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Mobile application for estimation of texture based hydraulic properties of soil and crop water requirement of major crops of Haryana

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Abstract: Hydraulic properties of soil depends on their texture which represents the relative proportion of sand, silt and clay particles in the soil. An android application was developed to find the soil texture based on GPS location of the mobile user. The application find the texture based on the position of location specific dot on the colour coded map of soil texture of Haryana state. The app then shows texture based saturated hydraulic conductivity, moisture content at field capacity, moisture content at wilting point and available soil moisture and calculates the irrigation depth required for major crop based on root zone depth and pre defined moisture deficit in the soil. The application was developed on freely available MIT App Inventor web platform.

Keywords: Soil texture, hydraulic properties, crop water requirement, MIT App Inventor

I. INTRODUCTION

Agriculture is a major economic driver, employing more than 27% of the world's workforce and contributing significantly to GDP in developing countries. But there is a serious risk of water scarcity. Over $30 billion was lost in agriculture worldwide in 2021 as a result of drought (World Resources Institute, 2021). Effective water management can reduce these losses and increase the profitability of agriculture. Water is essential to economic growth, environmental sustainability, and global food security. At over 70% of global freshwater withdrawals, agriculture is the major user of water resources. This percentage can increase to more than 90% in dry and semi-arid areas (FAO, 2020). By 2050, agricultural water usage is predicted to rise by 19% due to population expansion and rising food demand (United Nations Water, 2021). Furthermore, water availability directly accounts for 80% of yield variability in rain-fed agriculture. Only 20% of all cultivated land is used for irrigated agriculture; however, it produces 40% of the world's food (FAO, 2017). More than 60% of the grain produced in nations like China and India comes from irrigated areas, demonstrating how dependent these nations are on irrigation systems to maintain their agricultural outputs (World Bank, 2022).

Contemporary irrigation techniques, like sprinkler and drip systems, have improved water use efficiency by 30–50%, minimizing waste and guaranteeing steady agricultural production (Fereres & Soriano, 2007). The water use efficiency of agriculture systems can be improved by adding more automation, such as mobile applications that calculate the hydraulic parameters of the soil and the amount of water needed at any stage and site.

Modern agriculture's raising concerns, such as water shortages, diminishing soil health, and the need for precision farming, has highlighted the significance of incorporating technology into conventional farming operations. One of the most important steps toward sustainable farming practices is the creation of an Android-based application for assessing hydraulic properties of soil and calculating dynamic crop water requirements using location-based and soil texture data. This solution gives farmers real-time, actionable insights by optimizing water usage and improving soil management through the use of IoT, machine learning, and geospatial technology improvements.

The development of mobile technologies and their integration into precision agriculture has opened new avenues for addressing these challenges. Smartphones, with their widespread adoption and accessibility, have become a powerful tool for delivering real-time, location-specific solutions to farmers. Android-based mobile applications, in particular, have emerged as cost-effective and user-friendly platforms for disseminating agricultural information (Naresh et. al., 2023). Leveraging these technologies, a mobile application was designed to calculate irrigation water requirements based on soil texture and hydraulic properties. The mobile app offers a straightforward, affordable, and useful way to calculate the amount of water that crops need. By using this technique, farmers can avoid over-irrigation by applying the right amount of water to their crops based on the characteristics and texture of the soil.

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II. METHODOLOGY

A soil texture based map of Haryana state was created using Haryana State Soil Maps originally developed by National Bureau of Soil Survey & Land Use Planning, Nagpur (Sachdev et. al., 1995) in method used for Productivity Zoning of crops in Haryana State (Anurag et. al., 2017) From GPS coordinates of the mobile, the soil type of that location is identified from soil texture map of Haryana. The texture based hydraulic characteristics viz. saturated hydraulic conductivity (mm/h), moisture content at field capacity (%), moisture content at wilting point (%) and available soil moisture (%) are displayed as per type of soil (Saxton & Rawls, (2006). The available soil moisture, crop root zone depth and maximum allowed soil moisture deficit was utilized to quantify the depth of irrigation required for various crops for that location.

III. THE CODE

The application for this project was developed using MIT App Inventor, a user-friendly, drag-and-drop visual programming tool introduced by Google in 2010 and, it is now maintained by the Massachusetts Institute of Technology (MIT). MIT App Inventor offers a graphical user interface (GUI) that includes all the essential components required to design and build mobile apps, making it accessible to users with little or no programming experience. Applications created with this platform can be seamlessly deployed to Android devices, shared with others, or published on the Google Play Store for global distribution [Pokress & Veiga, 2013].

