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Decision Support System for Estimation of Pump Size for Irrigation

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Abstract: A Decision Support System (DSS) for estimation of pump size for irrigating major crops in Haryana was developed on Android platform using MIT App Inventor. The application enables farmers to select their district, crops grown, acreage under cultivation, pipe dimensions, and irrigation method to obtain accurate pump size recommendations. The DSS incorporates standard hydraulic equations including Hazen-Williams equation for pipe friction losses, and considers crop coefficients, reference evapotranspiration, and groundwater depth. The mobile application provides an intuitive interface with dropdown menus for input parameter selection and displays calculated results including total dynamic head, pump horsepower, and power consumption. The developed DSS is valid across multiple districts of Haryana covering major crops and other variables. DDS android application provides reliable pump size estimates, helping farmers make informed decisions about irrigation equipment selection, thereby optimizing energy consumption and improving water use efficiency in agricultural systems.

Keywords: Decision Support System, Pump Size Estimation, Irrigation, MIT App Inventor, Android Application, Haryana

1. INTRODUCTION

Agriculture employs over 27% of the world's workforce and accounts for more than 70% of global freshwater withdrawals, rising to over 90% in dry and semi-arid regions (FAO, 2020). By 2050, agricultural water usage is predicted to rise by 19% due to population growth (United Nations Water, 2021). Over $30 billion was lost in agriculture worldwide in 2021 due to drought (World Resources Institute, 2021), underscoring the urgency of efficient water management. India has only 4% of global freshwater resources despite constituting 2% of the world's geographical area. More than 85% of water resources in India are used for agriculture. The state of Haryana, with just 1.4% of the country's area, contributes 14% to the central pool, but intensive agriculture has put significant stress on water resources, with 70% of the irrigated area served by tube wells (Kaur et al., 2010). In this context, Naresh et al. (2023) developed an Android-based mobile application for estimation of tubewell discharge using the coordinate method, and Naresh et al. (2025) developed a mobile application for estimation of texture-based hydraulic properties of soil and crop water requirement of major crops of Haryana. These studies demonstrated the potential of mobile-based decision support systems in improving water management practices in agriculture. Selection of appropriate pump size for irrigation is essential to ensure adequate water delivery while minimizing energy consumption. Farmers often face difficulties in determining correct pump specifications due to the complex interplay of crop water requirements, pipe friction losses, suction and delivery head, and pump efficiency. Traditional methods rely on manual calculations, leading to over-sizing or under-sizing of pumps. Over-sized pumps waste energy, while under-sized pumps cause crop water stress. The objective of this study was to develop a Decision Support System (DSS) for estimation of pump size for irrigating major crops in Haryana on an Android platform, providing accurate pump size recommendations through a user-friendly mobile application.

2. MATERIAL AND METHODOLOGY

The DSS was developed using MIT App Inventor 2, a cloud-based platform for developing Android applications using visual block programming. The application was designed with multiple screens to guide users through the input selection and result display process.

2.1 Application Design

The application consists of multiple screens including a home screen with an introductory image, an input parameter selection screen (Screen2), and an equations/results screen (Equations). The home screen (Screen1) displays an

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agricultural-themed image with navigation buttons. Screen2 contains dropdown menus (ListPicker components) for selecting:

- Irrigation method (Sprinkler, Drip, Flood)
- Pipe type (Submersible, Monobset, Belt driven)
- Acreage under cultivation (acres) under different crops
- Suction pipe diameter
- Delivery pipe diameter

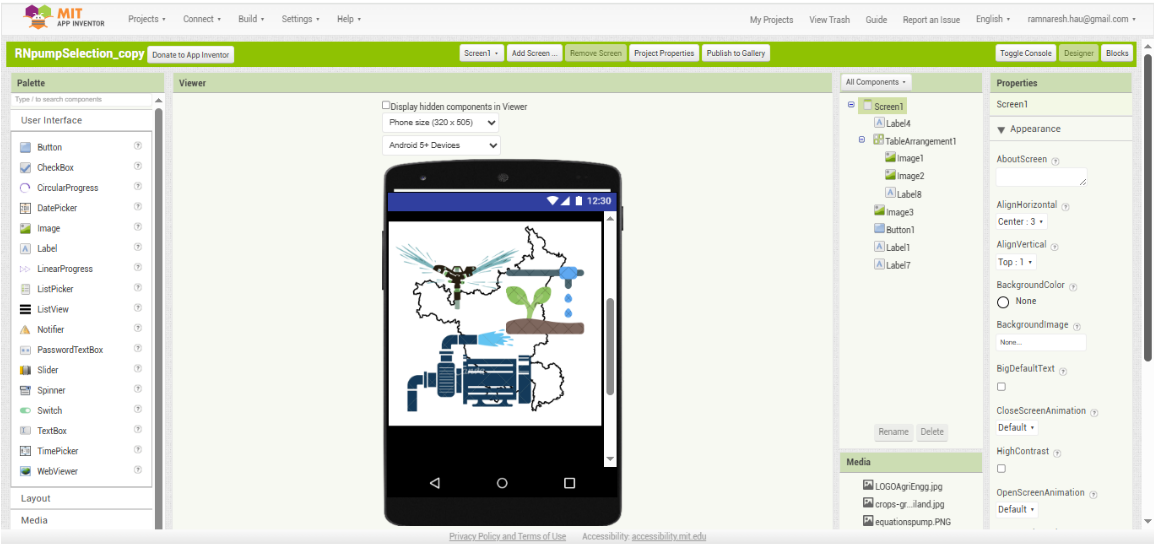

Figure 1: MIT App Inventor Designer view showing app layout with agricultural illustration

