HYDRAULIC AND STRUCTURAL DESIGN OF THE CENTER-PIVOT IRRIGATION SYSTEM FOR SMALL SCALE FARMERS

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ABSTRACT

In Pakistan surface water supply for irrigation is decreasing, while water demand is increasing for agriculture production. The time needs to develop appropriate technologies and design approaches to improve modern irrigation practices and improve water use efficiency and crop yields. In areas, where the topography is undulated high efficiency irrigation systems are currently considered one of the most efficient and widely water-applied methods. The Center Pivot Irrigation System (CPIS) is the advanced form of the high-efficiency irrigation system (HEIS). The CPIS is typically designed for large landholdings areas. In Pakistan, large holdings are decreasing due to increasing population and land division among the family members. So, there is a need to design CPIS on small scale. To improve the economic condition of the small-scale farmers, a small-scale CPIS system should be used. The local design and fabrication can reduce its capital cost. In the study, the hydraulic and structural components of CPIS were designed for small-scale farmers with some modifications. In modified structural design, the structure of the center pivot irrigation system (mass, geometry, shape, and material) was redesigned. The hydraulic method of CPIS includes a selection of lateral length, flow rate, application time for one revolution, and estimation of head losses and power requirements. Total six sizes of center pivot were designed for the different areas according to landholding design from 5 to 30 acres with Irriexpress software. The Digital Elevation Model of Dera Ghulam Muhammad Channar (District Bahawalpur) was imported in IrriExpress. In this study area, the span slope varies from 2.98 to 0.1 percent and the wheel slope varies from 2.35 to -2.4 percent. The timing setting was 60% of 60 seconds for the last span and the irrigation depth was 10mm. When the time setting was reduced from 100% to 10%, the number of irrigation hours per cycle and irrigation depth both increased. In structural design

Variendeel, type-II trusses were designed by using SAP2000 software. The weight reduction was 17 percent by changing the geometry of trusses and the connection reduction was 44 percent. The center pivot was divided into four components structural, hydraulic, power, and electric. The structural part was more expensive than other components. The structural cost was 61, hydraulic 13.5, electric 11.6, and power cost 13.7 percent for 5acres. The center pivot was suggested for land holdings from 100 to 250 acres for all farmers. When the area increased by more than 250 acres no significant change in the cost of the pivot and only a 1% percent cost increased. Towable is more economical for small-scale farmers due to its less per acre cost of 0.212 million for 5acres and towable should be used for 5 to 50acres.