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WATER AND IRRIGATION IN CANADA

PROJECTIONS covering the next quarter-century of Canada's present and potential economic sources of food supply, in relation to domestic and foreign demand, give little encouragement for much further development of irrigated lands. Such projections can readily be accepted in view of the country's northerly location, its relatively sparse population and its comparatively recent settlement and development, in contrast to older lands of warmer, dry climates with denser populations where irrigation is essential.

It is believed, however, that beyond the period covered by such projections, there will come a time when Canada's areas of food production will need to be extended. The extension can be in two directions—beyond the frontier of land at present occupied, and in more intensive farming. The amount of agricultural land beyond the present frontier is definitely limited by climate, and the soil is for the most part podsollic of low fertility merging into a northern forest tundra. More intensive farming of land at present occupied is likely to encourage irrigation where water can be made available.

Extent of irrigation

Today not more than 3 per cent. of the agricultural production of Canada comes from irrigated land. Most kinds of Canadian produce are represented within this small proportion, ranging from cereals to tree fruits and sugar-beet. There are approximately three-quarters of a million acres of irrigated land in Canada. Ninety per cent. lies in the southern plains region of Saskatchewan and Alberta and most of the remainder lies in the inter-mountain region of British Columbia. Approximately one-quarter of this irrigated land is devoted to 'high per acre' value crops, including canning crops and sugar-beet in southern Alberta and tree fruits in the southern inter-mountain areas of British Columbia. The other three-fourths of the irrigated land is devoted to the 'lower per acre' value cereal and hay crops.

Physiography of Canada

Canada is composed of five main geographical regions. Beginning at the east, the first region comprises the provinces on the Atlantic. The central provinces of Quebec and Ontario occupy the second region. It consists of a flat to undulating plain in the south, drained at its southern boundary by the Great Lakes and the St. Lawrence River system, and in the north, of the Laurentian Plateau surrounding Hudson Bay. The northern plateau of the second region extends into the northern part of the third region, which consists of the prairie provinces, Manitoba, Saskatchewan and Alberta. Precipitation varies from around 20 inches on the eastern and western sides to less than 15 inches in the interior. The southern part of the third region is a great plain containing approximately one-half of the arable acreage of the country. The irrigated section lies at the south-west corner of the plain. Of strategic importance in the water resources of this third region is the Saskatchewan River system. Three main ranges of mountains enclosing two well-defined valleys and a slope to the Pacific, with Vancouver Island, comprise the fourth region—the province of British Columbia. Precipitation varies from as high as 80 inches on the coast to a very few inches in the southern parts of the valleys, and it is here that irrigation is practised, the main enterprise being fruit-growing. Three mighty river systems stand out in importance among the resources of this fourth region, namely, the Fraser, Thompson and Columbia. The fifth region stretches to the Arctic and contains the northern portion of the Laurentian Plateau. This region, with the exception of a few small isolated river-delta deposited areas, is not potentially agricultural land, as conceived at present. Two of the largest lakes in the world, the Great Bear and the Great Slave, and three of the longest rivers, the Mackenzie, Yukon and Nelson, are located within this large northern territory.

Settlement in Canada is generally confined to a narrow belt along the southern boundary. This belt varies in width from a few miles to more than 600, but on average is less than 200 miles wide. The northern limit to agriculture is set by climate, particularly temperature, and, to a lesser extent, by soil.

Water problems in contrast

Water problems related to food production in the first and second regions are usually associated with draining off the surplus water

rather than applying it artificially. Wherever the climate and markets are conducive to the production of crops yielding a high value per acre, crop drainage works have been gradually extended over the past century. This drainage is particularly marked in the flat, undulating plain in the second region. In this area, however, some irrigation is practised on the relatively small acreage where higher-priced garden crops, flue-cured tobacco, &c., are grown. The sources of water are drainage ditches and wells. Water problems relative to food production in the third region, particularly the plains, are usually associated with a lack of water. It is here that most of the irrigation is practised and the greatest potential for increased food production exists. The land is accessible and the soils are generally fertile. Within the narrow range of kinds of food produced in a temperate climate the limit to production is set by the amount of water that can be procured.

Water for irrigation

Nearly one-tenth of the surface of Canada is covered with fresh water. Scattered across the country are innumerable lakes, large and small, as well as rivers, the waters of which flow to the west, north and east into the oceans, or south to the St. Lawrence, the Great Lakes and the Missouri-Mississippi systems. The water of these inland lakes and rivers is replenished from the melting glaciers in the Rocky Mountains, and from moisture-laden air moving in from the Pacific in the west and the Atlantic in the east and south. Thus the supply is large in total but critically limited in many parts, particularly in the more fertile areas of the plains.

