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Decision support system (DSS) for estimation of tank size for rainwater harvesting systems

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Abstract: In the face of growing water scarcity due to rapid urbanization, population pressure and climate variability, rainwater harvesting (RWH) has emerged as an effective and sustainable strategy for water conservation and management. One of the most critical aspects of designing an efficient RWH system is the accurate estimation of tank size for storage, which must take into account site-specific parameters such as rainfall intensity, runoff potential, tank geometry and user needs. Traditionally, the process of designing such systems requires manual calculations and technical expertise, which may not always be accessible to farmers, local engineers or planners. To address this challenge, a user-friendly Decision Support System (DSS) was developed in this study for the estimation of tank size for rainwater harvesting systems. The DSS, built on an Android platform using the freely available MIT App Inventor, combines user inputs with mathematical models to calculate tank dimensions for various geometries, including circular, square and rectangular shapes. Users can select key parameters such as desired storage volume, pond depth and side slope, while the application performs real-time computations using standard geometric and quadratic equations. The tool simplifies complex calculations into an easy-to-use interface, enabling the estimation of tank dimensions such as top and bottom radius, length and width based on storage volume requirements.

Keywords: Decision support system, rainwater harvesting, tank size, MIT app inventor

I. INTRODUCTION

Due to a growing population, high rates of urbanization and the existence of climate variables, water scarcity is becoming an issue of concern worldwide. In this context, Rainwater harvesting systems (RHSs) offer a sustainable solution to supplement existing water sources by collecting and storing rainwater from rooftops, pavements and other impervious surfaces. These systems not only provide water for non-potable domestic and agricultural uses but also help in reducing runoff, minimizing the risk of flooding and decreasing the burden on stormwater drainage systems(Kim et al., 2005; Rahman et al., 2014).Despite these advantages, the adoption of RHSs remains limited, primarily due to a lack of awareness and technical expertise among users (Imteaz et al., 2011). One of the key challenges in implementing an efficient RHS is the accurate estimation of tank size, which depends on various factors such as local rainfall patterns, roof area, user water demand, soil conditions, and the geometry of the tank. In addition, the quality of harvested rainwater can be affected by atmospheric pollutants and contaminants on catchment surfaces, limiting its potential uses (Silva-Vieira et al., 2013).Storage tanks play a vital role in compensating for the non-uniform spatial and temporal distribution of rainfall. However, traditional methods of tank sizing involve complex manual calculations, often requiring technical expertise not readily available to farmers or local planners. Factors like land availability, tank positioning and material costs further complicate the design process.

To overcome these challenges, the integration of mobile technology in agriculture has emerged as a promising solution. Android-based smartphones, due to their widespread use and ease of access, offer an effective platform for delivering simple, real-time solutions to farmers. Particularly, Android-based mobile applications have become popular as affordable and easy-to-use channels for sharing agricultural knowledge (Naresh et al., 2023; Naresh et al., 2025).Built using MIT App Inventor, this user-friendly application allows users to input basic parameters such as desired storage volume, pond depth, slant height and then calculates the appropriate tank dimensions based on standard geometric formulas. This technique provides a low-cost, accessible and practical tool that simplifies the design of rainwater harvesting systems, enabling users to make informed decisions for efficient water storage and management.

II. METHODOLOGY

The methodology for developing the DSS involves the following steps, organized according to the tank shape (Circular, Rectangular and Square). The application estimates tank dimensions based on user parameters for storage volume (V), tank depth (h) and slant height (z), using shape-specific equations and solving quadratic expressions as shown in Table

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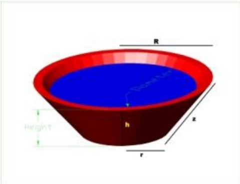
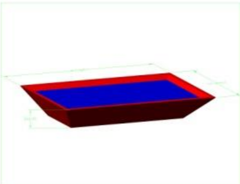
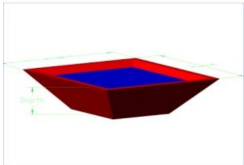
1. Based on the selected shape, the mobile application applies appropriate formulas or equations to compute the top and bottom dimensions. The results are displayed in a clear format, with wetted and surface areaof the pond for better understanding. These outputs or results support practical implementation and design planning.

