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Ergonomic design of weeds sprayer based on recycle energy to support palm oil replanting

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ABSTRACT

Research-based service activities on the development of weed sprayer have been carried out in Bukit Kratai Village, Rumbio Jaya District, Kampar Regency. The weed sprayer was developed by taking into account the ergonomics of the product based on an initial survey study of anthropometric data from Indonesians. While the design and selection of important product components was done using the VDI2222 method. After producing product, initial testing was carried out in the laboratory and then testing was carried out in the oil palm plantation area of Bukit Kratai Village. The developed weed control device utilizes a 0.8 Pa electric motor, 100 m flexible hose, and an adjustable nozzle whose energy is supplied by a set of solar panels. During product testing, in this case the oilm palm organization distinguished by Plasma Manager of PTPN V, the Chair of the Karya Sawit KUD in Bukit Kratai, and the Chair of the Sumber Jaya Farmer Group, all elements strongly support and accept the innovation or appropriate technology developed on the product due to minimizing the risk of work accidents, facilitate work, and increase work productivity. Farmers really hope for the sustainability of this tool to the point where they can use it in the field.

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1. INTRODUCTION

Oil palm plantations have become the main commodity in Indonesia's agricultural sector today. Riau Province is an area that has the largest oil palm plantations in Indonesia, where in 2020 there are 2,850,003 ha [1-3]. This oil palm plantation has been started from the Transmigration program in the 1990s. The population transmigration program from densely populated areas (Java Island) to areas that are still small (Sumatra and Kalimantan islands) [4, 5]. In Riau Province itself, oil palm plantations under the people's core plantation (PCR) program are currently entering the replanting phase because the average the average age is above 25 years [6-10]. One of the PCR oil palm plantations is in the Rumbio Jaya sub-district. This area has an area of 7,692.0 hectares of which 2,489.4 hectares or about 32% is PCR oil palm plantations. One of the Transmigration Villages in the sub-district This is Bukit Kratai Village which consists of 410 Heads of Families and has a population of 1,876 people, 90% of whom work as farmers with an area of 840 ha of oil palm plantations [11].

Oil palm plantations in Bukit Kratai Village are geographically bordered on the north by PCR oil palm plantations, in the west by Rubber and Oil Palm Plantations, in Pulau Birandang Village, in the south by the residential area of Bukit Kratai. This plantation can produce fresh fruit bunches (FFB) a minimum of around 1,500 tons and a maximum of 3,500 tons per month [12-15]. However, currently plantation yields have declined considerably due to the age of the oil palm, it is time for replanting, although the initial survey pre-proposal preparation shows that many farmers have carried out the replanting process independently without involving third parties such as PT and the Bank [16-18].

The management of oil palm plantations in Bukit Kratai Village is carried out in groups, where one farmer group consists of 20 members. There are 20 farmer groups under the umbrella of KUD Karya Sawit which have legal entities BH/XIII/VIII/1992, PAD deed no: 487/BH/PAD/ KWK.4/5.1/IX/1996. The proposed service activity will be carried out with one of the 20 farmer

groups, namely the Sumber Jaya Farmer Group. The selection of the group's partners was based on the many complaints from the farmers that their group's oil palm productivity had fallen drastically in the last 5 years. Previously, the Sumber Jaya Farmer Group was in the top 3 largest FFB producers in KUD Karya Sawit, but now it has decreased to 16th place. This is generally due to the difficulty of controlling weeds when the oil palms are old and during replanting (rejuvenation) where in these conditions a lot of sunlight hits the soil surface which facilitates and accelerates weed growth [19-24].

In the management of oil palm management, farmers still use conventional methods with other supporting technologies. For example, in harvesting FFB, farmers still use harvesting tools in the form of Dodos and Egrek, while the weed control process consists of two methods, namely the slashing method and the spraying method of weed poisons such as Roundup and Gramoxone herbicides at least 2 times a year. During oil palm replanting, weed growth rates also increase, requiring more intense control [25-28].