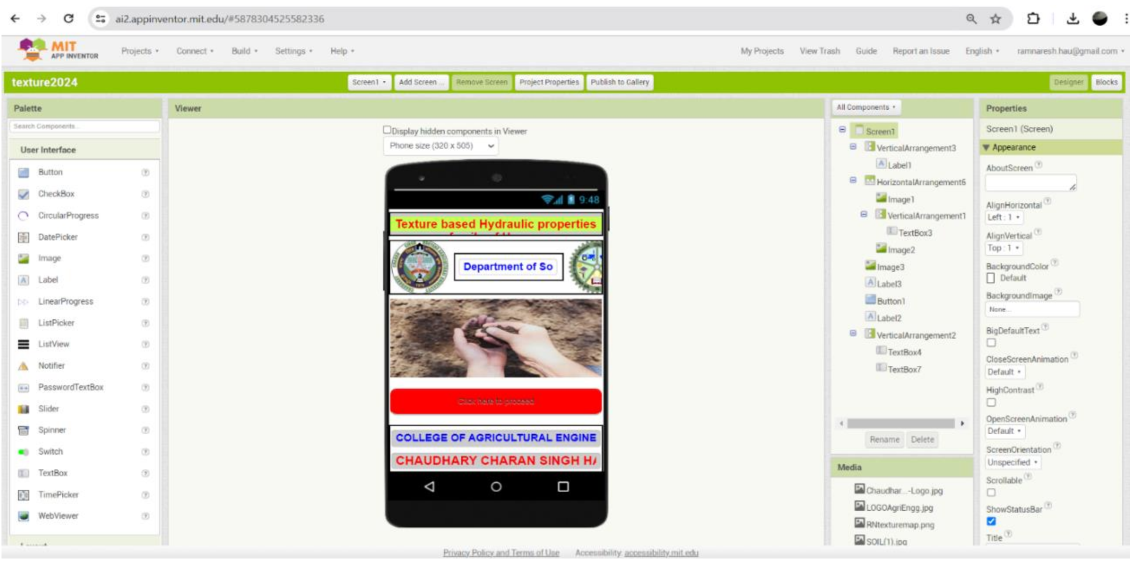

Figure 1: MIT app interface

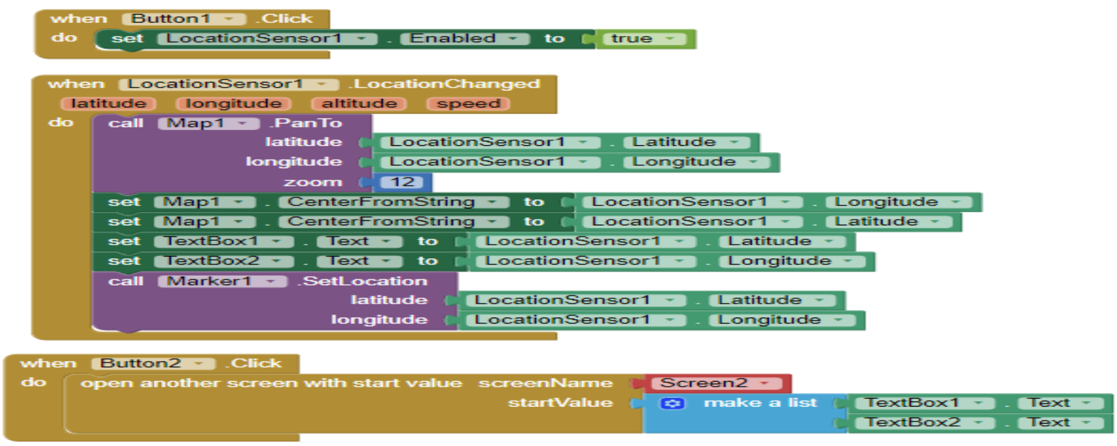

Figure 2: Code for insertion of latitude and longitude and for defining location at map

