EXPANSION OF COLORADO'S AGRICULTURAL POSSIBILITIES THROUGH IRRIGATION.

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The subject assigned me, namely, "Expansion of Colorado's Agricultural Possibilities Through Irrigation," embraces one of the most important of the varied industries of the State of Colorado, and I regret that the time and occasion permit of only brief reference to some features of it.

I am glad, however, to have the opportunity to present for your consideration some notes having a bearing on present day irrigation development in Colorado which I earnestly believe are of vital importance to the welfare of our state, and to refer you to an able and comprehensive paper, entitled, "Some Aspects of Irrigation Development in Colorado," by Mr. Geo. G. Anderson, read before this Society on December 4th last, and published in its proceedings, in which you will find much valuable information.

It is unnecessary for me to tell you anything about the agricultural possibilities through irrigation. The advantages, benefits, possibilities and profits resulting from irrigation, or, as it has been termed, "The World's Greatest Industry," are being constantly and prominently proclaimed by the newspapers and magazines of the whole country, as well as by advertising matter of all kinds put forth by the United States Reclamation Service and by land agents, promoters, contractors, bond brokers, etc.

The logic of the situation has recently been briefly stated as follows:
EXPANSION OF COLORADO'S AGRICULTURAL

"Properly developed irrigated lands present all the advantages possessed by agricultural lands watered by rainfall, in addition to which they possess in a marked degree the following superior advantages:

"Greater fertility. Plant food occurs in the soil as soluble salts, which are taken up by the plant. The effect of rainfall is to dissolve these salts and wash them away into the sea. Arid lands are rarely subjected to a washing or a leaching rain, consequently the fertile salts and salt bases of the original soil have been held since their formation under the surface, ready for the action of the sun, air and water to be transformed into plant food.

"Fewer uncertainties. The farmer on irrigated land is dependent upon the hazards of the weather for temperature only. Practically continuous sunshine is a certainty; the water supply is subject to the control of the farmer and is turned on or shut off as the needs of his crops demand; destructive storms are practically unknown; harvested crops cure quickly and with certainty, due to the prevalent clear weather.

"More rigid control of crops. Plants respond to skillful culture, they wither and deteriorate under neglect. The advantage of the irrigationist is not confined to the timely application of water. He approaches the problem in the knowledge that when the day arrives to stir the soil he will have weather which will permit him to work. As his young plants grow he gives them that essential addition to a well-balanced food supply, insuring the greatest returns; the timely application of water. By stirring the soil, by thinning the growth, each when needed, neither too early nor too late, he finally harvests in perfect assurance that his crops will cure properly. Thus he controls not merely the quantity of his crop, since he coaxes the maximum yield from the soil, but at the same time he secures the very highest quality. Thus he goes into the market with products which call for top prices, and with acreage yields which have no parallel except under identical conditions.

"Contrasted with this condition we find the farmer in the rain belt beset with uncertainties. The spring rains delay the planting or rot the seed in the ground. The summer drought dwarfs the plant, or the excess of moisture gives an excess of plant growth and a dearth of marketable product; as maturity approaches untimely rains start a new growth, giving a soggy, unsound product; or prolonged dry weather causes the product to grow in small, unmarketable sizes. Finally when the harvest comes, the crop is cured between showers in a more or less unsatisfactory condition.

"The advantages lie wholly with the irrigator, and when the superior income-producing possibilities of fancy products are more generally appreciated, irrigated lands will take on value far beyond those of lands which have the same range of crops in the rain belt. The desirability of
liens against such lands as investments hinges wholly upon reliability. When reliability is assured, loans to the same proportion of the value as are made upon other agricultural lands become securities of the very first class.

"Inquiry as to the stability of an irrigation enterprise requires favorable answers to the following questions:

"Are climate and soil conditions favorable?

"Is the water supply adequate for the entire body of land to be reclaimed and free from legal or physical complications which may result in impairment of the rights?

"Is the engineering certain to be done by engineers broadly experienced in all phases of irrigation work, and is the construction to be carried out by an efficient organization accustomed to hydraulic work and of such high business and professional standing as to insure safe and permanent construction?

"Do the plans for the enterprise call for efficient and timely development of the irrigation facilities, and permit that wise development of the irrigated lands essential for the mutual prosperity of the development company and of the settler?"

In what follows I desire to say sincerely that it is far from my intention to unfavorably criticise legitimate irrigation development. I am an enthusiast over the great and lasting benefits to our state which will result from the continued development and utilization of our water resources. The resulting large population and intensive agriculture will certainly add enormously to our prosperity.

That farm lands are increasing greatly in value is well known. The rise in price of lands during the last ten years is a natural result of the encroachment of demand upon supply. The rise in value is permanent and foreshadows the valuation of lands upon the basis of income-producing possibilities. This implies, during the next ten or twenty years, values hitherto unknown and a steadily increasing stability in securities based upon land values.

