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Greenhouse knockdown in Merauke

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Abstract. The farming method in Merauke Papua is conventional, therefore production is not maximized throughout the year. The purpose of this study was to build a household scale greenhouse that could be assembled. This research was an experimental and Action Research; the research phase including Knockdown greenhouse design, made greenhouses, greenhouse tested (transporting, assembling and installing and clearing). The results of the knockdown greenhouse structure research used a combination of iron pipe and hollow iron; the application was on the column pole/column using a 3-inch diameter iron pipe while for the roof and wall frame using 4 cm hollow iron 3 mm thickness. for foundations used pedestal / local foundations with a total of 18 foundations with dimensions of 27,000 m3 (30 cm x 30 cm x 30 cm). The knockdown greenhouse roof consists of 2, namely; 1). The rooftop used the used bottle roof cover material, 2). The lower roof used the Paranet / insect screen roof cover material. The installation and dismantling of the knockdown Greenhouse take + 2 hours 30 minutes, with time division: 1). + 45.40 minutes installer for greenhouse structure; 2). Thirty-five minutes installation of roof cover (used bottles) and; 3). Fifty minutes installation of the insect screen.

1. Introduction

Merauke is one area that still uses conventional methods in agriculture. At certain times agricultural products are quite difficult to find in the market because, in the rainy season, the intensity of rain is very high, water conditions are abundant and difficult to drain due to low soil conditions, on the contrary during the dry season the water is quite difficult to find. So that the agricultural business does not run optimally throughout the year. In the rainy season, some difficulty in obtaining agrarian products include vegetables, because the soil content is quite wet so that some types of plants such as vegetables do not grow optimally [1]. With the explanation above, it was necessary to design a greenhouse that functioned as a place for the cultivation of plants in controlled environment agriculture. With the existence of a greenhouse, farmers can cultivate throughout the season. Farmers in Merauke have agricultural land far enough from home; farmers are dominated by migrants from Java, almost all of them are farmers with less agrarian capital. Greenhouses that were made must be easy to assemble and install.

In this study was a continuation of previous research, the results of prior research on the roof shell material that PVC pipe cannot withstand excessive heat from the climate in Merauke-Papua and withstand wind speeds. The use of roof covering material in the form of used bottles was still being noticed and maintained because currently the used bottles in Merauke have not been utilized properly. Used bottles needed for a 24 m^2 (4 m x 6 m) greenhouse require around 1.890 used bottles.

The research aims to design and build greenhouses that could be assembled. The purpose of this unloading greenhouse was to move the greenhouse anywhere according to the needs of farmers and greenhouses for small farmers.

2. Scope review

2.1. Knockdown system theory

The theory of prefabricated systems with unloading construction must consider several things in development, this theory consists of:

a. Structure system theory
   The structural system used in the mixed system was the column modulation system, the panel wall system (unloading), the plate system (for building floors).
b. The theory of the financial system
   For this system, the partition wall was used in the inner space which functions as a baffle between the functions of the inner space. Also used are door components that can be assembled to be moved according to space requirements.
c. Connection system
   Connection systems for prefabricated systems generally use bolt connections.
d. Modular system
   The modular system was the coordination of dimensions between parts so that a systemic size was obtained. For residential buildings could be made original building modular system was a forming module that cultivated with integers to form a flexible space. Flexible space can be formed through the smallest unit for example a 6 x 6 module can be used for all building units. This is related to the types of residential standards such as types 36, 45 and 54. This system is a dimensional coordinate system that aims to simplify/limit variable dimensions of a building. The principle of this system was to look for a standard measure that could coordinate other dimensions in the same function; this was because the same function always demands the same dimensions. The basis of the modular coordination system is a module based on the human body and the direction of motion [2].

2.2. Greenhouse design

Design of greenhouse should depend upon sound scientific principles that facilitate the controlled environment for plant growth. Orientations of greenhouses were negotiated for wind direction, the latitude of location and type of temperature control and avoid dropping of shadow on the nearby greenhouses. It concluded that in the design of greenhouse, the shape and orientation of a greenhouse plays an important role [3]. Greenhouse having different shapes which as follows like a spherical dome, hyperbolic paraboloid, Quonset, modified Quonset, gothic arch, mansard roof, gabic even span, gabic uneven span. Basics shapes of greenhouses of are described in fig.2 [4].