The greatest source of water for irrigating the southern plains of Alberta and Saskatchewan are the streams which arise on the eastern slope of the Rocky Mountains. These are mostly in the province of Alberta but a few are across the Border in Montana. This is the beginning of the Hudson Bay watershed, which is drained from its origin by the Saskatchewan River system. The water crosses the Alberta-Saskatchewan border in the north and south branches, which are widely separated. Together they form one main Saskatchewan river about midway across the province of Saskatchewan in the northerly part of the settled portion. With other drainage streams from north-eastern Saskatchewan and north-western Manitoba, it merges into a chain of lakes of the Manitoba Lake system to flow on into Hudson Bay. The increasing importance of the water in the

Saskatchewan River for irrigating and other uses in the central and southern plains may be appreciated when it is noted that the water loss from surface evaporation and transpiration of plants is potentially greater than the precipitation. It is claimed that even if these areas were to get another 2 or 3 inches of rain it would be evaporated rather than carried off by streams. Other sources of irrigation water occur in much smaller and more scattered streams in an adjoining watershed to the south, which is the extension of the Missouri watershed into Canada.

The Saskatchewan River is by far the greatest potential source of surface water for irrigation and other uses on the dry plains of the third region. Of the three-quarters of a million acres of land being irrigated today, 600,000 acres are provided with water from the south branch and its tributaries. It is estimated that enough water could be drawn from this same source to irrigate nearly three times the existing irrigated acreage, or about two million acres, before conflicting too drastically with other needs. But even this would amount to only about 5 per cent. of the improved land in the brown and dark-brown soil belts of the prairie provinces.

Reflections upon irrigation development

Irrigation development began shortly after the turn of the century, in the early years of settlement. At first it was done on a small scale by ranchers in order to ensure feed supplies and, later, on a large scale by railway and other developing agencies to colonize extensive land holdings. A combination of conditions favoured this early development. There were sources of water in streams flowing from the mountains in the west. Diversions could be made from them by comparatively simple structures. The distance to the plains was short. The plains sloped to the east and provided a gravity flow. The fertile soil and the long days of sunshine were conducive to rapid growth, but this was frequently prevented by lack of precipitation. Irrigation could supply the needed moisture.

Nearly three-fifths of the present irrigated lands on the south-west plains were developed and colonized by the Canadian Pacific Railway. Most of such land had been acquired by means of financial grants given by the Crown to assist railway building. The land would return far more revenue to the railway company from crop production than from grazing, not only because of the produce which could be carried

to distant markets but also because of the number of people who could be supported on it and served by the railway in both in and out traffic. Most of the other two-fifths of the irrigated land was developed by corporation organization, community effort and private individuals. The acreage developed by individual effort was small and scattered in relation to the irrigated area as a whole. The corporation organization was a colonization as well as an irrigation agency. The community and private developments were associated with people who were already settled and had attempted dry land farming.

The course of irrigation development has been both accelerated and retarded according to circumstances. Furthermore, any appraisal of progress must be considered from both long-term and short-term points of view. And, indeed, progress itself must be defined. From a short-term point of view it is possible that, apart from helping to provide a supplementary feed supply for the cattle rancher, irrigation was introduced too early in the growth of the agricultural economy of the western area. When this development was taking place there was still more land open for settlement to the north and east. Here, too, there was a more dependable natural precipitation, and other conditions in respect to soil, topography and market outlet were as favourable as where the land was irrigated. Thus the irrigation farmer with his higher costs had to compete with the dry land farmer. This continues to be the situation for at least three-fourths of the acreage under irrigation. It is a case of obtaining much higher yields under the better controlled moisture conditions to offset the lower costs of the dry land farmer. For the remaining fourth of the irrigated land, which lies a little to the south and east of the other land at present irrigated, plants have been established for processing sugar-beet and for canning factory crops. These enable the farmers to grow crops of high value per acre which return a higher net revenue than do cereals and forage crops.

Much of the land was settled by farmers inexperienced in irrigation practices and it took a number of years before they acquired the necessary knowledge and skill. Even those who had experience had little to offer, for they were in a new country which differed in climate and economy from that from which they came.

