

Design of a Plastic Mulch Remover Implement in Mexican Pineapple Production in a Protected Environment

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Abstract: Pineapple cultivation is considered one of the most important in Mexico, since approximately 999 thousand tons have been obtained, according to the records of the Ministry of Agriculture and Rural Development until 2019, the production of this fruit in the country has a consumption annual per capita of 6.9 kilograms and a commercial value of around 2.9 billion pesos where the main producing States are Veracruz, Oaxaca, Tabasco, Quintana Roo and Jalisco, representing 92.3% of the total production in the Mexican territory. In recent years, two management systems have been used for this crop, the first based on “bare soil” production, which is simply an open cycle where there is no protection for the fruit and the plant; while the second is done through the use of plastic mulch that is mainly based on protecting the soil and the plant with the fruits. With the use of this last system, great benefits, higher yield, productivity and low cost have been found, unlike the cultivation in open field, however, as of 2018 a great deterioration in the soil of the producing regions of pineapple was observed in the country and one of the main reasons is due to the remains of plastic mulch that remain in the soil after being removed at the end of each cycle and that over the years prevents the optimal growth of the pineapple, so the aim is to solve this problem and avoid the continuation of soil deterioration as little as possible. This article refers to the design of an agricultural implement of machine with the ability to completely remove and triturate the plastic mulch used for growing pineapple, thus avoiding the continuation of crop losses due to damaged soil.

Key words: plastic mulch, crop, agricultural implement, farming, environment, machinery

1. Introduction

In Mexico, pineapple cultivation was considered a commercial crop at the beginning of the 20th century and today it ranks between the 7th and 9th place of production on a world scale, with approximately 20 thousand hectares planted per year. The area with the highest production at the national level (69%) is the Papaloapan region, in the State of Veracruz and the practice used in most of the hectares dedicated to pineapple production is carried out under the protected environment system, this with the use of plastic mulch, this practice consists of covering the planting beds in

the final stage of the preparation of the land with a black plastic band, buried in the ground. This practice allows temperature increase, weed control, soil moisture conservation, nitrate formation, improved performance for drip irrigation and is more financially accessible than other systems. Generally favors the development and growth of the plant. Within the country, this practice has generated, so far in 2019, an increase of approximately 25% in performance.

Currently there is no plastic mulch that is fully adapted to specific climatic situations, but the colors of this plastic make it easy to choose, as each color is suitable for different growing purposes.

However, speaking in the long term, the use of plastic mulch causes erosion in the soil, since the task of removing the mulch after the last step of the crop

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cycle is done by hand, which means that it is not completely removed. Therefore, over time, these remains that remains buried in the soil cause the effect of deterioration of the soil and the optimal growth of the pineapple, for which a solution is sought to this problem, by designing an implement or machine. With the ability to completely remove the padding without leaving residues and at the same time triture it to be reused, it would also be promoted that this activity is no longer manual, but mechanical, optimizing the time that is commonly required to remove it

2. Advantages of Plastic Mulch

Among the main benefits of using the plastic mulch system in the protected environment for pineapple cultivation are the following:

- Avoid excess moisture in pineapple beds.
- It favors weed control.
- The pineapple plant grows much better in conditions of use of plastic.
- It prevents the spread of pests and diseases since the entry of personnel areas is reduced.
- Plant roots are abundant and healthy.
- It presents the problem of harvesting at the end of the growing cycle.
- The silver-black color prevents the plants from overheating to a certain extent, reduces the presence of pests and favors agricultural work.

In the Fig. 1 we can see what the appearance of the crop in plastic mulch and the plant in medium growth looks like.



Fig. 1 Appearance of pineapple cultivation in the middle of the cycle.

3. Pineapple Under Plastic Mulch

Pineapple production satisfies the domestic demand for fresh and agro-industrial products; it has increased in 16 countries such as China, some members of the European Union bloc, etc.

In 2017, a system proposed by the INIFAP (National Institute for Forest, Agricultural and Livestock Research) called Protected Environment was implemented, which consists in that the crop during the entire production cycle takes place in an environment where the microclimate that It surrounds the plants or, when an almost transparent cover is placed on a structure, a spontaneous climate is generated inside them that facilitates the cultivation of pineapple and others. This is done by covering the beds or furrows of the crop, with the aim of increasing their yield, conserving soil moisture and reducing the leaching of fertilizers.