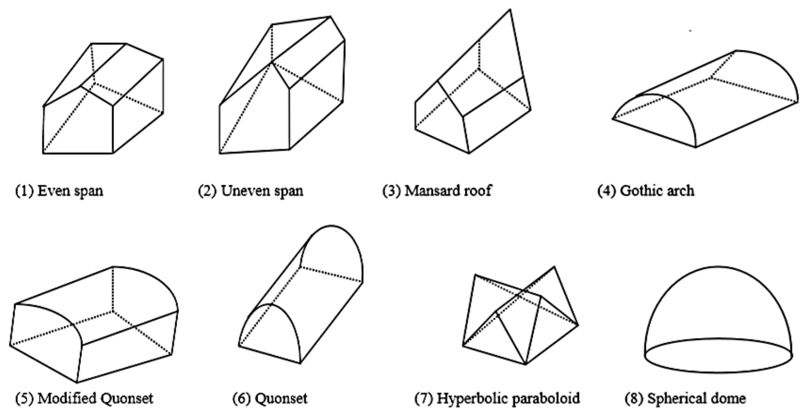

Figure 1. Basic shapes of the greenhouses

Alahudin suggested that the design of Greenhouse needs to pay attention to the following:

a. The extent of ventilation openings must meet the standard criteria for openings in the Greenhouse in the wet tropics which is 60% of the floor area.
b. For regions with wet tropical climates, the orientation of the house of the plant should extend east and west so that the roof of the house is facing north and south. This allowed the sun's rays to hit the plant more evenly throughout the day.
c. The material of furniture where he put the recommended plants was material that has insulating properties, so it did not radiate heat, for example, furniture materials made of wood.
d. The recommended Greenhouse roof material was Polyethylene and UV Stabilizer and wall material using a net/screen which also functions as a ventilation opening. However, consider the effect of the appearance of rainwater into the Greenhouse.
e. The recommended floor material was compacted or hardened with grass block, therefore did not emit heat and there should be no pavement around the Greenhouse.
f. Greenhouses must get enough sunlight from morning to evening; this means that the Greenhouse must not be blocked by other buildings or the shade of trees that can block sunlight. Also, the presence of buildings and trees near Greenhouse causes blockage of the wind flow needed for natural ventilation [1].

Concerning the nocturnal case, the ambient air temperature in the tunnel and vertical wall greenhouse was relatively homogenous and higher compared with the temperature distribution in the Venlo glasshouse. The air temperature at the center of the tunnel greenhouse was 290 K, while it was 288 K and 287 K in the vertical wall and Venlo glasshouse respectively. It could be concluded that for the nocturnal period, the plastic greenhouse, especially the tunnel one had better performances concerning the climate homogenization and the thermal energy storage [5].

The higher the building and the large volume of the greenhouse, the higher the temperature in the greenhouse room. This comparison occurred because of the difference in the wall area in each greenhouse where the higher the greenhouse building was, the wider the area of the wall. Comparison of greenhouse volume and difference in wall area caused the temperature in the greenhouse space to be homogeneous or heterogeneous. This was influenced by the circulation of the room and the reception of solar radiation in each greenhouse building, in a greenhouse with the narrowest volume of space and a small wall area, the air capacity in the room was small, so the circulation of air exchange was smaller. The capacity of the greenhouse space influenced the amount of heat that could accumulate in greenhouse greenhouses with 3.5 m high buildings has a relatively higher temperature than greenhouses with building height below them. This was because the greenhouse has a narrow room capacity which results in less air capacity accumulating in the greenhouse (the wider the capacity room, the higher the amount of hot air trapped in the room [6].

In the household scale greenhouse research in Merauke, the year was produced: greenhouse with type Quonset (curved roof), greenhouse made there are 2 (two); 1) greenhouse with Paranet and UV Plastic roof cover; 2) Greenhouse with paranet roof and Used Bottles, for greenhouses covering 4 m x 6 m (24 m^2) with used bottle roofs + 1890 used bottles. The thermal measurements of both greenhouses were: 1). Greenhouse 1 (greenhouse with paranet roof + UV plastic) average temperature of 28.7 °C, average humidity 70.4% and speed of 0.5 m/s; 2). Greenhouse 2 (greenhouse with paranet roof + used bottles) the average temperature was 26.2 °C, average humidity 66.4% and average angina speed 0.9 m/s. The second was measured in the building, the difference in measurement between greenhouse 1 and greenhouse 2 is; temperature 2.5 °C, humidity 4% and wind speed 0.4 m/s it could be concluded that greenhouse 2 was more 'cold' compared to greenhouse 1. While the average soil temperature in greenhouse 1 and greenhouse 2 was equal to 27 °C while the average soil pH for greenhouse 1 7.0 and the average soil pH for greenhouse 2 6.5 with a difference in pH between greenhouse 1 and greenhouse 2 that was 0.5 [7].

Figure 2. Greenhouse with used bottle roof cover material

Because the 1 inch PVC pipe greenhouse roof structure material could be curved due to solar heat conditions, structural material could be made stronger with iron or fixed pipes with PVC pipes with larger diameter, consideration of using a stronger greenhouse structure is high wind speed in Merauke , the frame structure with PVC pipe is not able to withstand the load [7].