From a short-term point of view, if progress is to be measured in any orthodox accounting method, few of the larger irrigation districts can be regarded in a favourable light, except where crops with high value per acre are grown. In the beginning it was planned that the

farmers who settled on the irrigated land would pay the cost of the operation of the irrigation systems, and over a period of years would repay the original investment. Contracts to settlers were issued accordingly. Almost from the beginning, however, settlers defaulted in their payments, and even with relief to the extent of having the price of the land reduced from around \$60 per irrigated acre to a quarter of that amount, they still continued to fall into arrears in their assessed payments for operating expenses and on capital accounts. Those districts which were developed by community effort were the first to get into financial difficulties and their affairs were taken over by the Alberta government which had guaranteed the irrigation districts' bonds. The Provincial government has continued to direct their financial affairs to the present time. Non-railway land developed with irrigation and colonized by corporation organization proved a losing venture for its shareholders after about two decades, and was transferred to the Dominion government for a fraction of the investment cost. The Canadian Pacific Railway operated the systems which it built for about the same length of time and then turned them over to the water users themselves. Thus for the decade following the initial development, irrigation farming on the south-west plains could not be acclaimed as a financial success. Nor was it successful in all other respects, for many settlers abandoned their irrigated farms, some to move into other employment and others into dry land farming to the north and east.

However, there came a succession of drought years—1929 to 1937 inclusive—over the whole south central and western plains, when irrigation farming looked more attractive. There was then an exodus of dry land farmers from elsewhere on the southern plains, and many found their way to the irrigated areas. The abandoned irrigated farms were rapidly reoccupied, and a cry arose for the extension of irrigation to lands beyond the range of existing irrigation facilities.

The advent of P.F.R.A.

In 1935 the Prairie Farm Rehabilitation Administration was created by act of the Dominion Parliament to assist in rehabilitating the drought-stricken farmers of the plains. Their headquarters were established at Regina which was centrally located. From here the rehabilitation administration embarked on a programme of systematically directed land and water use of far-reaching importance to agriculture. In the subsequent two decades nearly two million acres

of land which had proved unsuitable for cultivation was fenced into community pastures, the grass was improved and an adequate water supply was provided for the stock of about 6,000 farms. More than 50,000 farm watering dugouts and small dams or catchment basins were constructed on the plains under the direction and financial assistance of the P.F.R.A.

Before that body came into existence, the direct interest of the Dominion government in irrigation was largely confined to administering water rights¹ as set out in the North-West Irrigation Act of 1898, and to surveys locating potential irrigated areas and available waters. It did not actively participate in any development. With the commencement of the rehabilitation programme in the mid-thirties the Dominion government was drawn into active participation in this development. At first it participated in the resettlement of farmers from the poorer dry land farming areas of the plains on to irrigated lands and, shortly after, in the extension of irrigation to other lands. This required the creation of reservoirs for impounding more water. Its activities also included giving assistance in the construction of reservoirs for impounding water for domestic consumption and industrial use for a number of the larger towns and for a few cities in the west.

About this time too the Dominion and Provincial governments became a little more conscious of the limitations of the country's water resources in certain areas, and they moved towards guarding these resources and exercising more control over their use. Under the Eastern Rocky Mountain Forest Conservation Act a board was set up to protect and conserve the forests on the eastern slopes of the Rocky Mountains which include the greater part of the watershed of the Saskatchewan River. The functions of the Board are to engage in such work as will give proper protection to the forests and other vegetation cover and thereby provide the greatest possible flow of water in the Saskatchewan River and its tributaries. In 1921, by a treaty between the United States and Canada, waters arising in Montana and flowing into Alberta through the St. Mary and Milk rivers were apportioned between the two countries. This necessitated the construction of reservoirs for the proper utilization of their respective shares. While the United States interests built reservoirs on their side of the boundary for this purpose, Canada delayed making like provision.

¹ Since the transfer of their own natural resources to the prairie provinces in 1930 water rights have been administered by the respective provinces.

Impounding water on a large scale

As part of the overall rehabilitation the Dominion government, through the P.F.R.A. built the St. Mary Reservoir to store some 320,000 acre-feet of water to provide more water to existing irrigated land and to extend irrigation facilities to adjoining larger areas to the south-east. Another major dam, the Traver, was built by the P.F.R.A. to provide a more adequate water-supply for irrigated land north of this block and to extend irrigation there.

The largest dam to be undertaken by the Dominion government through P.F.R.A., is on the South Saskatchewan River about midway across the south-central part of the province of Saskatchewan. It is a multiple-purpose dam designed to provide water to irrigate some half a million acres and to produce 475 million kWh. of electrical energy. This dam will also be the source of water for domestic and industrial use of two of the Province's major cities and for raising nearby lake levels. In addition, the dam is expected to give a measure of flood control down stream.