The initial survey of this activity obtained data that 70% of weed control was using herbicide spraying, while 25% of mowing was done using a lawn mower, and only about 5% used conventional slashing methods. The number of herbicide spraying activities on average is still carried out with a manual sprayer type of backwear. The spraying activity is carried out for a long time, which is about 6 working days (48 hours) to complete an area of one 2 hectare oil palm plot. The risk of injury felt by farmers is getting worse, starting from back pain, pinched nerves, digestive irritation due to the very close spraying distance, poisoning, even wounds on both upper shoulders in the position of the sprayer's shoulder strap. This problem certainly directly affects the effectiveness and productivity of farmers' work, especially during the replanting period.This Community Service activity is intended to assist farmers' activities in controlling weeds by designing and manufacturing an ergonomic sprayer that is easy to use, pays attention to user posture, is efficient and can reduce the risk of injury.

2. FORMS AND METHODS OF ACTIVITIES

In the implementation of this service activity, the research objectives will be achieved using the VDI 2222 method with the following stages in Figure 1.

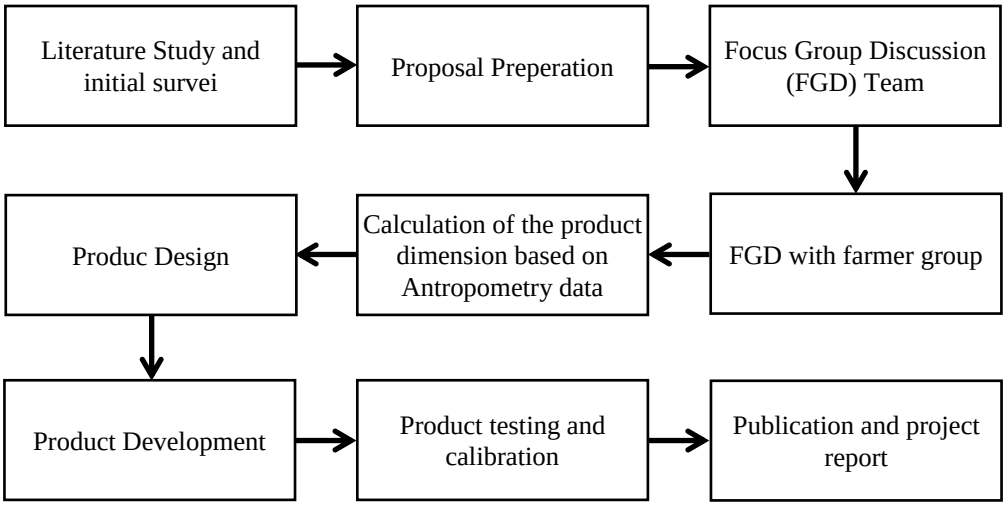


Figure 1. Step of service activity.

The calculation of ergonomic anthropometric data from the farmer's body posture aims to obtain the ergonomic dimensions of the product, so that this weed control machine is comfortable to use with the risk of injury being minimized. The product design specifications for this weed sprayer consist of two wheels with a diameter of 80 cm, the selection of a large enough diameter is of course very reasonable to facilitate product mobility in farmers' plantations consisting of grass and weeds, and also the terrain is muddy. The tanks that will be used are 60 to 70 liters in size so that the spraying area can be done wider for one filling. The spray machine uses a DC pump with a voltage of 12 Volts. This pump will be supplied with energy from a storage battery that is connected to a regulator charger so that when working on land this machine is always charged by sunlight through a solar panel that is

positioned at the same time as the roof of the machine. This design drawing will later be redesigned and optimized with the support of ergonomic and anthropometric data from farmers using Autocad or SketchUp. The product was tested directly for weed control in oil palm plantations PCR Sumber Jaya Farmer Group Bukit Kratai Village, Rumbio Jaya District. At the same time, data collection will be carried out consisting of data related to the functioning of the tool, efficiency (comparison of the time of land work using the previous equipment with the designed equipment) and data related to users, in this case the farmers themselves.

3. ACTIVITY IMPLEMENTATION

The Focus Group Discussion (FGD) with the Sumber Jaya farmer group and KUD Karya Sawit in Bukit Kratai Village discussed important things in product development. Interviews with 5 farmers related to use of conventional methods in weed control activities with the results as shown in Table 1.

Table 1. Interview results.