But it seems to me that under the influence of the prevailing enthusiasm on the part of land owners, contractors and bond buyers, more and more and larger and larger irrigation districts are being promoted, financed and constructed, and that sufficient attention is not being paid to the vital
features of the adequacy and permanency of the water supply.

Some who should know may have forgotten, and undoubtedly there are many who do not know, that the amount of water apparently now available for new irrigation enterprises is not the permanent and dependable supply.

Dry years, i.e., years of much less than normal precipitation, and perhaps several such years in succession, no doubt will occur again as they have in the past, and then the water supply may be insufficient for all of the lands under the extended irrigation systems.

Then the early appropriations and decrees will require all of the water, leaving the later appropriators to experience the bitter disappointment of being without water for their crops, which, in the case of a succession of dry years, would surely result in financial disaster to the farmer.

In that event, even the owners of the irrigation district bonds may find their investment much less profitable than they had been led to believe, and in some cases the interest and principal of the bonds may be defaulted.

It is no argument against the possibilities and the value of irrigated lands, and against securities based thereon, to emphasize the necessity for careful examination of the soil and of the water supply and of the plans proposed for the development.

Primarily, the lands proposed for irrigation must be fertile. Arid lands are subject to much variation in quality, even in localities where superficial conditions indicate uniformity. Soil content, including amount of alkaline salts; slope; topography; sub-soil; prevailing winds; exposure to sun; proximity to high mountains, forest areas, bodies of water or desert areas; character of natural vegetation and location of ground waters are some of the factors which indicate to the experienced investigator the results which should be anticipated. All these should be carefully studied by experienced irrigation engineers and experts, and en-
gineering plans and consequent construction should fully meet local conditions.

Water supply is a question demanding the most careful scrutiny. Usually the available supply will be an unknown quantity. Practically all sources of supply are complicated by numerous filings or applications for appropriation. Some applications will have been over-appropriated, others will have lapsed through non-use. Frequently streams which are proposed as the origin of water supply have not been gauged systematically for a sufficient length of time to give definite knowledge as to the probable run-off. The amount of water available must be estimated in such cases upon the investigator's knowledge of conditions which give the watershed of the stream its characteristics.

It is much to be regretted, but the fact nevertheless remains, that so far the State of Colorado has neglected to safeguard the farmer and the investor in this matter. It is a dangerous condition which should be remedied by amending the irrigation district laws at the first opportunity.

As things are at present, it is made easy for an irrigation district to issue and deliver its bonds, which are a first lien on all of the lands in the district, for what purports to be a complete and suitable irrigation system, consisting of an adequate and permanent water supply in connection with reservoirs, canals and ditches for the distribution of the water, without first having the questions of the adequacy and permanency of the water supply and the suitability of the proposed irrigation works passed upon by competent authority.

In this respect the irrigation district law differs from the well known "Carey Act," under which the government has provided that:

"Before the application of any state is allowed, or any contract or agreement is executed, or any segregation made of any of the land from the public domain, the state shall file a map of the lands selected and proposed to be irrigated, which shall exhibit a plan showing the mode of contemplated irrigation and the source of water. In accordance with the requirements of the act, the state must give full data to show that
the proposed plan will be sufficient to thoroughly irrigate and reclaim the land and prepare it to raise ordinary agricultural crops; for which purpose a statement by the State Engineer of the amount of water available for the plan of irrigation will be necessary."

It seems to me that our irrigation district laws should be so amended as to provide that when a district has been duly organized, before advertising or submitting the question of bonds to the electors, the board of directors should employ a competent engineer to make preliminary surveys of the reservoir sites, canals and ditches and to make an estimate of the probable cost of construction and to pass upon the sufficiency and permanency of the water supply.

And that, after the bonds have been voted in a sufficient amount to complete a practical irrigation system and to acquire the necessary water supply therefor, competent engineers should be employed to complete the plans, specifications and estimates of cost in detail, and that, before advertising for bids, these plans, specifications and estimates, and the report on the water supply, should be referred to the State Engineer for his inspection and approval, and that no bonds shall be given to contractors for the construction of said works, nor for the acquisition of the water rights, until after the plans and specifications and the estimates of cost of said irrigation system, and of the sufficiency of the water supply, shall have been passed upon and approved by the State Engineer.

And then final payment should not be made to the contractor until the State Engineer shall have approved the completed work.

This would provide a reasonable safeguard to the land owner and to the investor and assure the farmer that he would have a sufficient and dependable water supply delivered through properly constructed works.