Table 1 Standard volume equation for different tank shapes and solutions of quadratic equation for calculating the dimensions

Shape of tank	Standard equation for volume	Coefficients of quadratic equation	Tank dimensions
Circular 	$V = (1/3) * \pi * h * (R + R^2 + r + r^2)$ Where : V = volume of tank h = depth of tank R = top radius r = bottom radius	A = 3 B = -(3 * h * z) C = (h * h * z * z) - (0.955 * V / h) Where : z = slant height	$R = -B + (B^2 - 4 * A * C)^{0.5} / (2 * A)$ r = (R - h * z)
Rectangular 	V=16 * h * (a * b + (a + c) * (b + d) + c * d) Where : V = volume of tank a = top length b = top width c = bottom length d = bottom width	X = a/b A = 6 * X B = -6 * h * z * (X + 1) C = 8 * h * h * z * z - ((6 * V) / h) Where : X = ratio of length to width z = slant height	$a = -B + (B^2 - 4 * A * C)^{0.5} / (2 * A)$ b = a / X c = a - 2 * h * z d = c / X
Square 	$V=16 * h * (a^2 + (a + c)^2 + c^2)$ Where : V = volume of tank a = top side c = bottom side	A = 6 B = -6 * h * z * 2 C = 8 * h * h * z * z - ((6 * V) / h) Where : z = slant height	$a = -B + (B^2 - 4 * A * C)^{0.5} / (2 * A)$ c = a - 2 * h * z

III. THE CODE

This project mobile application was developed using MIT App Inventor, visual programming environment, which is based on a powerful and user-friendly visual programming language as well as is used to simplify the development of User Apps. This platform was originally produced by Google in 2010, but was later passed to the Massachusetts institute of technology (MIT) where today it is still highly maintained. The drag-and-drop interface developed by MIT App Inventor is block-based and will enable users without extensive programming knowledge to easily form complex application functions without using conventional codes, hence suitable when targeting beginners, educators and non-programmers.It is a complex tool having graphical user interface (GUI) and comprising the needs of designing and developing android mobile applications. It is also user friendly and enables users to create fully functional apps despite the less or no knowledge in programming. It is easy to install the applications created by means of the MIT App Inventor in Android devices, transfer them to other people, or post them on the Google Play Store to distribute the works globally [Pokress & Veiga, 2013].

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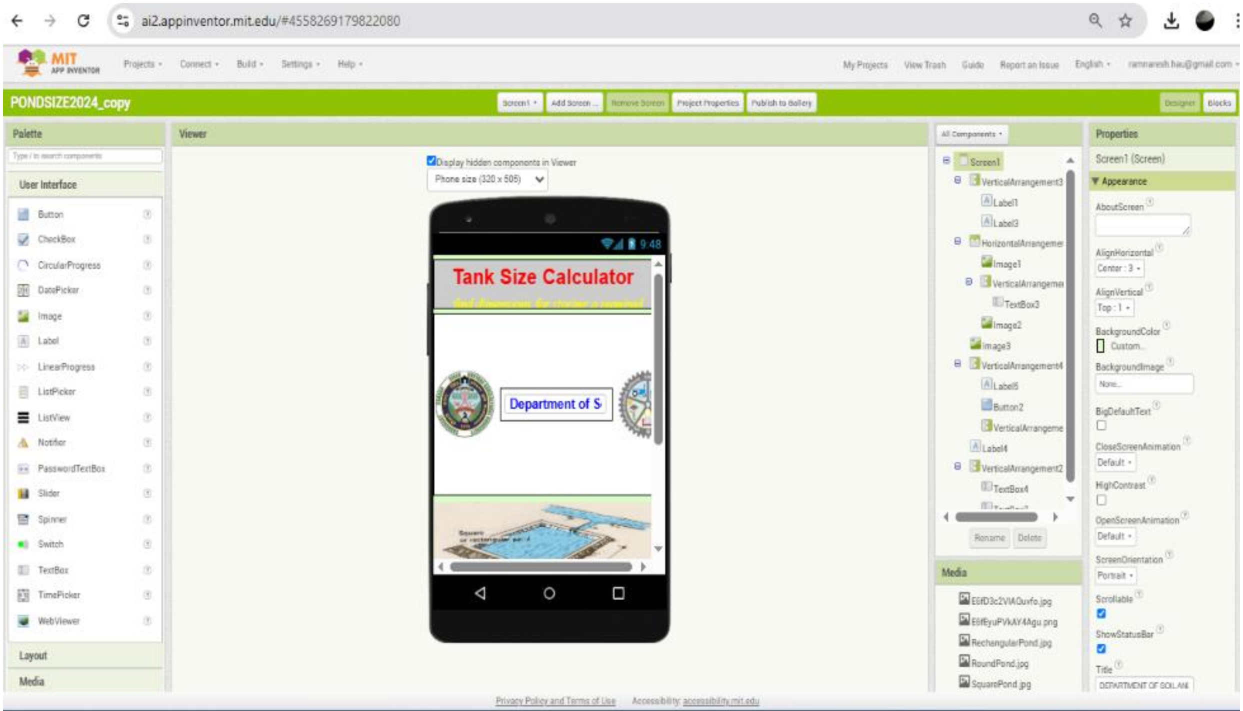

