field operations costs see Appendixes A, B, and C.

Table 3 shows that the cost of production could equal the sales value, but this does not indicate an unprofitable operation. If such a case existed, the operator would still be receiving $1.50 for every hour he worked and also six percent on his investment, along with full depreciation on his equipment. Farm buildings were not considered because they vary with each operation. All figures quoted must be considered only as an example and need to be adapted to the individual unit.

The budgeting shows that high yields are a necessity in successful irrigation farming. Irrigation equipment must be mechanized as much as possible to reduce the labor cost per acre.

Farm machinery costs must also be related to individual farms. Those that have both dryland and irrigated operations will be able to use many of the dryland implements. Entirely irrigated farms will require some basic units, but joint ownership or rentals could keep down the investment costs on seasonal equipment that may have limited use.

WATER USE

The amount of water required for various crops has been established by experiments and has a direct relationship to the rate of evaporation. The general rule of thumb is to consider cereal crops as requiring about 16 inches of water and forage crops about 22 inches for maximum production in Western Canada.

Irrigation Practices

Irrigation water is required to make up the difference between the natural rainfall and the needs of the crop plus the losses resulting from surface drainage and percolation. The losses by percolation beyond the root zone are greater in soils that have a porous subsoil. Soils that absorb water more slowly may lose water by surface runoff. Each soil type has different characteristics and must be treated accordingly. Some cultural practices help conserve soil moisture, but since there is no way of controlling the rate or quantity of natural precipitation, the benefit of heavy rains is often reduced on soils that cannot absorb water easily, or that have a porous subsoil which does not retain moisture for a long period.

Practical irrigation must be developed for each soil type, and yet it must be flexible to compensate for an irregular rainfall. The water-holding capacity of a soil should be established and irrigation water

Table 2 – Crop Yields at Pre-Development Farm, Outlook, 1951-64

Year	Wheat bushels /acre	Oats bushels /acre	Barley bushels /acre	Potatoes tons /acre	Brome-alfalfa average tons/acre
1951	37	66	40	0.84*	1.20
1952	44	51	47	–	1.87
1953	38	–	–	11.2	2.78
1954	14	53	41	8.5	2.48
1955	35	51	39	12.5**	2.30
1956	48	88	57	11.4	3.58
1957	33	89	53	5.9	3.39
1958	46	98	58	9.7	3.60
1959	52**	84	86**	8.2	2.84
1960	43	100	74	6.5	3.34
1961	31	84	66	10.0	3.08
1962	–	83	67	5.0	2.34
1963	–	107**	67	–	2.58
1964	–	72	72	5.0	3.42
Ave.	38	79	59	8.5	2.77
Ave. 1956-64	42	89	66	7.7	3.13

*No irrigation **Maximum

Table 3 – Machine Hours and Cost Budgeting* at the Pre-Development Farm, PFRA, Outlook

Year	Crop	Yield/acre tons	Yield/acre bushels	Machine hours/acre	Machine hours /ton	Machine hours /bushel	Cost $ /acre	Cost $ /ton	Cost $ /bushel
				Flood Irrigation Crop Records					
1963	Hay	2.34		4.6	1.95		44.54	19.02	
1962	Hay	2.72		3.3	1.22		39.33	14.66	
1961**	Hay	1.05		6.9	6.53		57.55	54.80	
1960	Barley		74.0	3.5		0.05	46.01		0.62
1959	Oats		83.8	2.4		0.03	42.30		0.50
1957	Wheat		33.0	6.3		0.19	55.74		1.69
1956	Hay	2.74		8.2	2.99		59.55	21.72	
1953	Hay	3.10		3.3	1.07		39.36	12.68	
				Sprinkler Irrigation Crop Records					
1963	Hay	3.56		4.5	1.26		43.41	12.21	
1962	Hay	2.18		3.0	1.39		37.93	17.41	
1961	Hay	2.72		4.7	2.18		49.54	23.17	
1960	Hay	2.14		3.9	1.84		47.05	22.01	
1959	Barley		86.5	2.5		0.03	48.58		0.56
1957	Potatoes	5.90		28.7	4.86		177.49	30.10	
1956	Wheat		48.0	5.7		1.20	61.26		1.28

*Cost budgeting includes: Machines at 1964 new cost depreciated on actual experience at Outlook. Repairs at 2 to 5 percent per year. Labor at $1.50 per hour. Irrigation charge at $4 per acre. (For equipment charges see Appendix A; for method of equipment cost calculation see Appendix B.) Investment and taxes charge at 6.2 percent. All fields fertilized with 100 lb. 11-48-0.
(For method of field budgeting see Appendix C)

**Year of establishment.

Table 4 – Irrigation Applications, Pre-Development Farm, 1951-64

Crop	Average inches	Maximum inches
Wheat	9.5	12
Oats	9.0	15
Barley	10.0	13
Potatoes	10.5	20
Hay	12.0	18
Pasture	–	18