2.2 Block Programming

The application logic is implemented through visual blocks in MIT App Inventor. The block programming handles three main categories of operations:

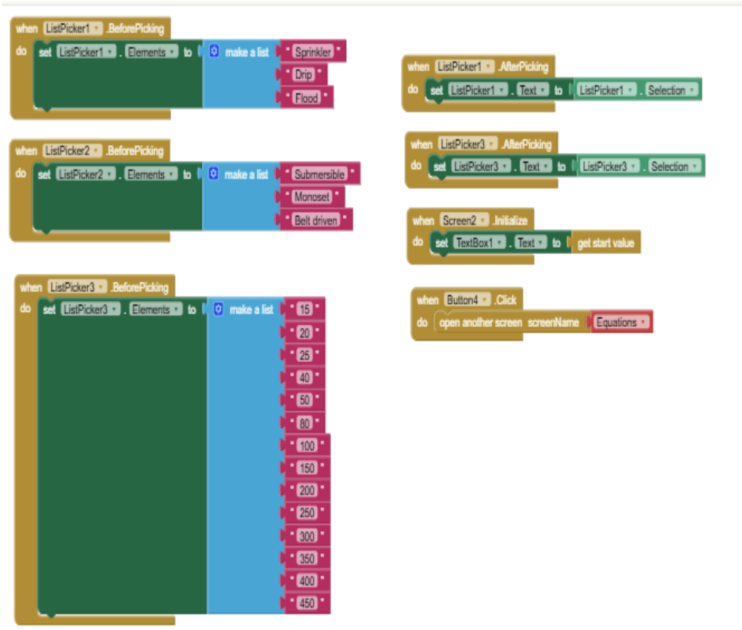

Figure 2: MIT App Inventor blocks for input parameter selection and list picker initialization

The input parameter selection blocks initialize dropdown menus with predefined lists for irrigation method, pipe type, and acreage. When users make selections, the chosen values are stored and used for subsequent calculations.

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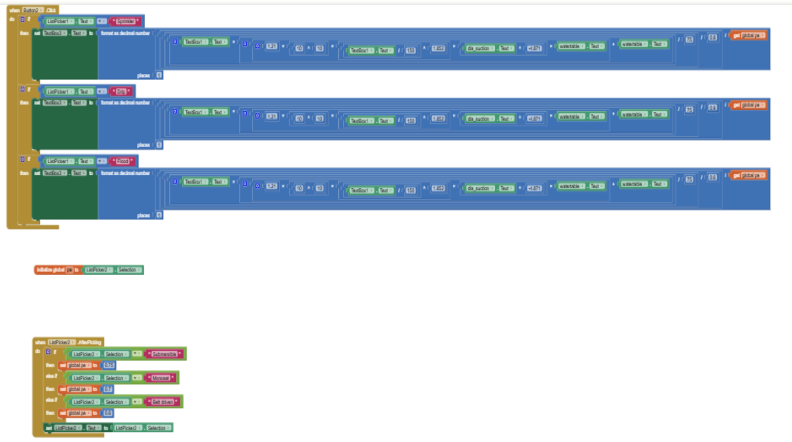

Figure 3: MIT App Inventor blocks for pump size calculation using hydraulic equations

2.3 Standard Equations

The DSS employs the following standard equations for pump size estimation:

Table 1: Standard equations used for estimation of pump size

Parameter	Equation
Peak Water Requirement	$Q = Max(ET0 \times Kc \times A)$ where Q = peak water requirement (litres/day), ET0 = Reference ET (mm/day), Kc = crop coefficient, A = area under crop (ha)
Pipe Friction Loss (Hazen-Williams)	$J = K \times (Q/C)^{1.852} \times D\_l^{-4.871} \times F$ where J = head loss gradient (m), Q = total discharge (lit/sec), C = friction coefficient, D_l = inside diameter (mm), F = friction factor
Total Dynamic Head	$H = Hs + Fs + Fd$ where H = total dynamic head (m), Hs = suction head (m), Fs = friction loss in suction pipe (m), Fd = friction loss in delivery pipe (m)
Power Consumption	$P = hp \times 746 / 1000 \times$ operational hours

3. RESULTS AND DISCUSSION

The Decision Support System for estimation of pump size for irrigating major crops of Haryana was successfully developed on the Android platform. The application provides an intuitive interface where users are required to select the district, different crops grown and acreage under cultivation, size of suction and delivery pipe, and irrigation method. The DSS incorporates crop coefficients of major crops, reference evapotranspiration data, groundwater depth information, irrigation method specifications, and pump efficiency parameters to provide accurate pump size recommendations. The application calculates peak water requirements based on district-wise climatic data and crop characteristics.