Figure 1: MIT app interface

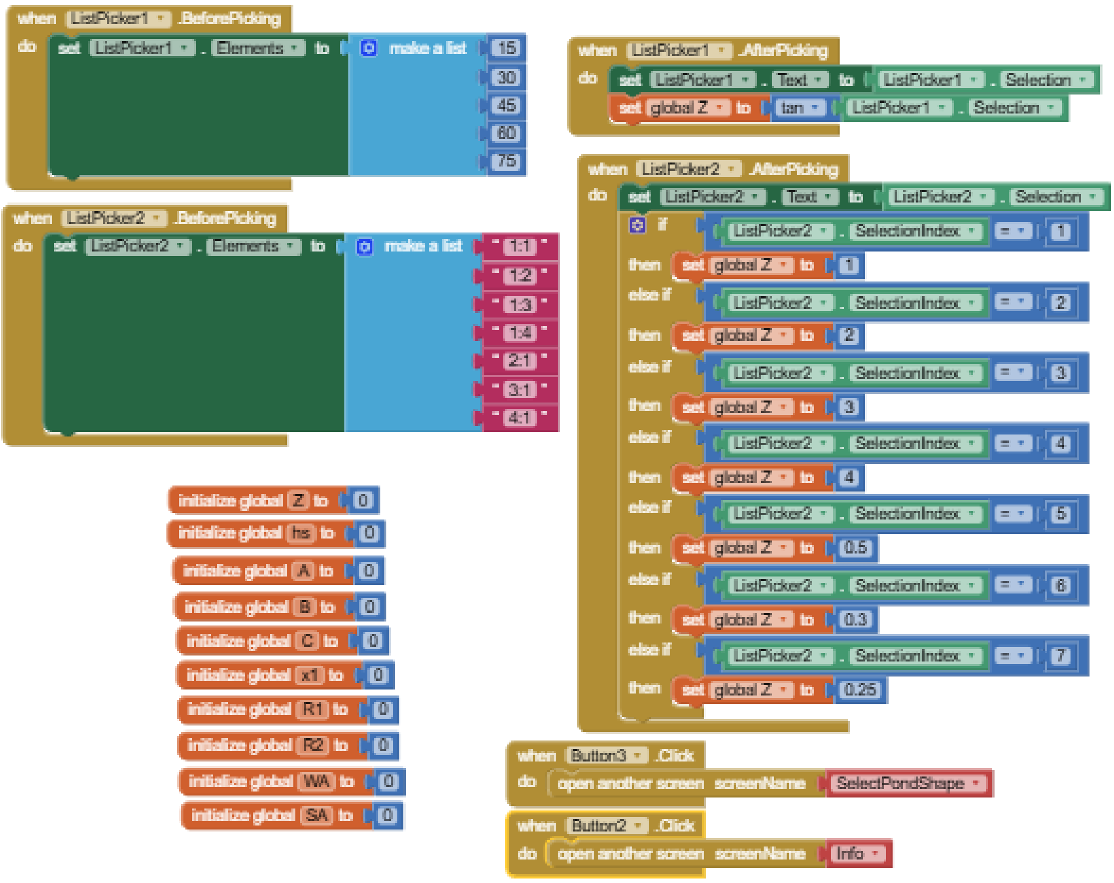

Figure 2: Selection of area and crops

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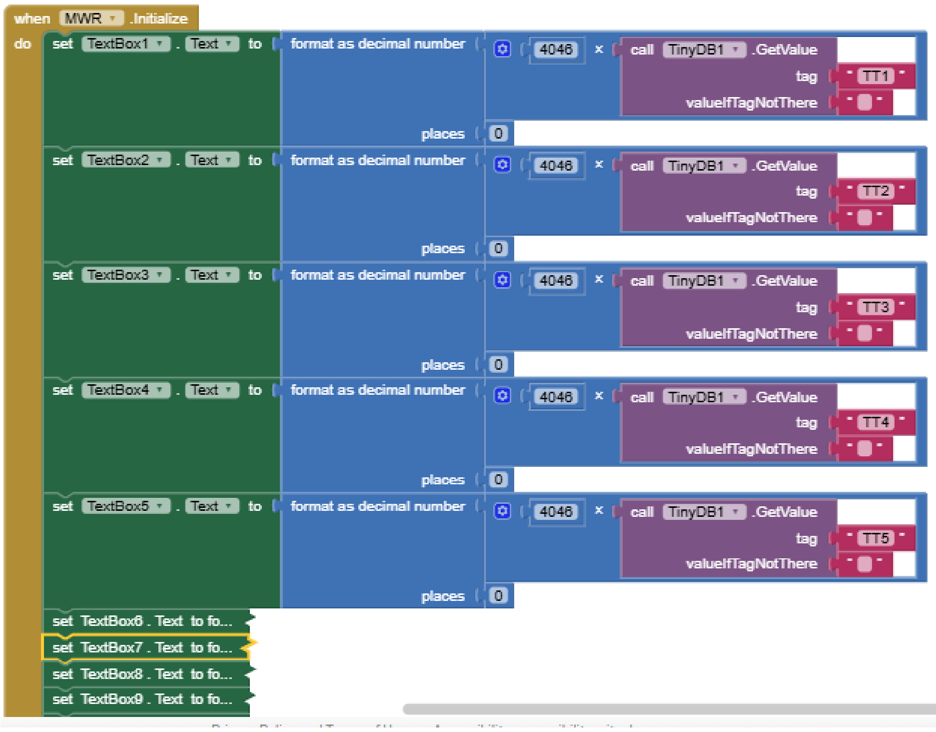

