Compost applicators for horticulture

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Abstract. Horticulture is the art of planting fruit trees, vegetables, and ornamental or agricultural science that deals with the cultivation of gardens, including planting vegetable plants, fruit, flowers, and shrubs and ornamental trees. Fertilization is one of the important things to increase production, even until now regarded as a dominant factor in agricultural production. The use of compost can provide benefits for soil and plants. Problems that occur at the time of application of compost needed manpower and considerable expense, so it needs an efficient technology in the form of mechanical equipment that is simple and easy to operate. This study aims to modify applicator for sugar cane dry land so that it can be used on horticultural crops (vegetables) land and seeks to increase the efficiency of the applicator compost through modifications the system coupling that can be drawn using the tractor two wheels. The results show that the prototype model of applicator conveyor belt type had been made was functioning properly. Modification is done by replacing the joint connection between the applicator and the tractor. The volume of applicator compost is one meter cubic.

1. Introduction
Horticulture is a science that studies about the cultivation of vegetables, fruits, and ornamental plants. Currently, horticulture becomes a commercial farming enterprise [1]. Horticulture subsector is an important component in agricultural development which continues to grow and develop over time [2].

Factors causing low production of horticultural commodities at the farm level include the low quality of seeds, cultivation techniques are still limited, cost production are relatively large, small-scale enterprises and seasonality.

Fertilization is an important to increase production, even until now regarded as a dominant factor in agricultural production. Until the end of the 20th century fertilization is an important factor to increase production because there is no other alternative to replace [3].

Recently, organic fertilizer (compost) has been considered the heart of organic farming systems [4]. The function of compost is as soil conditioner. In terms of increasing the soil bearing capacity, compost is clearly superior and environmentally friendly than synthetic chemical fertilizers because it can increase the content of organic matter in soil. The content of organic matter in the soil has a very important and the amount of organic material that is often used for directly measuring soil fertility index. The compost can provide benefits for the soil and plants, among others: provide nutrients for the plants, improve soil structure, increase the population and activity of soil organisms, improve the ability to water holding and soil aggregates, increases infiltration, preventing erosion, supporting the deployment and penetration of plant roots, and to strengthen plant resistance to pests and diseases.

Organic fertilizer is useful in improving the physical, chemical and biological properties of the soil [5]. Beside that, soils that are given organic matter will be more easily processed [6]. Organic fertilizers can be made from various types of materials, such as crop residues (straw, corncob, and...
coconut husk), sawdust, animal waste, mushroom media waste, market waste, household and factory, and fertilizer green [7].

Application compost as a fertilizer on agricultural land must be in large amounts (high dose), this is caused by the nutrient content of the compost is lower compared with inorganic fertilizer so that to get an equivalent dose of the nutrient needs of plants. Problems that occur at the time of application of compost is needed manpower and considerable expense, so it needs an appropriate technology like mechanical equipment that is simple and easy to operate.

Applicator compost is one alternative problems solver in the application of compost on the farm. This study was conducted to modify the dry land sugarcane plant compost applicator pulled by four-wheel tractor to be used in the horticultural crops (vegetables) field pulled by hand tractor. Compost applicator is designed to help the process of fertilization use compost on farm. Compost applicator design previously been performed by Iqbal [8] were used for the process of fertilization on sugarcane plantations. The results of the previous research showed the rationing metering device mechanism using a type of conveyor belt has been able to function properly [8]. The spending rate of compost can be adjusted to the height of door openings regulator or the percentage of door openings regulator. The width of the door opening and the forward speed of the applicator can be adjusted to the rate of expenditure or dose of compost desired when the application of compost in the cane fields.

The application compost equipment or applicator compost in the field is a specifically designed to apply organic fertilizer or compost into the soil or in between the plants with specific dose of compost. Compost applicator is a trailer pulled by a tractor. The components of applicator are auger, pit where the discharge of compost, regulator doors, conveyor belt as a metering device, and fertilizers bin as the main framework. Applicator will be operated by hand tractor.

The general objective of this study was to modify the sugarcane applicator compost on dry land so that it can be used on land horticultural (vegetables).

2. Material And Method

2.1. Tools and Materials
The tools used in design process are welding equipment, tools kit, drill, grinder, hacksaw and gauges. In the process of designing applicators compost materials used are steel, iron plate, iron, welding wire, bolts, wheels, rubber conveyor belt, sprocket, auger, iron shaft, chain, wooden planks, and bearing.

2.2. Applicator Design
The expected of compost applicator is it capable putting compost into the soil or in between the plants with specific dose of compost. Compost applicator is a trailer pulled by a tractor. The components of applicator are auger, pit where the discharge of compost, regulator doors, conveyor belt as a metering device, and fertilizers bin as the main framework. Applicator will be operated by hand tractor.

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of compost by taking the power source of motion of the wheel axle applicators are connected by pulleys auger of compost. While the rotary power to drive metering device of conveyor belt, taking the source of compost auger pulley attached to a conveyor belt pulleys. This transmission splicing system uses a chain and sprocket.

3. Result And Discuss

3.1. Analysis of Mechanical Design Applicator
Compost applicator design process is requiring several parameters that constitute the basic data for designing the applicator. Equipment list and the field condition where compost applicator to operate is important that the design can be done well. The data is about the physical characteristics of compost, horticultural cultivation techniques (chili), the land condition, pull the power source, and a dose of fertilization.