Figure 3. The roof structure material of the PCV pipe is unable to withstand wind loads

3. Method

This research was an experimental and Action Research, and the research phase was among others; 1). Knockdown greenhouse design, 2) making greenhouses, 3) greenhouse testing (transportation, assembly, installation, and demolition). The study began in June - August 2018, greenhouse design activities were held at the Musamus University Architecture Laboratory, for the work of making workshop greenhouses around the research site in Yasa Mulya Village, Tanah Miring District, Merauke-Papua city.

4. Result and discussion

4.1. Greenhouse design results

The greenhouse that was designed using a Modified Quoset with a greenhouse size was 24 m^2 (6 m x 4 m). This size was used with consideration that knockdown greenhouses are intended for small farmers (if made larger, of course the cost of manufacture would be more expensive). Roof covering material using used bottles and paranet. The roof was a part of the building that directly interacts with the sun, so this was the first part to receive heat. For the construction of the roof made 2 stacking at the very top using a used bottle roof cover, while the roof at the bottom uses a Paranet roof cover. The Knockdown greenhouse height was 370 cm.

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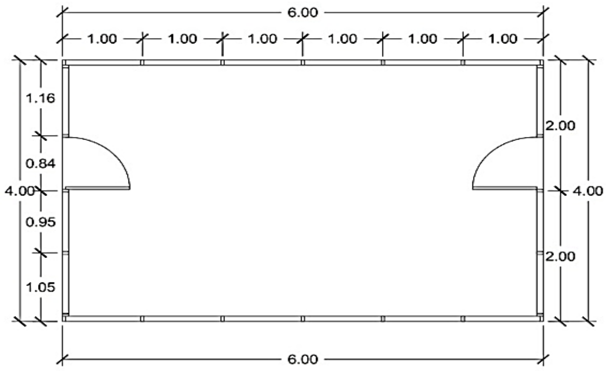

Figure 4. Greenhouse plan

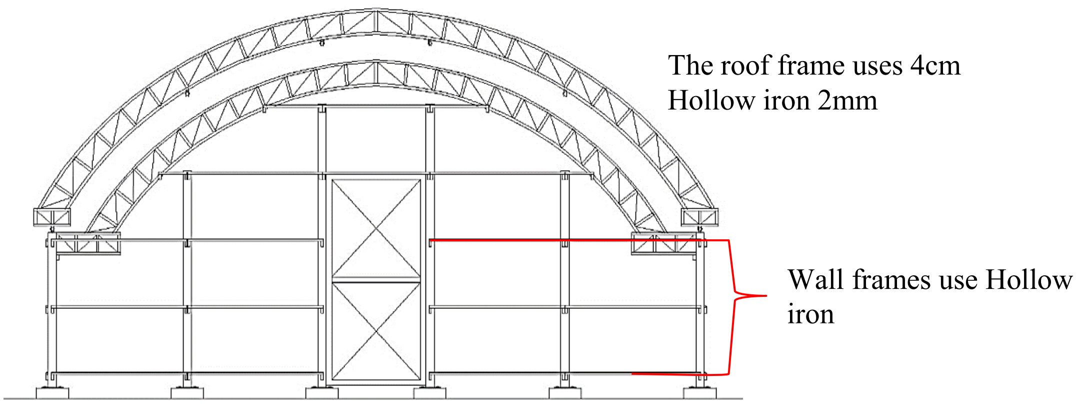

Figure 5. Greenhouse front view

The structure of the greenhouse for the pillar/column section uses a 3-inch diameter iron pipe while for the wall both front, rear, left and right side using a 4 cm hollow steel frame with a thickness of 3 mm. For the bottom/foundation, use a pedestal / local foundation that is useful for feet/greenhouse reinforcement, for pedestal foundations made with a size of 30 cm x 30 cm x 30 cm (27,000 m^3) with some pedestal / local foundations 18 foundations. The supporting pillars are ten poles, which are connected between the pole 1 and the others using a wall structure that was a hook between the poles (socket knockdown). Paranet (Insect screen) was a greenhouse cover material on the walls and roof.