Figure 3: Estimation of water to be stored\

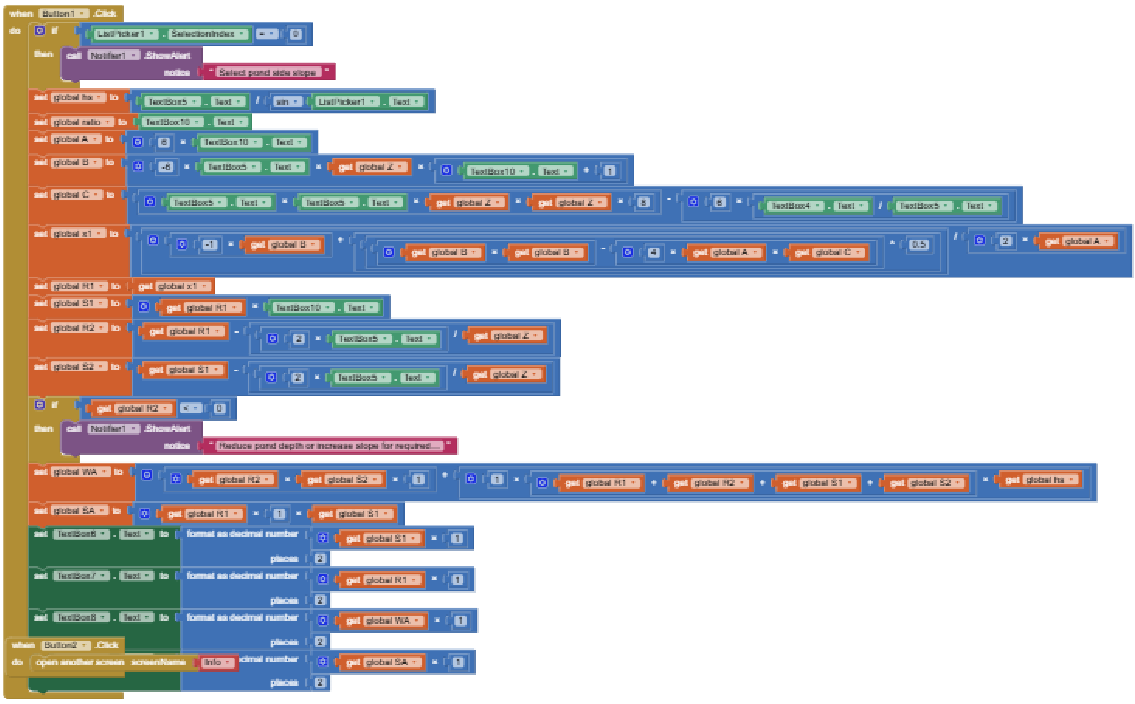

Figure 4: Calculation of tank dimentions

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IV. THE APP

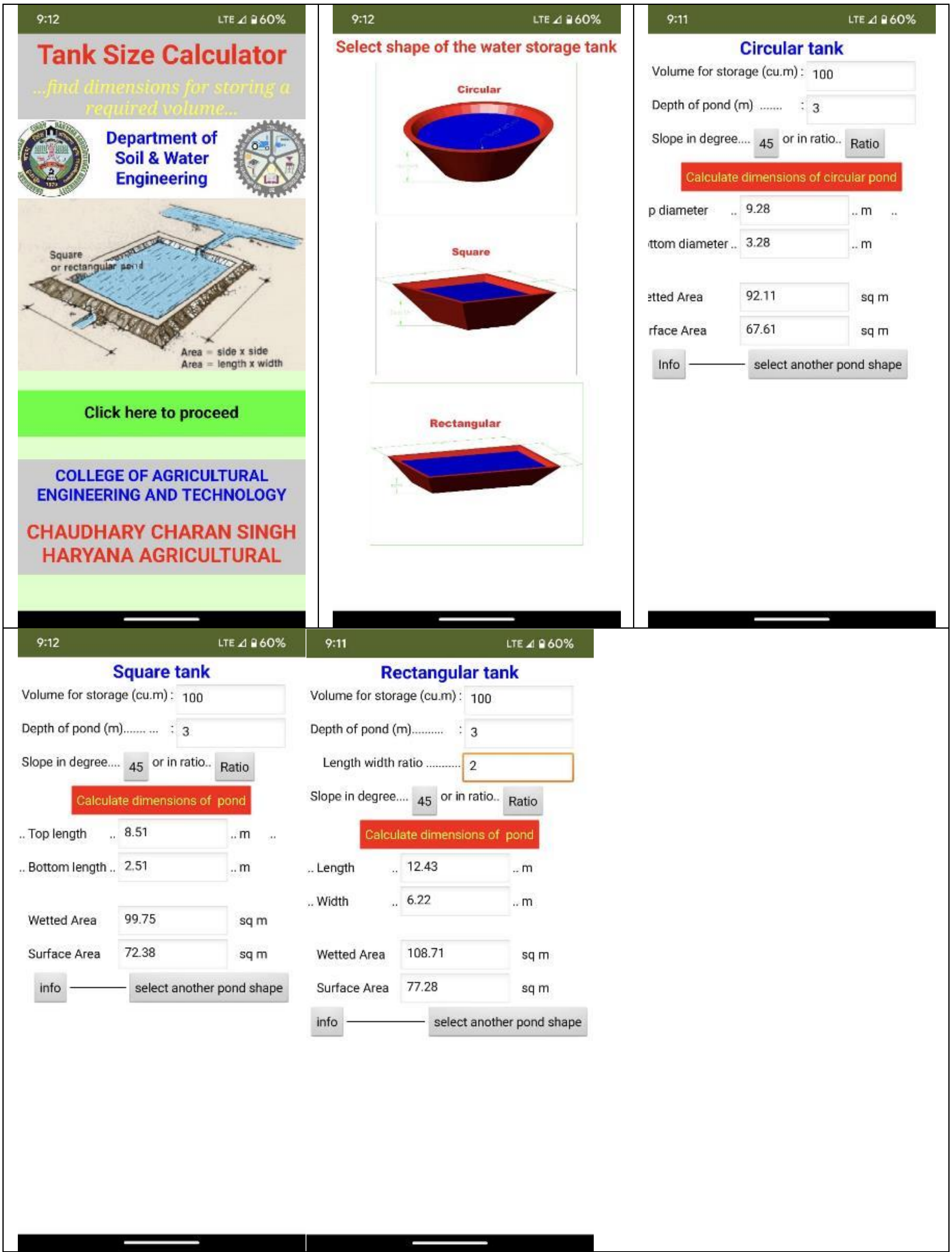

Figure 5 : Screenshots of developed app for calculation of tank size

V. CONCLUSION

The presentation of Decision Support System (DSS), in the way of android-based mobile application to estimate the size of the tank in rainwater harvesting system, is a desirable step forward in terms of sustainable water management

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and agricultural planning. It has been developed through the use of MIT App Inventor and allows a user to receive specific recommendations depending on the local weather conditions, thereby increasing water conservation and crop yields. It could be further enhanced by inclusion of more advanced technology such as machine learning and IoT in the future, which further increase its accuracy and effectiveness in precision agriculture.

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