Farmers	Interview Results	Productivity	Noted
Dadang	Use in a conventional way results in: - Bruises on shoulders and back - Back pain - Pain at the base of the arm	16 h / Ha	1 day = 8 h
Bustami	Use in a conventional way results in: - Scratches on elbows - Bruise on shoulder - Back pain - The left arm cramped easily	24 h / Ha	1 day = 8 h
Giono	Use in a conventional way results in: - Pinched nerves - Poisoning	16 h / Ha	1 day = 8 h
Guritno	Use in a conventional way results in: - Backache and backache - calf cramps (raised calves)	20 h / Ha	1 day = 8 h
Sutrisno	Use in a conventional way results in: - Bending of the spine	16 h / Ha	1 day = 8 h

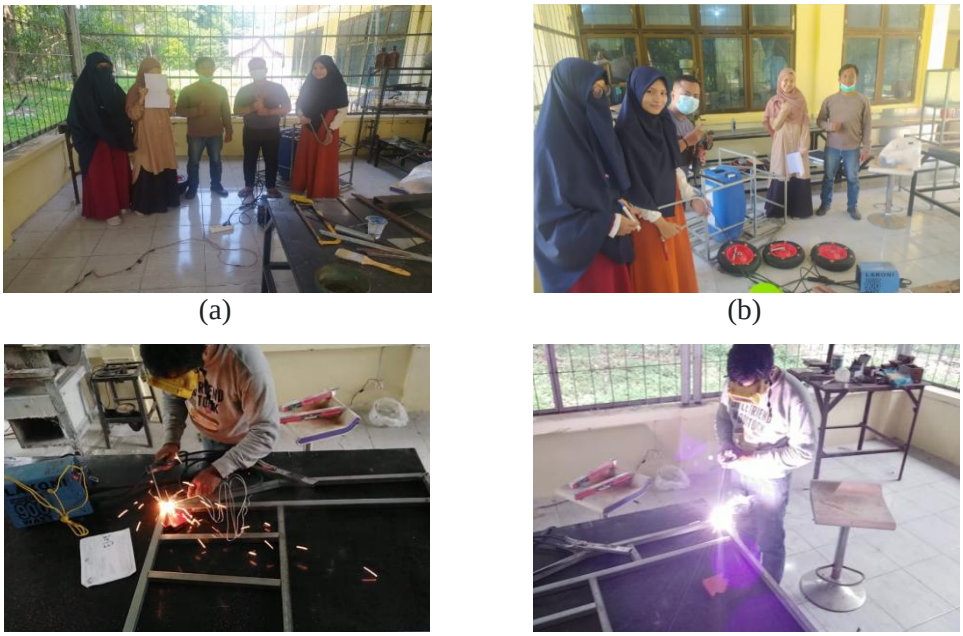
The results of this FGD become important inputs and considerations in product design to help the community.Indonesian Anthropometric data is used in calculating product dimensions and selecting equipment components using the VDI2222 method. The following Table 2 shows important components related to product design resulting from processing VDI2222.

Tabel 2. Important parameter of product design.

Item	Dimension
Tools height	90 cm
Tools width	80 cm
Tools long	120 cm
Handle diameter	3 cm
Hose pipe length	100 m
Rolling ratio	1:1
Coupling	¾ cm
Water pump (brushless motor)	0.8 Pa
Solar panels 40wp	35cm × 50cm
Battery 7,5 A	5cm × 12cm × 10cm
Sprayer gun (Adjustable Nozzle 2 mm)	40 cm

3.1. Tolls development

The making of the tools was carried out at the Educational Physics Laboratory, FKIP, Universitas Riau, which involved a team of researchers and students. Figure 2 below shows the activity of making a product.



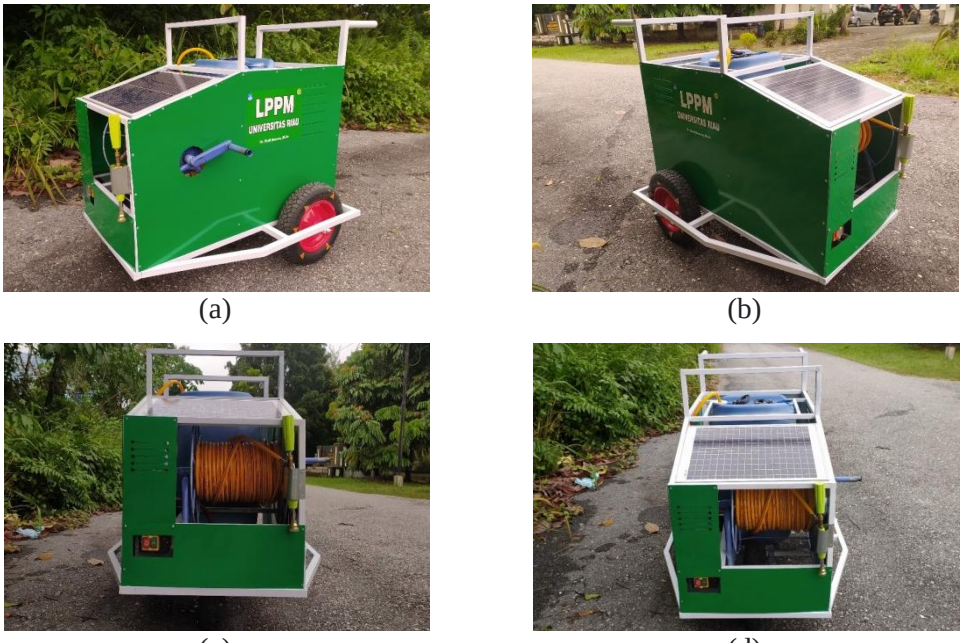
(a) (b)