Table 5 – Precipitation at Outlook, 1951-64

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	April - Sep.
							inches							
1951	1.80	0.80	1.90	1.03	1.13	2.61	3.63	4.32	1.55	0.38	0.40	0.40	19.95	14.27
1952	0.60	0.00	1.00	0.00	1.24	3.03	1.42	0.59	0.79	0.02	0.43	0.00	9.12	6.05
1953	0.60	0.52	1.85	1.19	2.15	1.90	2.82	2.24	2.56	0.20	0.00	0.02	16.05	12.86
1954	1.00	0.20	0.40	1.10	1.86	2.12	2.46	3.11	1.03	0.12	0.57	0.14	14.07	11.68
1955	0.75	0.60	0.70	2.49	1.93	1.10	1.63	0.31	1.29	0.16	0.10	0.97	12.03	8.75
1956	0.57	1.36	1.36	0.13	0.20	2.26	2.74	0.83	0.21	0.70	0.02	0.75	11.13	6.37
1957	0.12	0.11	0.34	1.38	0.41	1.97	0.98	1.90	0.76	1.14	0.14	0.61	9.86	7.41
1958	0.27	0.70	0.10	0.24	0.09	0.97	2.78	0.59	2.18	0.04	0.90	0.02	8.88	6.85
1959	0.00	0.03	0.22	0.24	0.87	4.35	0.67	1.14	2.99	2.08	0.12	0.50	13.21	10.26
1960	0.70	0.00	0.00	0.24	0.70	3.35	0.72	1.05	0.00	0.20	0.10	0.24	7.30	6.06
1961	0.70	0.20	0.05	0.33	1.47	1.69	0.49	0.00	0.20	1.20	0.25	0.65	7.23	4.18
1962	0.70	0.90	1.30	0.30	1.84	2.31	1.61	2.97	1.50	0.08	0.26	0.40	14.17	10.53
1963	0.30	0.50	0.20	1.54	1.77	3.64	1.49	2.46	0.85	0.07	0.47	0.43	13.72	11.75
1964	0.63	0.41	0.24	0.30	1.90	1.48	1.83	0.66	1.95	0.48	0.36	1.28	11.52	8.12
Ave.	0.67	0.51	0.74	0.75	1.25	2.34	1.81	1.58	1.37	0.56	0.55	0.49	12.01	9.01

applied whenever the moisture content falls below the optimum level for crop use. However, only as much water should be applied as the soil is capable of retaining, or it will be wasted and the drainage problems increased.

Table 4 shows the average and the maximum amounts of irrigation water applied to different crops at Outlook during the growing season from 1951 to 1964. All averages are low as a result of the inadequate water supply during two years. The monthly, yearly and average precipitation at Outlook from 1951 to 1964 is shown in Table 5.

The average precipitation during the crop season – April to September inclusive – is about 9 inches, but the relatively low rainfall until June makes it apparent that irrigation is usually needed early in the spring as well as through the period of rapid growth in June and July. Fall irrigation of forage crops is generally recommended since the average rainfall after September is usually low.

Irrigation Methods

The amount of irrigation water applied at any time should be sufficient to recharge the soil to its field capacity to the depth of the root zone. Practical methods have been developed whereby a farmer can measure the moisture content of the soil and thus apply water to better advantage. The usual irrigation is three to four inches of water, and since sprinklers can seldom apply more than ½ inch per hour without ponding, it takes six to eight hours to irrigate each area covered by a sprinkler. The time to irrigate a well-leveled field with border dykes is much less.

Experience at Outlook indicates that there is a definite advantage in irrigating leveled land by gravity methods compared with a sprinkler or pressure system.

Sprinklers are needed when the land to be irrigated is higher than the supply ditch, or when the field is so rough and uneven that it is not practical to level it and enable border dykes to spread the water uniformly. Sprinklers are also desirable on some soil types for a light application of water when starting a new crop of forage, and when some types of specialty crops are being grown. Not all land can be effectively leveled without serious damage to its productivity, but the Bradwell and Asquith types common to central Saskatchewan do not appear to present serious problems. Many fields can be leveled to suit border dykes for less than $60 per acre. This represents a permanent investment that can be maintained by little more than routine cultural practices.

The investment in sprinkler equipment including a pump, power unit, pipe and sprinklers ranges from about $60 to over $100 per irrigated acre. The depreciation charge on this equipment along with the fuel to operate it may amount to $10 per acre per year. Labor for moving the sprinkler pipe at Outlook has averaged nine man-hours per acre compared with 5.4 to operate the gravity method. Wheel-move systems have cut the sprinkler moving time to 3.6 man-hours per acre. The cost of maintaining structures, field ditches and dykes cannot be overlooked, but this is not likely to be more than one-third of the energy cost and depreciation on a sprinkler system.

Even with well-designed sprinklers the wind, particularly in the dry seasons, seriously affects the water distribution patterns. Poor distribution of water leaves parts of the field short and results in lower yields. This was evident at Outlook over a nine-year period when hay yields averaged nearly half a ton per acre more on fields irrigated by gravity compared with those irrigated by sprinklers. The difference has been as much as 1½ tons per acre, and there was only one year when the yield with sprinkler irrigation exceeded that of gravity irrigation by about three-quarters of a ton per acre.

Sprinklers will be needed on many fields in an irrigation project, and particular attention must be given to the design and operation of these systems to make them competitive. The availability of cheap electric power for pumping and the use of mobile or wheel-mounted pipelines may overcome the cost disadvantages of pressure systems.

A sprinkler system capable of irrigating 50 to 60 acres on soil similar to that at Outlook should apply about three inches of water in six to eight hours and cover about 1½ acres in that period. When the unit is operated continuously, it should be possible to irrigate the whole area in 10 to 12 days. During dry periods, a second application of water will likely be needed by forage crops and pasture as soon as one cycle is completed.

pril Sep.