It is a well known fact that the supply of agricultural lands available for settlement is largely exhausted and rapidly disappearing. It has also been shown that lands included in properly developed irrigation areas are liable to minimum
risks from natural causes, and that crops are not only more bounteous, but are also of the finest quality. This is particularly true of fruits and vegetables. As the largest and most profitable crops can be produced from irrigated lands, the rise of these lands to values proportionate to their earning capacity is assured during the next generation. The rapid increase in population, and the resultant demand for farm products of all kinds, will tend to increase the price of all agricultural lands. Irrigated lands will share in this increase in greater degree, because of their climatic and income-producing superiority. Consequently securities based on actual costs of development, or on present values of irrigated lands, may properly be considered as belonging in the class of exceptionally desirable investments.

In view of all the well known advantages of sound irrigation developments, and in connection with what I have presented to your attention this evening, is it not a sad commentary on our laws and the practice thereunder that municipal irrigation district bonds issued under the laws of the State of Colorado are not considered a satisfactory and safe investment for the state school funds?

As before mentioned, the irrigation district laws of the State of Colorado should be revised and amended at the first opportunity.

It has been pointed out frequently that the method of appointing and compensating the Water Commissioners of the state does not yield satisfactory results.

The information contained in the Water Commissioners' Annual Reports is the official history of the use of water, is much sought after by the irrigation engineers and actual users, is often required in case of litigation over water rights, and therefore it should be accurate and dependable.

It would seem best that the Water Commissioners should be appointed by the State Engineer after an examination to ascertain the qualifications of the applicant who, after appointment and giving bond, should not be removed from
the office except for good cause shown or upon charges sus­
tained by the State Engineer. The distribution of water is
being complicated by the construction of long canals extend­
ing into more than one county, and sometimes in more than
one district, such as the diversion of water from the western
to the eastern slope.

The uncertainty and annoyance now experienced by
Water Commissioners may be avoided by classing them as
state officials and paying them from the general fund of the
state.

It would seem also that the interests of all concerned
would be very much better served if the term of office of the
State Engineer were made very much longer than at present.

It requires some time to become familiar with the duties
and records of the office, and it is obvious that he can dis­
charge the duties more efficiently after he has become fa­
miliar therewith.

There seems to be room for a material improvement in
water right contracts and in the unit of measurement.

All water right agreements should promote economy. A
charge for water by the acre foot delivered, rather than by
the acres of land irrigated cannot fail to have a marked in­
fluence in increasing the duty of water.

Most of the early water right contracts stipulated the
second-foot as the unit for the sale and use of water, but ex­
perience is demonstrating that the acre-foot unit per acre per
annum is a far more satisfactory and equitable basis.

The United States Department of Agriculture for several
years has been securing data of the actual use of water as
irrigation is practiced in the west.

The general conclusion is that far too much water is be­
ing applied, and that in the future it will be possible, through
improved methods, to double the average duty of water now
obtained, so that the quantity now used for one acre may be
made to irrigate two acres.
We, therefore, have reason to believe that with the increasing duty of water, the better construction of canals, the development and use of all seepage waters and with further construction of storage reservoirs, the irrigated area in the State of Colorado can be largely increased.

The problem of the proper drainage of irrigated lands is one of vital importance and one whose magnitude is not yet fully realized. Although a troublesome and intricate matter, it is one which if undertaken in time can usually be solved safely and satisfactorily. Colorado in this respect is only reaping the earlier experience of Egypt and India.

The history of irrigation shows rather that canals have first been made and used for a long time before any attention has been paid to drainage. It was assumed that it could take care of itself, and that rainfall and the surplus water of irrigation would disappear somehow by evaporation, absorption, or otherwise.

To some extent, in high-lying lands, drainage will take care of itself, provided the natural drainage channels are not interfered with. But in low-lying lands the evils that result from the neglect of drainage will inevitably call attention to the subject.

Experience throughout the arid region is demonstrating that the greatest danger to irrigated lands is lack of drainage. Water applied to crops raises the ground water which brings with it the salts dissolved from the soil; capillarity brings this water to the surface, where it evaporates, leaving the salts to accumulate until all vegetation is destroyed. The only insurance against this is proper drainage. The drainage conditions are therefore equally important with the water supply, and should be looked into with as much care. When there is not good natural drainage it must be supplied artificially. This, usually, is as expensive as securing the water supply.

While good drainage is the only guarantee against these evils, anything which will check the rise of ground water or lessen evaporation, will decrease the danger. The two most
effective means of accomplishing these ends are economy in the use of water and thorough cultivation, and cultivation makes possible the greatest economy in the use of water. Cultivation should follow as soon as possible after the water is applied, and be repeated often. This will check evaporation and keep the water in the soil for the use of plants, making it unnecessary to apply more so soon as it would otherwise be needed, and in this way reduce the volume which might go to damaging the land.

The carefully conducted investigations made by the United States Department of Agriculture have shown the entire feasibility in most cases of preventing the ruin of irrigated land by the accumulation of excess seepage water and alkali. Furthermore, it has been shown that, in general, such land can be restored to fertility, even after it has reached such a condition that it can support no useful crop.