The system was implemented in the first instance, in the region of Papaloapan, Veracruz, where it increased approximately 30% of the crop yield, thanks to this, the producers took better advantage of each cycle.

4. Preparation of the Land for Cultivation

For the preparation of the land, it is a fundamental



Fig. 2 Pineapple cultivation sample.



Fig. 3 Characteristics of the furrow for pineapple cultivation.

part so that the state of the pineapple when harvested is as expected, taking into account a good relationship between water-air within the soil for good growth and development of the roots. The acceptable slopes for this crop range from 0.5 to 1.0%. The land must have a pH in water greater than 4.0, to have the assurance that the soil will not remain dry if the crop is neglected.

Of the most common preparation practices are: first the harrow and then the subsoiler.

In the case of the furrows, they should have the following measurements (Fig. 3): seedbed no more than 25 cm, width 45-60 cm and centers equidistant

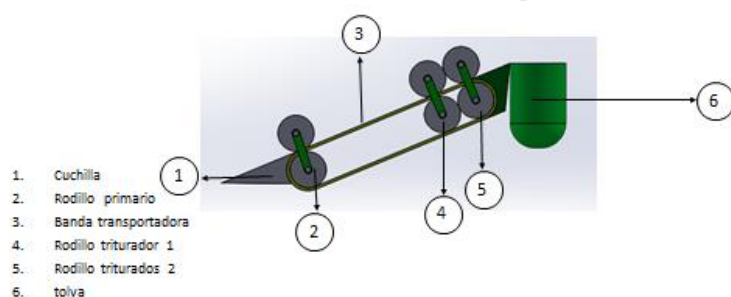


Fig. 4 Primary design.

This design, until now is believed to be the most optimal, speaking of process and size, by the end of 2020 it is planned to carry out a 3D simulation with the design already modified according to the results of the next soil analysis and resolution of equations for determine the proper speed for this machine to complete its work

from 115 to 140 cm; where the optimal number of plants is 30 to 35 thousand plants per hectare.

5. Plastic Mulch Remover Implement Design

The problem statement is very clear, it is required to solve the problem that plastic causes when burying itself in the soil in each crop cycle. So far, it is in phase one of the design, as various external factors have prevented continuing with the corresponding studies at the planting place of the crop.

It is known that the width of the furrow in the Papaloapan region for pineapple is generally 45 cm wide, and a distance between furrows of 50 cm, so these data were initially taken into account to define the size of the implement and later carry out the corresponding soil studies, and obtain the parameters to calculate the minimum and maximum speed at which it is going to work, in terms of removal and crushing of the plastic.

The initial design was worked in a 2D plane (not solid) by SolidWorks software, where the first phase of this could be captured. Resulting in what can be seen in Fig. 4, which is broken down as follows:

1. Knife: Aims to separate the plastic from the ground.
2. Primary roller: will begin to raise the entire plastic into the hopper.
3. Conveyor belt: it will perform a type of plastic wrap.
- 4/5 .Triture rollers: they will carry out the activity of crushing the plastic.
6. Hopper: Inside it, the plastic will be shredded to begin its reuse.

6. Conclusion

Within the Mexican countryside, pineapple is one of the crops that generate significant profits for producers, especially the Papaloapan region, where most of the production is carried out in the Mexican territory, due to the use of plastic mulch in every cycle.

For this reason, a solution must be given to the problems in the environment that it generates when using plastic for each cycle of pineapple cultivation, this machine will benefit producers, since continuous soil erosion will be avoided, in addition to having the capacity to crush it, it can be reused, either for the same activity or for a different one.

The design is in the initial stage, in which the appropriate parameters will be considered, depending on the width and height of the furrows, so that the machine can work on them, avoiding damaging leaves, plants and fruits. According to the soil study carried out by students and professors of the Chapingo Autonomous University, in the Papaloapan Region in August 2019, it was obtained that the soil erosion from 2017, which began with this plastic mulching system, was of a 20%, data with which it began to work with the design in SolidWorks Software, taking into account the aforementioned parameters, although it will undergo changes according to the next analyzes. It is expected that this machine or implement can be transferred to the producers at a low cost and strengthen the benefits of using this plastic mulching

system for their crops. The design may be used for different types of crops, however, it will first be adjusted to the pineapple crop.

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