4.27
6.05
2.86
1.68
8.75
6.37
7.41
6.85
0.26
6.06
4.18
10.53
1.75
8.12

9.01

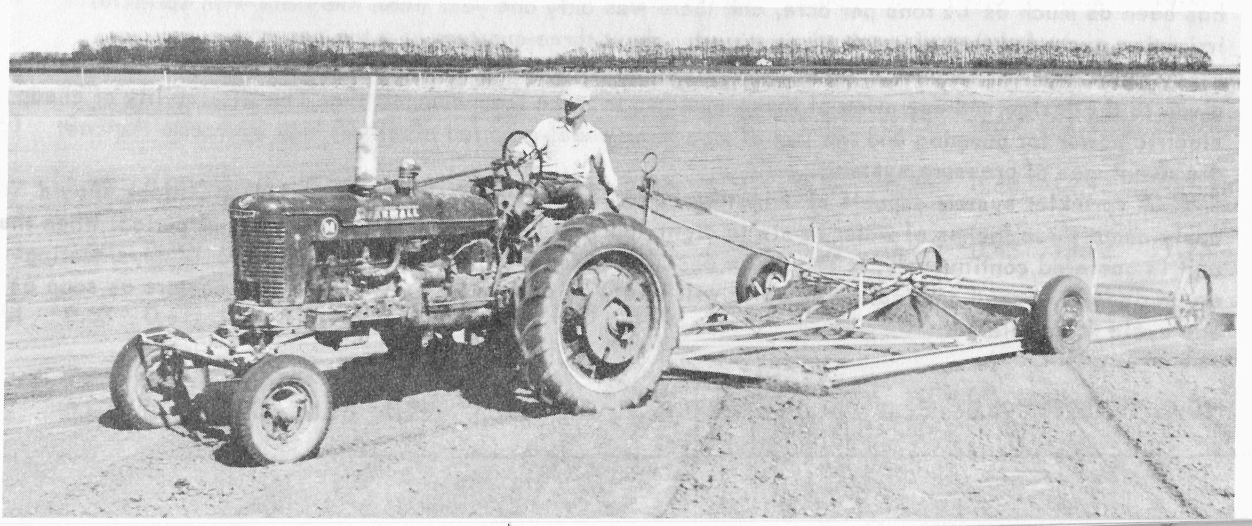


Figure 6 – Border dyke irrigation at the Pre-Development Farm.



Figure 7 – Wheel-move sprinkler system in use at Outlook.

Figure 8 – A farm leveler at work in a field at Outlook.



A comparable area of 50 to 60 acres, properly leveled and laid out for a border-dyke gravity system, can be irrigated with a few simple turnouts, checks or canvas dams. This type of system can supply three to four times the volume of water that the sprinkler system can handle, and will irrigate the same area in about a third to a quarter of the time. Poorly prepared land requires border or contour ditches to spread water, resulting in more labor and inconvenience in field operations.

Drainage

The draining of excess irrigation water or rainfall is as essential to successful irrigation farming as the application of water. It becomes more critical on heavier soil types where the rate of water penetration is slow and the under-drainage may be limited. It is also essential on soils with an appreciable salt content that will accumulate on the surface and in the root zone, if the excess water is permitted to gather and evaporate. Drainage problems are less likely to occur with sprinklers since the amount and rate of water application are more closely controlled.

Subsurface drainage is important, regardless of the method of application, if the moisture-holding capacity of the soil is exceeded and the natural downward movement of moisture in the soil is retarded or stopped. Drainage ditches must be provided to remove excess surface water and prevent the build-up of water above the lower limit of the main root zone of the crop.

Leveling

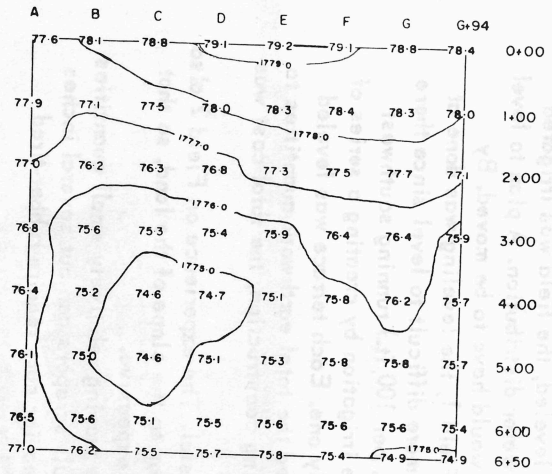
The method of leveling for gravity irrigation will depend on the slope, the nature of the soil and the general topography. The maps of Fields 1 and 2 at Outlook (Figures 9, 10 and 11) indicate the various methods that might be followed. The fields are shown before and after leveling, and the contractor's map indicates the areas that were cut, filled and terraced.

In the "before-leveling" map (Figure 9) there is a low area at the bottom left and a high area along the west and north. As water is delivered at the north end, it would have been possible to use contour ditches or border dykes down the field, if the low area could have been drained by a deep ditch. The field was leveled by removing soil along the west side and at the top and bottom to create a more uniform slope down the field. Border dykes were placed every 33 1/3 feet to guide the water down the slope (as in Figure 10). A drainage ditch along the lower edge collects any excess water. The earthwork cost for leveling the field in this way was about $40 per acre, and it resulted in a water spreading system that is effective and requires a minimum of labor.

