Historical Improvements in Groundwater Pumping Equipment and Resulting Changes in Farming Economics in the United States

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It is difficult to quantify the rise in the standard of living that has resulted from irrigated agriculture using groundwater. Without groundwater irrigation, man was completely at the mercy of nature and variations in rainfall to grow crops. Human and/or animal power has been used for thousands of years to provide water for irrigation. However, these inefficient methods severely limited the amount of land that a single farmer could efficiently cultivate.

The invention of self-regulating windmills and other pumping machines resulted in revolutionary changes in farming, especially in the arid areas of the western United States. Wind-powered devices pumped at limited and uneven rates, requiring significant water storage for crops to be adequately watered. Wind devices eventually gave way to pumps powered by carbon-based fuels. Steam-powered pumps, although an improvement over windmills, required a skilled operator, and could not be left unattended for any extended period of time. Wood or coal-fired boilers for steam engines were inefficient and dangerous to operate.

In the late 1800s, rapid improvements in mechanical devices led to more efficient oil and gasoline-powered equipment that could be used to lift and distribute even greater quantities of groundwater. An oil or gasoline powered pump could be left unattended for hours, allowing each farmer to manage more acreage. Better equipment designs meant that more water could be lifted from greater depths, and more acreage could be irrigated.

Each improvement in machinery resulted in economic benefits. Human and animal powered equipment limited each farmer to just one or two acres. Depending on the size, a single windmill might irrigate four or five acres. An 1898 review of irrigation practices in New Mexico indicated that windmill irrigation “can hardly be a financial success, owing to the great initial outlay” of as much as $800 for a windmill, land, and well (U.S. Geological Survey, 1898, Irrigation Paper Number 10). At the same time, a steam pump and equipment might cost $15,000, however, it could be used to irrigate a much larger area at a cost of about $100/acre. A comparison of irrigation costs in 1896 in Texas indicates that the cost of water to irrigate one acre was $20-$50 (U.S. Geological Survey, 1898, Irrigation Paper No. 13).

The advancement of gasoline-powered pumps, line shaft turbine pumps, and right angle gear drives further advanced the use of deep groundwater for irrigation. As a result, a single farmer could more efficiently irrigate larger and larger areas in the arid West. In the first decade of the 1900s, a farmer, using a gasoline powered pump, could irrigate a large number of acres with groundwater for only a few dollars per acre. In the 1890s, an acre of oranges or lemons in the Los Angeles area yielded between $500 and $1,500, a handsome profit for a farmer willing to invest in pumping equipment and irrigated agriculture.