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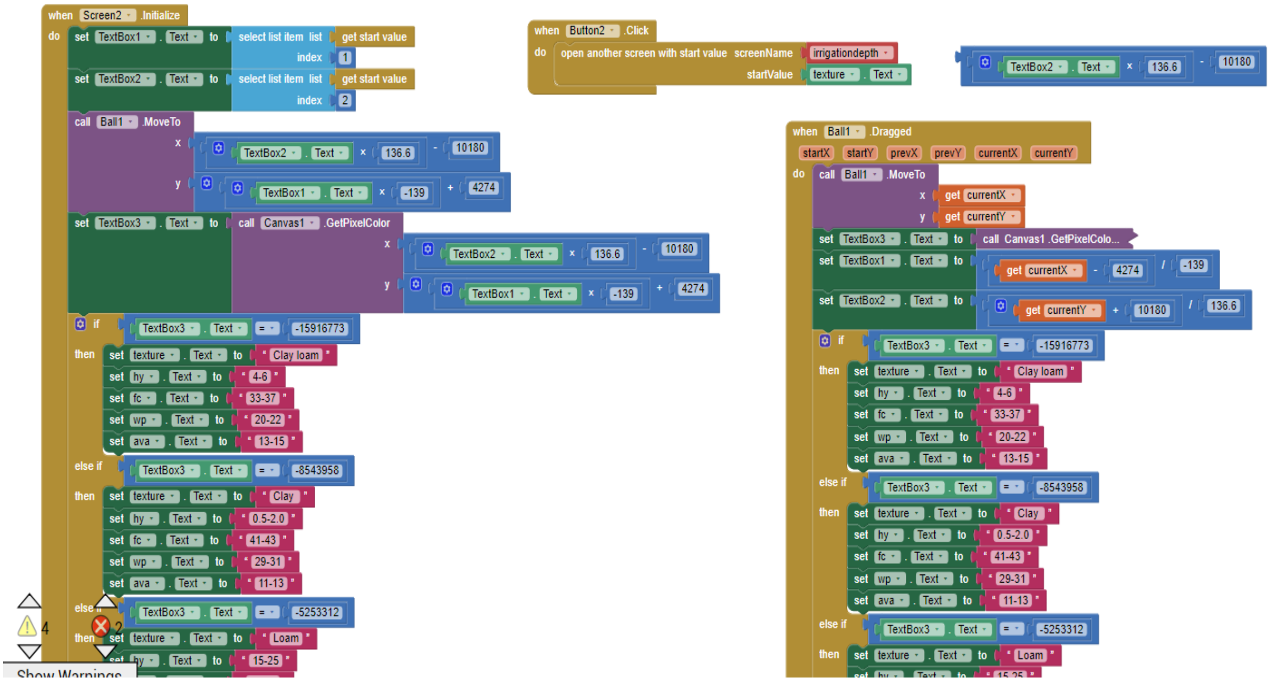

Figure 3: According to location it pick up hydraulic properties of soil at screen