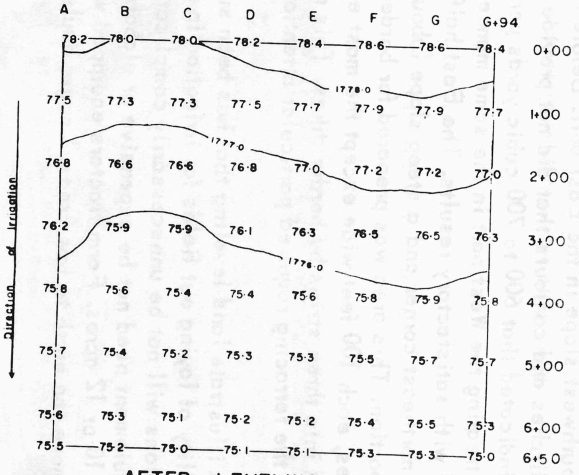
Field 2 was divided into two parts, 2W and 2E, for leveling (Figures 10 and 11). This was necessary because of the distinct change from a northwest to southeast slope in the West part to a steeper northeast to southwest slope in the East part. Before it was leveled, the field was irrigated by a series of border ditches and contours that did not provide good water distribution. A plan to level the field in one piece indicated that 600 to 700 cubic yards per acre would have to be moved. By dividing the field and treating the West part in the same manner as Field 1, the leveling was done at a comparable cost and with satisfactory results. The East half was more difficult to level since there was a flat area at the northeast corner and a steep slope (about 2 ft. per 100 ft.) running southwest across the remaining portion. This area was prepared for border dyke irrigation by creating a series of six north-south terraces, each 100 feet wide except the most easterly one. Each terrace was leveled separately and divided into three strips by border dikes. This reduced the total earthwork quantities to a minimum, and while the terracing required particular attention during construction, the total cost was about $60 per acre.

These examples illustrate land leveling that has been successful. The experience on Field 2 also indicates the desirability of laying out fields for irrigation in relation to the slope of the land, so that future leveling operations will not be unnecessarily complicated or expensive.

The leveling equipment need not be expensive or elaborate for moving relatively small quantities of earth on a field of 10 or 12 acres. Farm tractors equipped with pull scrapers can cut several inches from high spots and move the earth to low areas. Longer hauls or heavier cuts require rubber-tired



BEFORE LEVELING MAP



AFTER LEVELING MAP

GRADE LIMITS

TRANSVERSE

(A to G+94) N=3

Min. +.003
Av. Level
Max. -.003

NOTE: Av. trans. slope was +.001 However av trans. slope was taken as level for calculations so that direction of irrigation would be parallel to the side of the field.

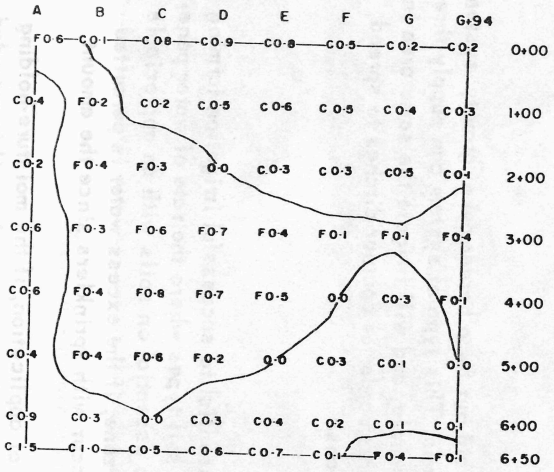
DOWNFIELD

(0+00 to 6+50) N=3

Min. -.001
Av. -.004
Max. -.007

N

CONTRACTOR'S MAP



CUT 2972 yds. } 25% Shrinkage
FILL 2222 yds. }
AREA 10.4 ac.
286 yds. per ac.

FIELD 1

Land preparation for border dike irrigation by Parkinson Method.

Constructed 1959

LAND PREPARATION - FIELD 1

PRE-DEVELOPMENT FARM
OUTLOOK, SASK.

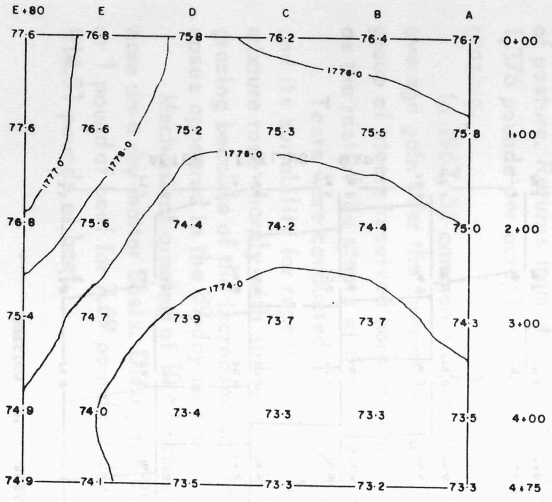
FIG. 9

INFORMATION FROM SWIFT CURRENT PLAN S.C.O. 1238 B

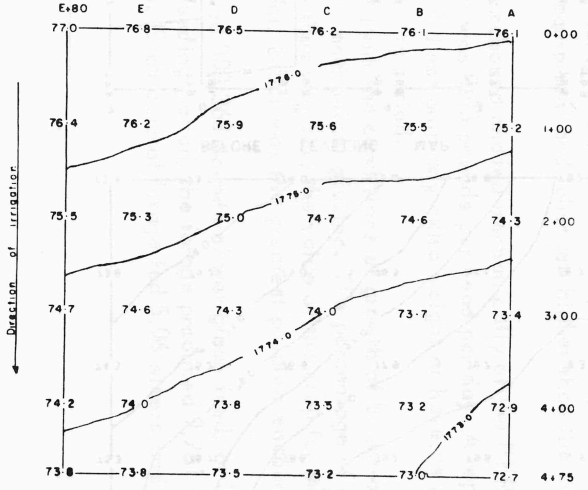
OUTLOOK, SASK.