3.1.1. Physical Properties and Compost Characteristics. The raw material compost is from the residue of the sugarcane (filter cake). It is cut by chopper into small pieces with a length 1-5 cm. The Density of compost is 340 kg/m$^3$.

3.1.2. Land Condition of Horticultural (chili). Horticultural cultivation system especially chilies are used by farmer in several areas in the southern of South Sulawesi province, there are 2 system. The first system is to use a seedbed (rice fields and plains) with a width of 1 meter beds and the second without beds (the highland and tilt). Spacing average is used is 60-70 cm, and is mediated furrow that can serve as irrigation and drainage channels to a depth of 25 cm and a width of 30 cm. The height of bed on land is 20-25 cm. The second system is planting chili on the garden on a hilly terrain (altitude with terracing and use of plastic mulch to prevent weed growth and erosion. This is planting pattern using a distance of 30 cm between plants and 1 meter between beds.

3.1.3. Hopper. It serves as a container or a compost before it is applied in the field. This box is a tub that can be made with basic materials such as stainless steel, iron plates, wood (board) and plastics. It is can prismatic hollow elongated or truncated cone that tapers toward the drain holes. Outlet can be circular or square usually located at the bottom or at the bottom of the tub wall.

3.1.4. The Metering Device Hole. The function of metering device hole is as a regulator of the output dose of compost before it is applied to land. It used in compost applicator design model is a type of conveyor belt assisted by auger. Type of conveyor belt is a unit that serves issued a fertilizer with a relatively high speed. Fertilizer pushed onto the running belt and the dose is set by adjusting the width of the door opening at the top of the running belt. Auger is the type of metering device that is fully taken manure to drain holes between the rotating screw thread $[9]$. Dose is set by adjusting the forward speed of the tractor which is connected to the shaft of belt conveyor and auger shaft.

3.1.5. The Transmission. It is a component serves to distribute or move a motion from sources such as motors, PTO or drive wheel. Some types of transmission to be used in the design of these applicators include: sprocket and chains, gears and chains.

3.2. Applicator Prototype
Compost applicator consists of several parts of the framework, like hopper, door openings regulator (dose), metering device (conveyor belt), the shaft conveyor belt, transmission systems, auger and outlet holes compost. Applicators compost has a height of 160 cm (from the ground), a length of 300 cm and a width of 136 cm.

This applicator consists of several parts which are detailed as follows:

3.2.1. Frame. Frame is the first part that made in the design of compost applicator prototype. The size of the frame without wheels applicator is 100 cm high, the length is 200 cm and width is 110 cm.

3.2.2. Compost Bin. The volume of compost applicator bin can be calculated using the equation:
Where: $V_b = 0.5 \times (ab + cd) \times ae \times ds$

(1)

The volume applicator based of dimension of the figure above is:

$V_b = 0.5 \times (136 + 100) \text{ cm} \times 55 \text{ cm} \times 160 \text{ cm} = 1038400 \text{ cm}^3 = 1 \text{ m}^3$

The compost bin of applicator is trapezium shaped prism and has a volume is 1 m$^3$, equivalent to 353 kg of compost if the density of compost is 340 kg/m$^3$ [8]. The function of compost bin is to accommodate the compost ready to be applied to plants. Additionally, tub holder compost should be strong for the pivot shaft of metering device because they work in a tub of compost. Because there is a hole of metering device and door openings, it takes place for the belt distributor, auger, and the regulator door of compost. The compost bin is made from steel frame with walls of sheet iron plate.

Doses of compost that will be applied is 10 tons/ha. If the density of compost is 340 kg/m$^3$, the total volume of compost is 10000 kg divided by 340 kg/m$^3 = 29.4$ m$^3$. This is a very large volume and weight (figure 2), so it will affect less well on land as it can cause soil compaction and requires a very large tractor. Therefore, in designing the volume of compost tub, applicators only operate with the compost along the 100 m length of the groove, and then fill up again and so on.

3.2.3. Compost Metering Device. The suitable of metering device of the applicator is conveyor belt type [10]. It could application the compost with big dose. The compost will be distributed by using a conveyor belt leading to the outlet holes, where spending or compost dose adjustment can be set with the door (regulator dose) above the belt. This applicator will use power from the wheel axle applicator that is transmitted through the chain. Distribution of fertilizer can be divided into multiple streams in accordance with the need to use an auger. The materials used for the conveyor belt is a hard rubber sheet is capable of supporting heavy loads such as compost. Auger as a distributor of compost is made from iron.

3.2.4. Regulatory Door Openings. The door is located directly above the end of the conveyor belt, can be increased or decreased. The function of this component is to adjust the amount or volume of compost which will be allocated on crop lands or as a regulator of doses of compost. Door openings
regulator may include an iron plate or board that height of the openings can be adjusted as desired dosage of compost.

3.2.5. Transmission system. The power source to applicate the compost is from axle applicator. So that is needed a transmission system can adjust the spin speed required and the direction of rotation. There are several things that must be caution in making transmission systems such as the treatment is simple, inexpensive, easily available and cheap. The transmission system consists of chain, gear, belts and pulleys.

![Applicator compost for horticulture](image)

**Figure 2.** Applicator compost for horticulture

4. Conclusions
The results showed that the prototype of applicator conveyor belt type had been made and modified according the hand tractor specification. It is functioning properly. The shape of applicator compost bin is prism trapezium and the volume is about 1 m$^3$ or equivalent 352 kg of compost.

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