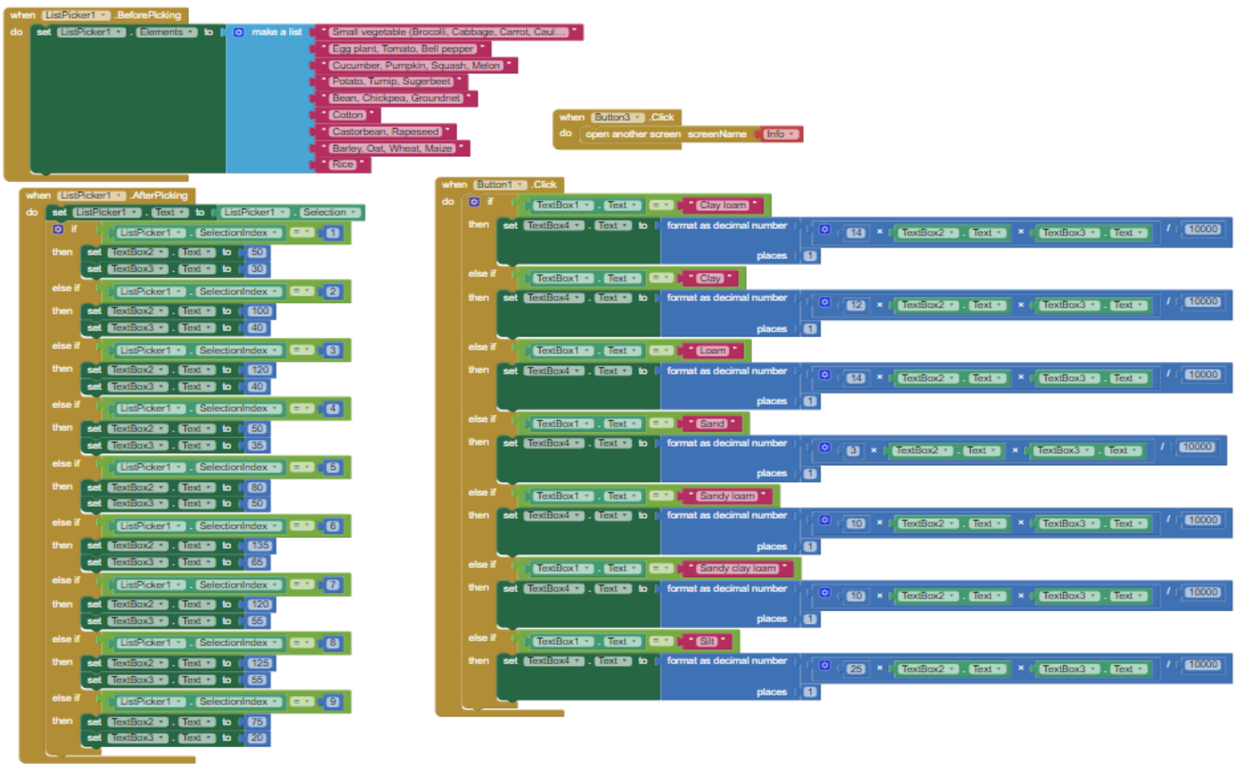

Figure 4: Selection of crop and calculation of irrigation requirement on basis of soil texture

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IV. THE APP

Figure 5: (i)Interface of Application Soil Texture and (ii) Provide Location info. and get soil Properties of Region.

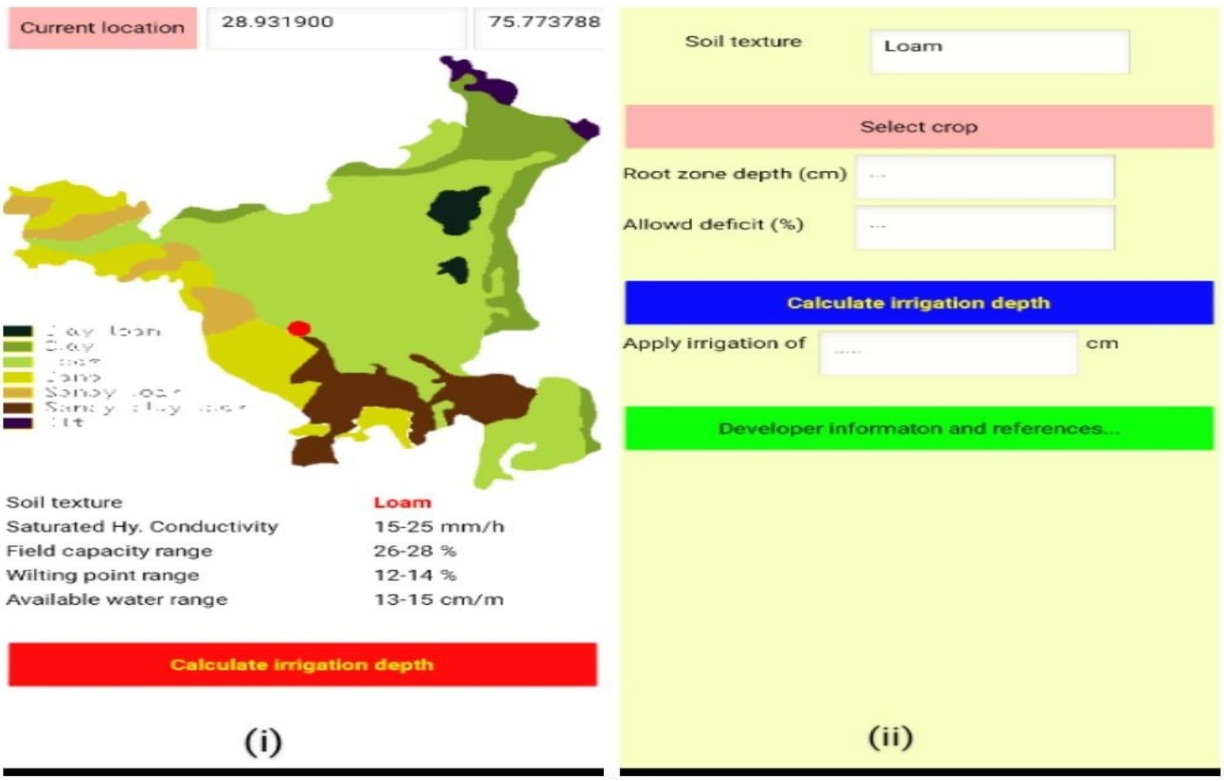

Figure 6(i) Soil Hydraulic properties on basis of current location and (ii) Soil Texture of Region, then select crop