FIG. 9

INFORMATION FROM SWIFT CURRENT PLAN S.C.O. 1238 B



BEFORE LEVELING MAP



AFTER LEVELING MAP

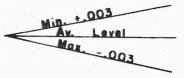


GRADE LIMITS

TRANSVERSE

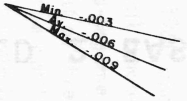
NOTE. Av. trans. slope was -.003. However av. trans. slope was taken as level for calculations so that direction of irrigation would be parallel to the side of the field.

(E+80 to A) N=3

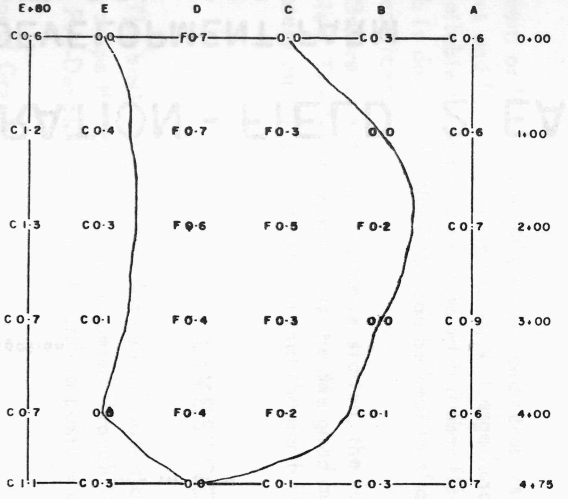


DOWNFIELD

(0+00 to 4+75) N=3



CONTRACTOR'S MAP



CUT 1541 yds. } 19 % Shrinkage
FILL 1250 yds }
AREA 5.3 Acres
291 yds per ac.

FIELD 2 WEST

Land preparation for border dike irrigation by Parkinson Method.

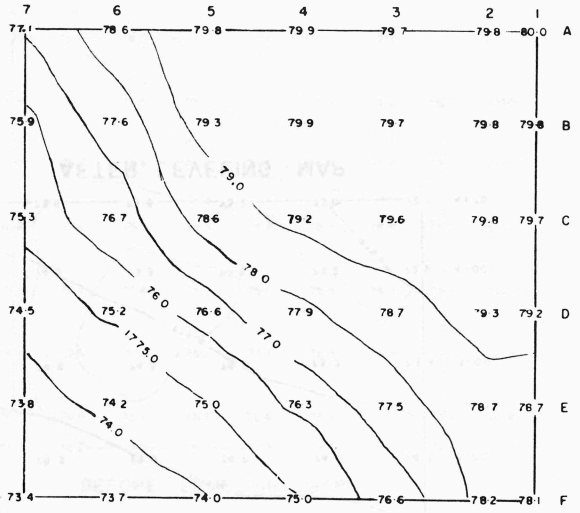
Constructed 1959

LAND PREPARATION - FIELD 2 WEST

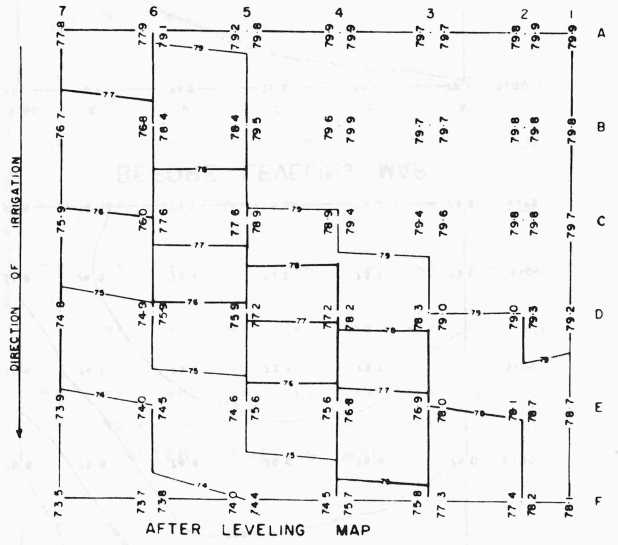
PRE-DEVELOPMENT FARM OUTLOOK, SASK.

FIG. 10

INFORMATION FROM SWIFT CURRENT PLAN S.C.O. 1238 C



BEFORE LEVELING MAP



AFTER LEVELING MAP



GRADE LIMITS

TRANSVERSE

N = 2

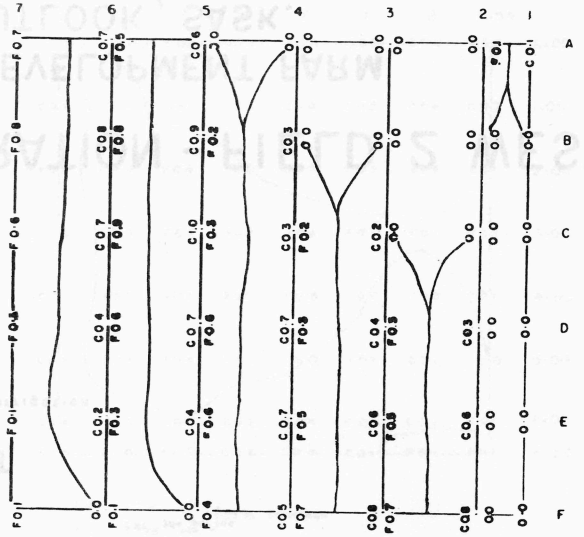
Max. ± 0.2'/100 strip

DOWNFIELD

Min — level

Max. — existing slope

CONTRACTOR'S MAP



CUT	1080 yds	24% Shrinkage
FILL	821 yds	
AREA	6.3 ac	
	171.4 yds per ac	

FIELD 2 EAST

Land preparation for border dike irrigation by the Terracing Method.