Dynamic head calculation considers the combined effects of static head, friction losses, and velocity head to determine the required pump specifications. The mobile application was tested across multiple districts of Haryana, covering diverse agricultural conditions and irrigation practices. The results demonstrate that the DSS provides reliable pump size estimates that align with established engineering practices. The user-friendly interface enables farmers with limited technical knowledge to obtain accurate pump recommendations, thereby bridging the gap between theoretical calculations and practical application.

4. CONCLUSION

A Decision Support System (DSS) for estimation of pump size for irrigating major crops of Haryana was developed on the Android platform using MIT App Inventor . The application successfully integrates crop water requirements, hydraulic equations, and field conditions to provide accurate pump size recommendations. The DSS offers a practical tool for farmers to make informed decisions about irrigation equipment selection, contributing to improved water use

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efficiency and energy optimization in agricultural irrigation systems. The mobile-based approach ensures accessibility across rural areas with smartphone penetration, making the tool widely available to the farming community.

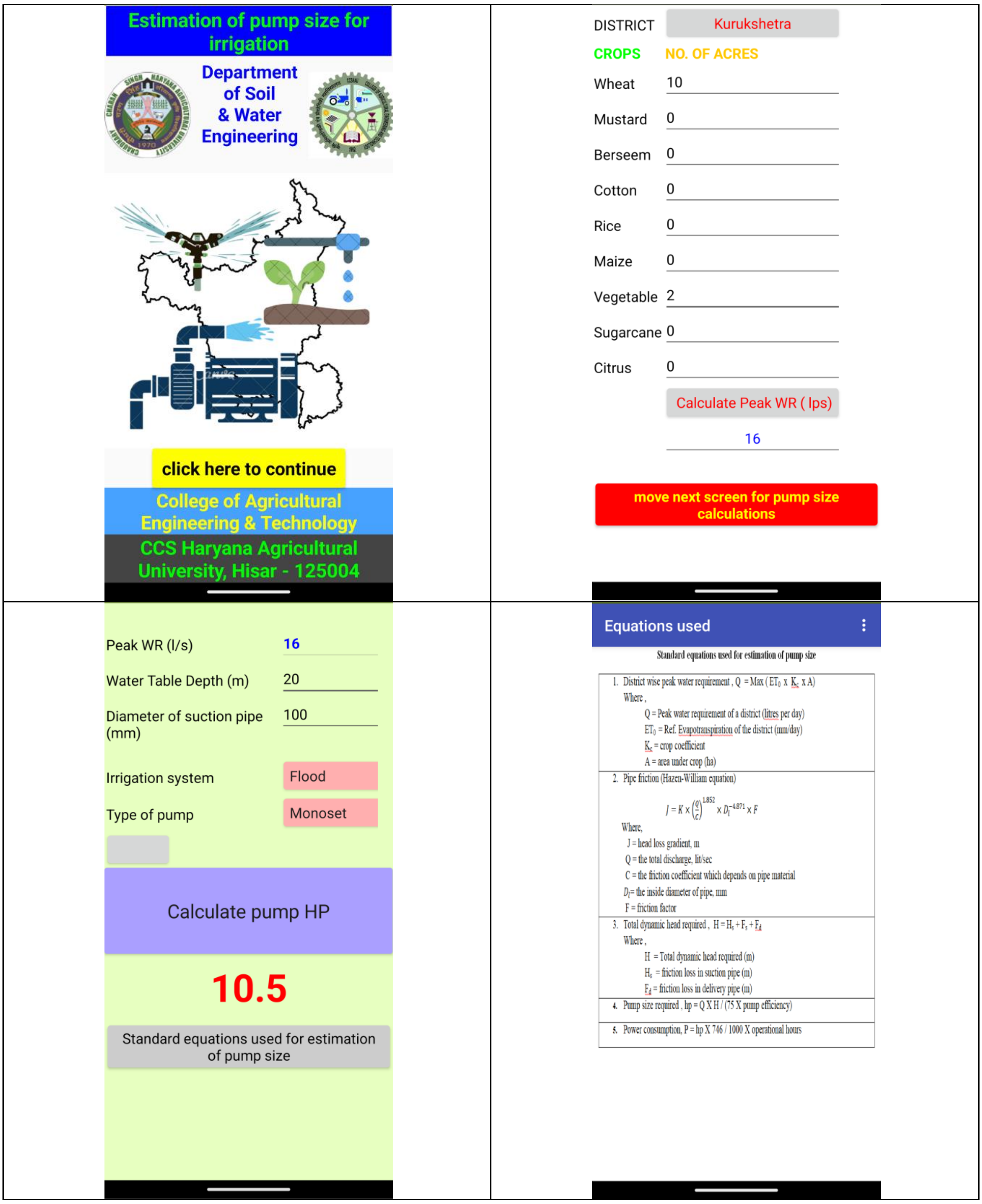

Figure 4: Screenshots of developed app for estimation of pump size for irrigation

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