Water from North Saskatchewan for irrigation

The north branch of the Saskatchewan River has also been proposed as a source of water supply for irrigating land in central Saskatchewan. The plan is to divert water from one of its main tributaries, rising in the same Rocky Mountains as do the tributaries of the south branch but farther to the north, and to carry it by existing river channels and lengthy canals to the proposed central Saskatchewan irrigation block. Suitable irrigable lands across the drier central and eastern region of Alberta could also be provided with irrigation, stock watering and other services from the same channel. The advocates of this scheme argue that such an undertaking would operate mainly by gravity flow, and would cost less than the high dam and pump lift. However, it would not provide the water power for electricity which is offered by the dam on the South Saskatchewan branch.

Plans for diverting water from the upper reaches of the North Saskatchewan River for irrigation in the Province are looked upon askance by two cities located thereon which draw their water supply from this river. With their rapid population growth of recent years and their increased industrialization more and more water is used, and to ensure adequate supplies large reservoirs up stream will shortly be required.

Farther to the north of the sources of the Saskatchewan River the waters rising in the Rocky Mountains empty into rivers flowing north and eventually into the Arctic Ocean. It is proposed that water from these nearer north-flowing streams be diverted into the North Saskatchewan to augment the supply where needed. No doubt in the not-too-distant future these far-away sources will have to be drawn upon. It is probable that long before the water from the more northerly streams is diverted south for domestic consumption or irrigation, it will be used in its northerly flow at strategic sites to generate power which can be more economically transported to the settled area than the water itself. A plan to develop hydro-electric power on the Peace River in northern British Columbia is being considered by the government of that Province.

Control in the use of water

The jurisdiction over the use of water is vested in the governments of both the Dominion and the Provinces. Where a body of water lies wholly within a province the right to its use, its regulation, &c., is administered by the province. Boundary waters and waters in the territories outside the provinces are subject to the jurisdiction of the Dominion. Such jurisdiction is shared with the provinces where waters serve as, or cross, provincial boundaries, and with the United States where the waters similarly affect the two countries.

International control

The boundary line between Canada and the mainland of the United States is approximately 3,500 miles long, and 2,000 miles of it are marked by navigable and non-navigable waters. The right to the use of these waters for sanitary and domestic purposes, power, navigation, irrigation and development is one which the inhabitants of both countries enjoy in common. In the exercise of their common rights, controversies have arisen from time to time. A series of these disputes led to the treaty of 1909 relating to boundary waters between the two countries and to the evolving of more permanent machinery for settling border water controversies.

Under the Boundary Waters Treaty of 1909 an International Joint Commission, consisting of a chairman and three other members from each country, was established to advise on all cases involving the use, obstruction or diversion of boundary waters. Such waters were

defined as those forming the boundary and those flowing into or out of one country or the other.

Matters respecting the carrying out of the treaty of 1921 regarding the waters of the St. Mary and Milk rivers have been arbitrated by the International Joint Commission. The St. Mary is an important stream for irrigation in Canada. At least one-third of the land irrigated at present in Alberta is irrigated by water diverted from this river.

To the west, beyond the Hudson Bay watershed within the fourth geographic region which is marked by the Rocky Mountains, there are a number of United States-Canada boundary waters. In a few instances control of these waters for irrigation has been referred to the International Joint Commission but there has been little interest in this use to date compared with the control in respect to power. The Columbia River rises in the Columbia Lakes in the province of British Columbia on the western slope of the Rocky Mountains. The main stem of the river is 1,210 miles long, the first 465 of which are in Canada. Although only 15 per cent. of the Columbia drainage basin is on the Canadian side, that portion yields one-third of the total volume. There has been considerable development down stream using the waters of the Columbia for power and to a lesser extent for irrigation—notably that associated with the Grand Coulee Dam. It is proposed that for fuller use of these waters, reservoirs should be built up stream on the Canadian side. The benefits of such fuller use would be obtained by the down-stream users, and the Canadian contention is that Canada should be compensated for any storage created up stream to benefit United States users. These issues are now before the International Joint Commission.

The conflict of interest in the use of water of the Columbia basin, which is being arbitrated by the International Joint Commission, and other noted boundary waters on the plains indicate the complexity of the problems which come before this tribunal and the variety of solutions which are called for. Problems in the Columbia basin, where power interests are involved, require a different sort of solution from those in the arid section of the plains where irrigation interests are paramount. Further differences are likely where a combination of these uses is sought.