Constructed 1959

LAND PREPARATION - FIELD 2 EAST

PRE-DEVELOPMENT FARM OUTLOOK, SASK.

FIG. 11

INFORMATION FROM SWIFT CURRENT PLAN S.C.O. 1238 D

equipment or larger crawler tractors and scrapers. After the basic leveling, there are various types of levelers and floats to finish the work. Large land planes are very effective at this stage, but if they are not available the job can be done with timber floats or farm levelers, although these take longer. When the job is done well, the field can be kept in shape for many years to come with normal irrigation farm practices.

Before a leveling program is started, the land should be surveyed and mapped as shown in the examples. The leveling plan must be designed and drawn up so that the grades can be established accurately on the ground, and so that the earth is moved the least distance.

LIVESTOCK ENTERPRISES

The basic crop rotation for central Saskatchewan will necessarily contain a large proportion of forage crops that can best be marketed through livestock enterprises on the farm. Cattle have been used at the Pre-Development Farm to utilize pasture as well as hay and coarse grains.

Rotational Grazing

In the early spring of 1959 and 1960 about 45 grade steers were bought at an average weight of 650 pounds. They were fed hay and a small amount of grain until grazing was available on about May 15. The cattle grazed on four grass and grass-legume fields of about five acres each. They were put into a field as soon as the grass reached a height of three to four inches, and were left for several days before being moved to the next field. As soon as the cattle left a field it was clipped with a mower, if there was any advanced growth, and harrowed and irrigated. During the season of rapid growth, it was usually necessary to mow one or two fields between grazing periods to prevent the grass from becoming too mature before the cattle could use it. Nitroger fertilizer (33.5-0-0) was applied at the rate of 100 pounds per acre in the spring and 100 pounds in early August. During the grazing period of 123 days, the steers were each fed six pounds per day of crushed grain mixture in addition to the grazing provided by the irrigated pasture. The average daily gain was 1.75 pounds per animal, with a gain per acre of 574 pounds of beef each season. The average carrying capacity was three head per acre. The costs, including grain and hay fed during the grazing period, amounted to 10 cents per pound of beef produced. After the grazing season, the steers were put on a finishing ration until their weight reached about 1,000 pounds.

Zero Grazing

Average returns from two seasons of natural grazing at Outlook were 575 pounds of beef per acre of pasture. Returns from mechanical, or zero, grazing at Outlook and Hays, Alta., have ranged from 665 to 1,376 pounds per acre, but operating costs for equipment and labor are higher than the cost of natural grazing.

In 1962, 54 common stock feeders were purchased and fed mechanically at the PFRA farm. Their average gain over the summer period of 89 days was 2.03 pounds per head per day. A representative group of steers received hormone implants and did not gain any extra weight or have as good a finish as the rest of the steers at the close of the grazing period.

Tests were conducted in the field to determine the conditions of growth of brome-alfalfa forage and its suitability for repeated harvesting under mechanical grazing. The percentage of alfalfa in the mixture rose sharply with successive cuttings, thus reducing the value of the crop for mechanical grazing because of the increased danger of bloat. Bloat was the greatest problem encountered; 30 cases appeared in the 89-day period.

Mechanical grazing of 10.67 acres produced 300,363 pounds of wet green feed, or 3.5 tons per acre on a dry matter basis. During the 89-day feeding period, the forage produced 9,761 pounds of beef, or 1 pound of beef for 7.69 pounds of dry forage. Each acre of forage fed 5.06 steers and produced 914.81 pounds of beef.

OUTLOOK, SASK.