(c) (d)

Figure 2. The process of making products in the laboratory (a) and (b): involving students, (c) and (d): welding process.

3.2. Service product results

The results of this research-based service activity are in the form of a weed control tool product (Weed sprayer) which is designed with user ergonomics in mind, and uses renewable energy technology. The physical product produced can be seen from Figure 3 below.



(a) (b)

(c) (d)

Figure 3. Product of service activities: weed control device (weed sprayer); (a) left view; (b) right view; (c) front view; and (d) top view.

3.3. Product testing

Product testing is carried out in two stages: first, testing is carried out in the laboratory by measuring the physical parameters of the product. This measurement obtains some important information related to the products produced, including related to product operational time. This product can operate continuously in bright sunlight, this is because in bright conditions the intensity of the sun will charge the battery through a set of integrated solar panels. However, on cloudy or cloudy weather the battery lasts for 8 hours. For the water pump pressure obtained about 0.6 Pa, this is considered sufficient for spraying purposes where the water output at the output nozzle can be adjusted in such a way that the level of distribution is as desired. Figure 4 below shows testing activities in the UNRI campus area.

Figure 4. Product testing in the area of Universitas Riau.

The second stage of testing was carried out directly in the field, the test was carried out in one of the Sumber Jaya Farmer Group's plantations which is currently entering the replanting period. This test is carried out together with:

1. Head of KUD Karya Sawit, Bukit Kratai Village, Rumbio Jaya District
2. Head of Sumber Jaya Farmers Group
3. PTPN 5 Plasma Manager
4. Field assistant for PTPN workers 5
5. Farmer

as shown in Figure 5 and Figure 6.

Figure 5. PTPN 5 field assistants and farmers conducting product testing

Figure 6. FGD in the field: First from right: PTPN V field assistant, second: Head of KUD Karya Sawit, third: PTPN V Plasma Manager, fourth: Research Team, Fifth: Research TEAM, Sixth: Head of Sumber Jaya Farmers Group, Seventh: Farmer.

From the results of the test involving all of these elements, I really appreciate this service activity. The product is seen as very convenient in weed control activities, not only that, the product will also be very useful in spraying pest poisons on plant leaves. The innovation provided is a solution to several current problems in weed control, especially the use of an electric motor as a water pump with a long enough hose up to 100 m. In addition, this tool covers the weaknesses of the previous equipment which relied heavily on PLN electricity for charging, as well as fuel, while this tool uses renewable energy technology through the solar charging system.

In this field discussion, the KUD of Palm Oil Works in Bukit Kratai Village, PTPN V, is very interested in being able to get the product being developed, and they are ready to become partners for the next stage of product development. This will certainly provide value generating potential for LPPM Universitas Riau.

4. CONCLUSION

Research-based service activities for weeds sprayers have been carried out by paying attention to ergonomic aspects based on anthropometric data of body posture. Appropriate technology products (TTG) in the form of a weed control device were developed as a solution to reduce the risk of work accidents and to increase the work productivity of oil palm farmers in controlling weeds during the rejuvenation period. The developed product can operate using the concept of renewable energy where the product can operate continuously under the sun as an energy source for charging batteries as a water pump energy supplier. With the ability to operate for a long time, and the integrated technology of flexible hose coiling along 50 - 100 meters, as well as an adjustable nozzle make this tool very feasible to use.

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