Domestic control

Less thought has been given to and administrative action taken

concerning waters which affect provinces within Canada. A number of reasons for this are apparent. Perhaps the foremost is that the provinces are one in sovereign right and hence are of the same national entity. Geography may be cited as a further reason; stage of development also plays a part. The eastern provinces in the main are separated by water. Up to now, generally, there has been a surplus supply. With few exceptions there does not appear to have been any question arising from one province diverting more than its share of the water. Between British Columbia and Alberta the great divide of the Rocky Mountains serves as a boundary so that nature decides the question of the distribution of the water, except where the Peace River crosses from the province of British Columbia into Alberta. Until more development takes place in that part of the country, questions concerning rights to water flowing from one province to another are not likely to arise.

However, while water at no place serves as a boundary between the prairie provinces there are, as noted with the Saskatchewan River System, inter-provincial streams which have called for the setting up of a permanent tribunal to arbitrate the interests of the three provinces with regard to common water.

All bodies of water within a province come under the jurisdiction of the government of that province.¹ A water resources branch in each province exercises control over its use, by issuing licences, by engaging or supervising improvement works, &c. Water within the national parks is an exception to this.

On 28 July 1948 the Prairie Provinces Water Board was established by the governments of Canada, Manitoba, Saskatchewan and Alberta. It consists of two members appointed by the Dominion and one by each of the three provinces. The director of the P.F.R.A. is one of the two Dominion representatives and is also the chairman.

The Board's function is to recommend the best use of inter-provincial waters in relation to associated resources in Manitoba, Saskatchewan and Alberta and to recommend the allocation of water between each province of streams flowing from one province into another.

¹ The Northwest Irrigation Act of 1894 was the first Canadian statute dealing with the subject of irrigation. It declared surface water to be property of the Crown and provided for granting of leases for use only, subject to revocation by the government for abandonment, wasteful use, or non-use. This was retained in the statutes of the Prairie Provinces with transfer of natural resources to those provinces. British Columbia has a similar statute regarding the ownership of water and rights to its use.

Thus the Board's duties¹ are of an advisory nature and to that end it (1) collates and analyses available data relating to the water and associated resources of inter-provincial streams; (2) determines what other data are required from time to time and makes recommendations to the appropriate governmental organizations for the carrying out of such surveys and studies as the Board considers necessary; (3) recommends the allocation of the waters of inter-provincial streams upon the request of any one of the three provinces or the Dominion government; and (4) reports on any questions relating to specific projects for the utilization or control of common river or lake systems at the request of one or more of the ministers or authorities charged with the administration of such river or lake systems.

The recommendations of the Prairie Provinces Water Board for the allocation of more than three million acre-feet of water per annum, chiefly from the south branch of the Saskatchewan River, for major uses in Alberta and Saskatchewan are of interest. More than two million acre-feet of this water provides for irrigation projects at present in operation or for which the provinces were in reality committed at the time the Board came into being. Nine hundred thousand acre-feet has been allocated for irrigation in connexion with the multiple-purpose project on the South Saskatchewan River in the central part of Saskatchewan.

The future and water supply

It is evident that considerably more preliminary study, planning and debating have gone into the South Saskatchewan River project than into any previous irrigation development on the plains. There are a number of reasons for this. The development requires a larger reservoir with a dam more costly than any structures made for storing and diverting water elsewhere for irrigation in the west. It is a government undertaking which is to be financed largely by the state. The experience on at least two-thirds of the present irrigated land on the plains, where the physical, climatic and economic environment is very much the same as that of the South Saskatchewan River development, promises only a long, slow, uphill climb towards a generally acceptable measure of successful accomplishment.

Of more immediate encouragement is the multiple purpose nature of the development. The dam promises to give the Province of

¹ Tenth Annual Report 1957—Prairie Provinces Water Board.

Saskatchewan, which is short of fuel and devoid of strategically located natural water-power sites, the cheapest source of power energy. It will provide a guaranteed supply of water conveniently located for two of the Province's major cities which have been frequently short of water. The project calls for the weighing of many factors, of which the most important, possibly, as with similar proposals in the plains region of the prairie provinces, is a commitment for the use of water. Water is critically limited for the many uses which can be foreseen in the economic growth of the prairie provinces.

One of the most important uses is certain to be for irrigation, for it must be conceded that, from a long-range point of view, more and more food will be needed both at home and abroad, and with assured moisture conditions the fertile plains of the prairie provinces have much to offer in the economy of food production. Irrigation is a long-term venture, and an essential part of its programme of development is a carefully worked-out plan for water supply.