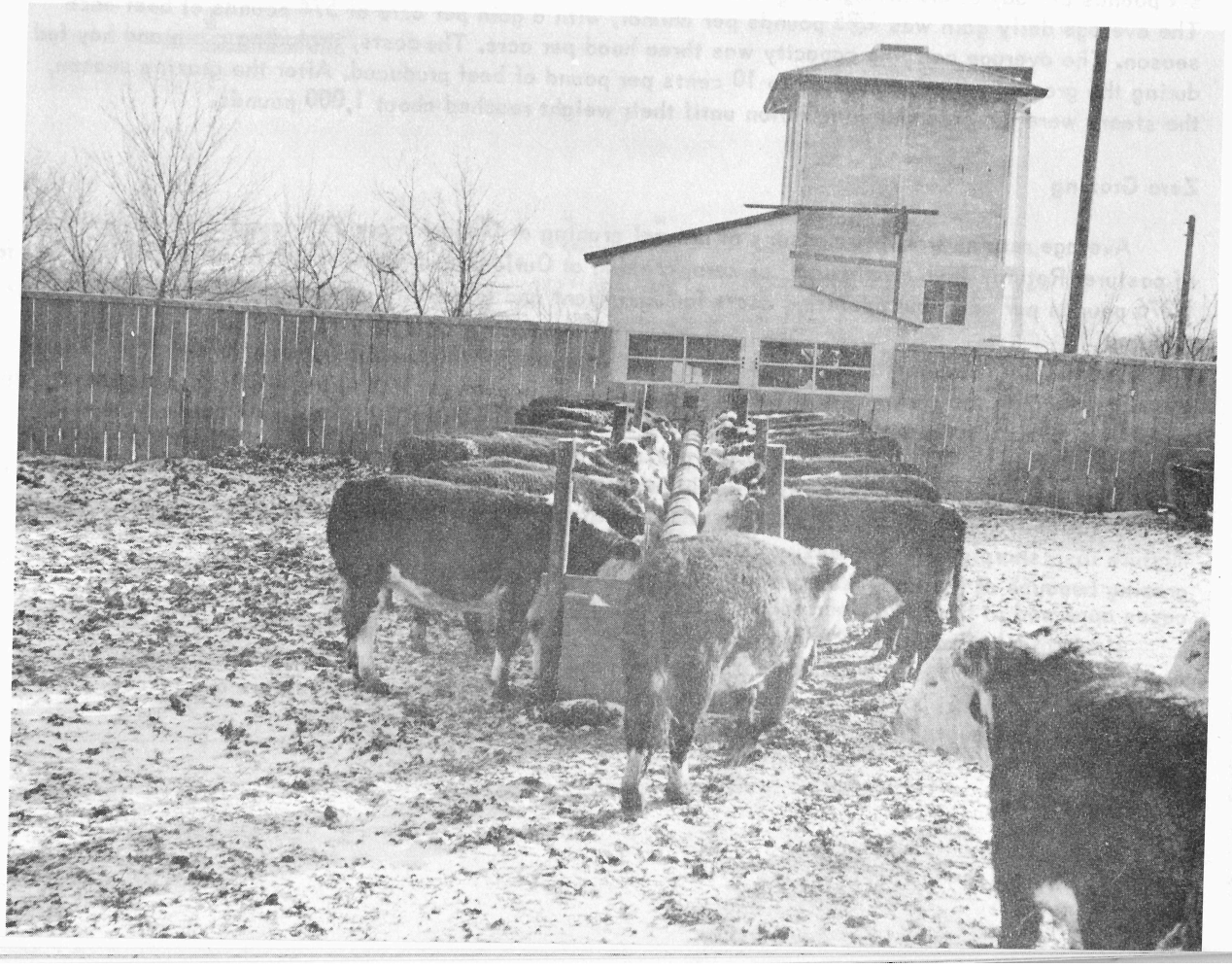
FIG. 11

INFORMATION FROM SWIFT CURRENT PLAN S.C.O. 1238 D



Figure 12 – Feeder bunks at the Pre-Development Farm.

Figure 13 – A mechanical feeding device at Outlook.





Mechanical grazing presents itself as a profitable enterprise in the intensive use of irrigated pasture. It returned $53.12 more than the average return from a corresponding field in a 10-year rotation of hay, cereals and potatoes. The return to overhead was $118.99 per acre, or $23.51 per head of steers fed.

A similar project at Hays, Alta., from 1958 to 1960 produced an average daily gain of 2.35 pounds per head at a comparable cost. The forage mixture used at Hays was predominantly grasses, which provided a better ration than the high alfalfa mixture at Outlook. After the green-feed period, the cattle were put on a dry ration for finishing.

Comparison

The two grazing methods for using green forage offer possibilities of high-value production in summer, and both require good management to maintain the grass at a near-maximum feed value. Natural grazing requires more fencing and water facilities to use the pasture in a rotation, whereas mechanical grazing can be practised without these extras. The investment in equipment and the routine daily labor requirement are higher for mechanical grazing, but there is more positive control of the feed ration and less danger of damage to forage stands by tramping when wet.

Bloat – There is the possibility of bloat when green forage is fed to cattle, or when lush pasture is available for grazing. Some losses occurred at Outlook in several years with both natural and zero grazing. The conditions that cause bloat are not clear, but experiments elsewhere and observations at Outlook indicate that there is little danger of bloat for most cattle when the forage mixture contains no more than 50 percent alfalfa. The legume in a pasture mixture must be controlled and be uniformly distributed among the grass plants so that the animals cannot select clumps or patches of the legume separately.

Materials Handling and Storage – Buildings for livestock can be adequate without being elaborate. They should be constructed so as to permit them to be changed to some other use if necessary. Grain storage buildings should be located so that labor-saving equipment can be used to move grain from the bins to the feeding areas. Silage is also a very nutritive feed when it is handled and stored properly. Self-feeding gates, front-end loaders and mechanical feeding equipment can be used to handle silage with a minimum of labor.

The development of mechanized systems will depend on the type of enterprise. Complete farm systems require considerable investment and must be justified by labor-saving and improved efficiency, or by making it possible to undertake additional enterprises. Many items of commonly used equipment such as augers, conveyors, bale loaders and dump wagons can be acquired at moderate cost and incorporated into modified systems as the farm program is developed. When making plans to expand existing farm enterprises or introduce new ones, these items should not be overlooked as a means of reducing labor requirements.

FARMSTEAD PLANNING

The normal boundaries of a farm property will not likely coincide with the main topographic features of the area. Therefore, considerable attention should be given to laying out a field to take full advantage of the natural slopes and drainages. The advantages to be gained are evident when considering the requirements for land leveling. Although rectangular fields are generally preferred, the disadvantages of irregular fields are not as serious as might be expected, since the type of farming operation is much different from that to which a dryland farmer is accustomed.

The size of irrigated fields will depend somewhat on the type of rotation to be employed and the crops that may be grown. Fields of 10 to 15 acres provide reasonable units that may be used for most of the common field crops.

For sprinkler systems, it is preferable to have rectangular fields of uniform width and extending side by side for some distance, so that the sprinkler equipment may be mechanized as much as possible. This feature was temporarily defeated at the Pre-Development Farm by hedgerows having been planted between the fields irrigated by sprinklers. The hedges prevented wheel-mounted equipment from being moved from field to field without dismantling, and they have since been removed. (See Fields 7 to 10, Figure 1). Hedges between fields irrigated by gravity do not present the same problems.