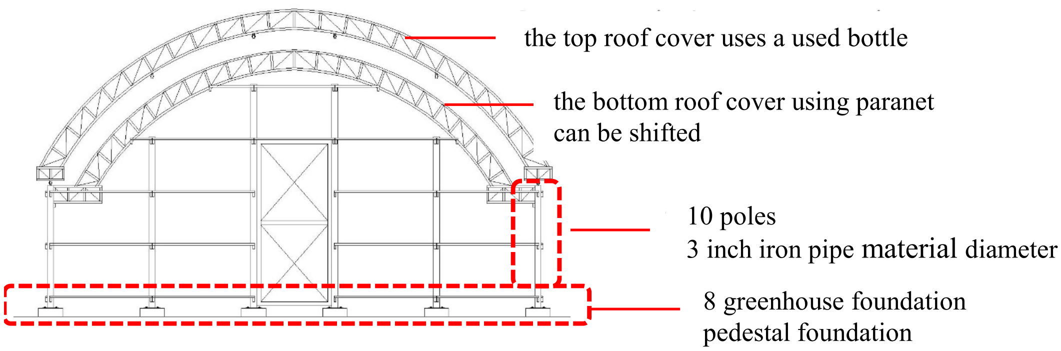

Figure 6. Greenhouse parts

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Between the roof structure, the wall and the foundation are all connected by bolt and only by means of linking, the consideration of using bolts was, of course, the strength of the connection between the temporary structure of the connecting structure which was associated with the speed in installation and dismantling (this was because the purpose of making knockdown greenhouses is where greenhouses can be moved just easily and quickly). At the bottom of the roof can be shifted the aim was to be able to take advantage of good climatic conditions for plant needs and reduce conditions that were not for plants, the roof covering material used was the Paranet (insect screen).

Figure 7. Modified quonset type of greenhouse

Greenhouse height 370 cm high difference with the first research was 50 cm, with this difference it was expected that the thermal conditions in the building would be better (temperature, humidity and wind speed). With good thermal conditions in the building, the researchers hope that the soil temperature and soil pH will be good and later the plants grown in greenhouses could grow and develop well.

4.2. Results of installation and demolition testing

This greenhouse with knockdown system could be installed with skilled personnel with a time of + 45.40 minutes (not including installation of roof cover and insect screen) installation starting with installation of pedestal foundation, after that the column / column and then the roof frame, for installation of greenhouse value framework for a long time because there are some parts that are reinforced with bolts, for the installation of a cover in the form of a used bottle that is assembled takes 35 minutes while the installation of an insect screen takes 50 minutes, installation of an insect screen for longer because the greenhouse can actually be covered by pests from outside The overall total takes + 2 hours 30 minutes.

5. Conclusion

The design of the greenhouse with Quonset type (curved roof), the roof material used is the roof of the used bottle, the structure of the greenhouse uses a combination of iron pipe and hollow iron, the application is on the pole/column using a 3 inch diameter iron pipe for the roof frame and the wall uses hollow iron 4 cm thickness 3mm. for foundations using pedestal / local foundations with a total of 18 foundations with dimensions of 27,000 m^3 (30 cm x 30 cm x 30 cm). The knockdown greenhouse roof consists of 2, namely 1) the rooftop uses used bottle roof cover material, and 2) the lower roof uses the Paranet / insect screen roof cover material.

The installation and dismantling of the knockdown Greenhouse take about 2 hours 30 minutes, with time division: 1). 45.40 minutes installer for greenhouse structure; 2). Thirty-five minutes installation of roof cover (used bottles) and; 3). Fifty minutes installation of insect screen.

Future Work

- Measurement of thermal conditions in a knockdown greenhouse, to determine the effect of greenhouse building structures on temperature, humidity and speed in a greenhouse.

- Development of a utility system in a greenhouse for the process of watering plants and greenhouse coding according to the thermal requirements of plants.

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References
[1] Alahudin M 2013 Evaluation of thermal condition of greenhouse building with polycarbonate roof materials at Musamus University Merauke *Journal of Agricola* **III**
[2] Akhmad AG, Fachruddin P A 2008 “Knock Down” construction house design *Jurnal SMARTek* **6** 18-28
[3] Condori M, Saravia L 2003 Analytical model for the performance of the tunnel- type greenhouse drier *Renewable energy* **28** 467-485
[4] Sahdev R K 2014 Open sun and greenhouse drying of agricultural and food products: A Review *International Journal of Engineering Research & Technology* **3** 2278-0181
[5] Kamel M I, Kheireddine M, Pierre-Emmanuel B 2017 Thermal analysis of greenhouses installed under semi arid climate *International Journal Of Heat And Technology* **35** 474-486
[6] Yuliasih P, N, Sumiyati S Y 2016 Temperature profile analysis on arch type Greenhouses for chrysanthemum flowering (Chrysanthemum morifolium) *Program Studi Teknik Pertanian, Fakultas Teknologi Pertanian, Universitas Udayana*
[7] Alahudin M, Widarnati I, Suryaningsih N L S 2018. Household scale of greenhouse design in Merauke *IOP Conf. Series: Journal of Physics: Conf. Series* **1025** 012026.