United States seems attended by certain dangers; but the reasons for these may be assigned to other features of the United States banking system, among which may be mentioned the dominance of speculative influences in the New York money market, the independent Treasury system, and rigidity of the bank note issues.

To the fact that Canadian banks refuse to encourage speculation to any extent whatever may be assigned the comparative steadiness of the Canadian stock markets.

I have before referred to the tendency towards equalization of the rates of interest in all parts of the Dominion, due largely to the branch system and freedom of note issues of the Canadian banks.

THE RATIONAL USE OF WATER IN IRRIGATION.*

Dr. John A. Widstoe.

To all who have dipped ever so little into the history of irrigation, the annual meetings of this Congress appear of great importance. Irrigation is one of the great world-movements for subduing the "waste places" of the earth, and also for solving many of the social problems that perplex mankind. It is not impossible that upon irrigated lands, with their possible small family units, and their fertile soils and abundant sunshine, shall be formulated by actual experience the social ideals that eventually may bring the nations with their legions of human hearts into co-operative peace. This Congress is the only organized body which assumes general interest in all the methods, purposes and results of irrigation.

From its humble beginning in this city, modern American irrigation has grown, until the census of 1909 reports nearly 14,000,000 acres of irrigated lands. One-half of this vast area was brought under irrigation since 1899, and three-fourths since 1889. That is to say, during the last twenty years, three-fourths of the irrigated lands were reclaimed; while only one-fourth was brought under irrigation during the first forty-two years after the entrance of the Utah pioneers into the Great Salt Lake Valley. Clearly, the efforts of the country in behalf of irrigation have increased in geometrical ratio. This interest appears to continue undiminished, so that it can only be a matter of comparatively short time until most of the irrigation waters of the West shall have been brought upon the lands.

There are three main stages in the development of an irrigation project. First, the construction of satisfactory dams and canals in which the water may be stored and then led upon the land; second, the settlement upon the reclaimed land of a sufficient number of people to make full use of the opportunities of the project; and third, the correct use, by the settlers, of the water and land so that the project may be highly and permanently profitable. While these three stages are of equal necessary importance, yet it is evident that the first two, construction and settlement, once accomplished, are practically forever done, but the third, the use of the water, is of annual recurrence, and in the end will determine the success or failure of the project.

This third stage, the use of water, has been given least systematic attention; but with the increasing population under irrigation, it is insistently clamoring for attention. In the arid and semi-arid region, irrigation, under present methods of use, can probably never reclaim more than one-tenth to one-fifth of the total area of tillable land. For our 14,000,000 acres of irrigated land there are at least 500,000,000 acres that must be reclaimed, if reclaimed at all, by other methods. There will always be more land than water in the arid region; and one of the chief concerns of every project should be to cover profitably the largest possible area. The actuating spirit of irrigation enterprise is, or should be, to make possible happy homes for the many.

With this thought in mind let me call your attention to two vital principles of irrigation success. First, the beginning of irrigation wisdom is the conservation of the natural precipitation, i.e., the rain and the snow. Irrigation is not a primary art; it should always be supplementary to the natural precipitation, and should only make up for the deficiency in the rainfall. The progress of dry-farming during the last decade has brought this truth home to the irrigated section. The water which falls from the heavens, even under an annual precipitation of ten inches, is amply sufficient to produce crops, could it only be fully held in the soil. By properly conserving the rain and snow-water in the soil by dry-farming methods, large crops may be grown with small quantities of irrigation water. This is well brought out in a series of experiments conducted during the last ten years at the Utah Experiment Station.

Table No. 1—The Crop-producing Power of the Natural Precipitation.

Yields per acre.	Inches of irrigation water used. None.	5.0 to 7.5.	Per cent. of yield due to rainfall.
Wheat (bush. of grain)....	39	47	84%
Oats (bush. of grain).....	55	64	86%
Corn (bush. of grain).....	44	54	81%
Wheat (pounds of straw)..	3,934	4,526	86%
Oats (pounds of straw)...	2,233	2,274	98%
Corn (pounds of stover)...	3,228	3,888	83%
Alfalfa (tons of hay).....	5,540	7,178	77%
Potatoes (bushels)	97	145	67%

The data in the above table show that approximately 85 per cent. of the yields, under irrigation conditions, of wheat, oats and barley, 77 per cent. of the yield of alfalfa and 67 per cent. of the yield of potatoes, was due to the natural precipitation stored in the soil. This is only a fair sample of what may be done on any irrigated farm if careful soil tillage be practised. If, now, by careful tillage the natural water had been allowed to escape into the air, much more irrigation water would have been required to produce the crops. By the proper storage of the rain and snowfall in the soil, alone, it is possible to extend our irrigated 14,000,000 acres considerably. Therefore, to make our irrigation projects of greater service, the settlers upon them must be taught that irrigation is designed only to supplement the natural precipitation.

Second, the yield of any crop under irrigation is not in proportion to the quantity of water applied. The more water is used in irrigating a crop, the less yield is obtained per unit of water. This has been amply demonstrated also in the long continued investigations at the Utah Station, already referred to. As examples, note the following results obtained with wheat and sugar beets:—

Table No. 2—Inches of Irrigation Water Applied.

	5	10	15	20	30	50
Wheat (bush. grain per acre)	38	44	46	47	49	49
Wheat (lbs. straw per acre)	2,986	3,452	3,954	4,311	4,755	5,332
Sugar beets (tons per acre)	14	19	20	21	21	24
Wheat (bush. grain per acre-inch)	7.56	4.35	3.05	1.86	1.39	0.99
Wheat (lbs. straw per acre-inch)	597	345	264	172	136	107
Sugar beets (tons per acre-inch)	2.76	1.86	1.30	1.06	0.69	0.49

As the water increases, the yield becomes relatively smaller, and if enough water is applied, there is an actual diminution of yield. The studies of the United States Irrigation Investigations under Drs. Mead and Fortier have shown that excessively large quantities of irrigation water are used in ordinary practice. The losses which the irrigated

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