With gravity systems, either border dyke or border ditch, fields should be in approximate multiples of 100 feet wide and up to 1,400 feet long on a uniform grade. The length should be such that water turned in at the upper end should continue to run in one strip for long enough to obtain adequate penetration and to extend the time between sets for the convenient use of labor. Gravity irrigation on light soils or very flat land will require shorter strips and greater heads of water to be effective.

Areas to be used as irrigated pasture should be near, or have access to, the farmyard and be adjacent to a dry area on which cattle can be grazed or fed during wet weather, when they would damage the pasture.

The farmstead itself may be already established, but if a new one is needed, it should be planned in relation to the other parts of the farm. Livestock buildings, granaries and sheds should be arranged so that grain and hay can be used directly from storage, and fields and livestock areas are easily accessible for machinery. The farmhouse, garden and lawns should be located to provide a pleasant setting and still be convenient to the base of farm operations.

A dugout will likely be required for livestock and home use, and it should be placed on the initial plan. Water to fill the dugout can come from the irrigation ditch, hence it can be located above and away from the barnyard, and conveniently for garden or home use. Steps must be taken to prevent seepage from the dugout getting into the house basement or waterlogging other areas of the farm. In many soils it may be necessary to put a lining in the dugout.

Ornamental trees, shrubs, orchards and shelterbelts usually grow well in central Saskatchewan when enough water is applied. The basic shelterbelt must be planted with the types of trees that give protection from the prevailing winds. A rectangular planting pattern is not essential and can be modified to suit the slopes on which the field layout is based. Square corners may not be any advantage, and wide cultivated strips between outer and inner rows of windbreak trees may use several acres that might be put to better use as part of a field. When outer rows of fast-growing trees are used as a snow trap to protect the inner trees, the outer rows should be removed when they have served their purpose. The area occupied by them can be included in the adjacent field, if provision was made to do so in the original layout.

APPENDIX A

MACHINERY COST PER HOUR AND HOURS OF USE AT PRE-DEVELOPMENT FARM, OUTLOOK

Machine	Cost per Hour	Hours of Use
Tractor	1.66	600
Drill	7.26	40
Conditioner	4.78	60
Mower	4.07	110
Harrow	3.47	40
Baler	5.17	200
Rake	4.17	110
Plow	3.85	100
Disker	4.81	50
Cultivator	3.85	50
Ditcher	4.50	30
Sprayer	6.54	30
Leveler	3.57	30
Potato Planter	3.70	70
Potato Digger	4.51	60
Potato Bagger	7.04	60
Combine rental	4.00	–
Swather rental	1.50	–

Note: Machine costs include tractor at $1.66 per hour and operator at $1.50. (For method of calculating costs see Appendix B.)

APPENDIX B

WORKSHEET FOR CALCULATING MACHINERY OWNING AND OPERATING COSTS

Fixed Costs per Year.

1. Obsolescence depreciation: $\frac{\text{Original purchase price } \textit{minus} \text{ End-use value}}{\text{Years of life}}$ .....

2. Investment cost: $\frac{\text{Original purchase price } \textit{minus} \text{ End-use value}}{2} \times$ Interest rate .....

3. Insurance and housing: $\frac{\text{Original purchase price}}{2} \times$ 1 percent .....

Total fixed costs per year _____

Variable Costs per Hour.

4. Fuel cost: Max. drawbar h.p. $\times \begin{matrix} .096 \text{(gas)} \\ .066 \text{ (diesel)} \end{matrix} \times$ Price/gal. $\times$ Load percent .....

5. Repair allowance: $\frac{\text{Original purchase price}}{\text{Expected normal use (hours)}} \times$ Repair rate .....

6. Labor: Hours $\times$ Rate per hour .....

Total variable costs per hour _____

Total Fixed and Variable Costs.

1. Per year: Total fixed cost/year *plus* (Total variable cost/hour $\times$ Hours annual use).....

2. Per hour: $\frac{\text{Total fixed cost/year}}{\text{Hours annual use}}$ *plus* Total variable costs per hour .....

3. Per acre: $\frac{\text{Total costs per year}}{\text{No. of acres of use}}$ .....

APPENDIX C

METHOD OF COST BUDGETING

The 1960 barley crop is given as an example.

Field No. 1 Year 1960 Acres 10.5 Yield 74 bushels/acre Total yield 10.5 × 74.0 = 777 Crop Barley

Machine	Hours of use	Rate	Cost
Harrow	3	3.47	10.41
Cultivator	3	3.85	11.55
Disker	21	4.81	101.01
Drill	4	7.26	29.04
Sprayer	–	–	–
Swather rental	–	1.50/acre	15.75
Combine rental	–	4.00 /acre	42.00
Plow	–	–	–
Potato planter	–	–	–
Farm leveler	–	–	–
Mower	–	–	–
Conditioner	–	–	–
Rake	–	–	–
Baler	6	5.17	31.02
Total	37		$240.78

Fertilizer: 100 lbs. 11-48-0, 10.5 acres at $5.50	58.00
Irrigation charge: 10.5 acres at $4 per acre	42.00
*Land use and taxes: $130 at 6.2%: $8 per acre	84.00
Irrigation labor: 39 hours at $1.50	58.50
Total costs	$483.28

Total machine hours per acre: 37 ÷ 10.5	3.52 hours
Total machine hours per bushel: 37 ÷ 777	0.05 hours
Total cost per acre: $483.28 ÷ 10.5	$46.01
Total cost per bushel: $483.28 ÷ 777	$00.62

*Land use charge includes: Value of land $50, cost to level land $50, construction irrigation work $30; total $130.