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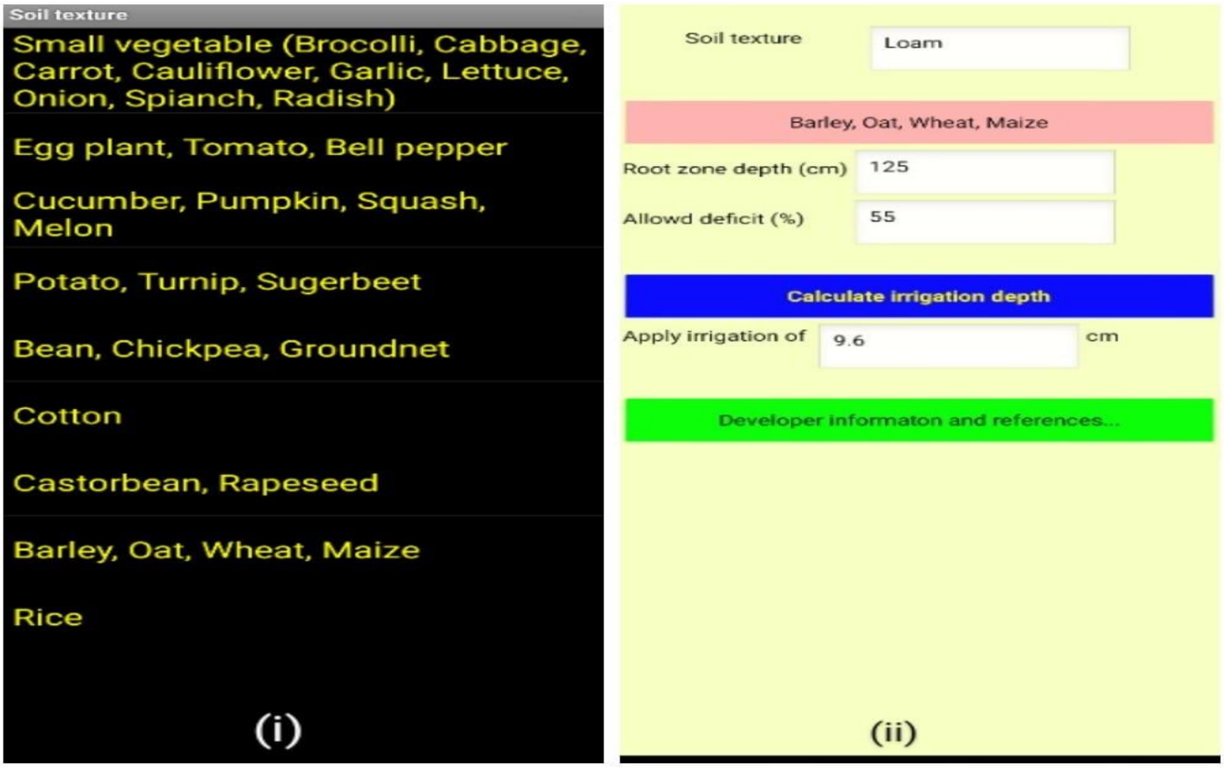

Figure 7 (i) Select Crop type and (ii) Calculation of irrigation depth by application algorithm

V. CONCLUSION

The development of an Android-based mobile application for dynamic crop water requirements and soil property analysis represents a significant step toward improving agricultural efficiency and sustainability. The integration of user-friendly features, enabled by MIT App Inventor, ensures accessibility even for individuals with minimal technical expertise. The application can adapt to diverse climatic conditions and soil types, providing tailored recommendations to optimize water usage and enhance crop productivity. Furthermore, its portability and ease of sharing or distribution make it an invaluable tool for promoting precision agriculture practices. Future enhancements could include incorporating advanced data analytics, machine learning algorithms, or integration with IoT-based sensors for even greater accuracy and automation.

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