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Application of formative and supportive propping in cacao: An innovation in cultural practices to increase cacao production

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Abstract

The study was conducted to investigate the impact of formative and supportive propping to the production of cacao as an innovation to the existing and traditional cultural practices in raising cacao. A demo farm was introduced with the innovative process using the stepwise methods of both formative and supportive propping. Observations were then recorded and analyzed. Based on the results of the study, it was observed that given the right amount of fertilizer and performance of other cultural practices, formative propping can increase the production of cacao up to 40-50% per hectare per year. Both formative and supportive propping can also minimize the pruning activity, reduce soil evaporation through self-shading, maintain soil fertility through self-shading, produce healthy cacao leaves through self-shading, minimize the practice of weeding beneath the cacao farm, maintain the temperature beneath the canopy, and help ease in doing other cultural practices inside the cacao farm. If the innovation is adopted, farmers may be able to meet the production targets of Cacao Challenge 2020 in the Philippines.

Keywords: Formative Propping; Supportive Propping; Increased Cacao Production; Innovation; Cacao Challenge 2020

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1. Introduction

Increasing the volume of production is a major challenge to cacao farmers in the Philippines. The low supply has been overtaken by the increasing demand for cacao products worldwide. On account of productivity level, a declining yield from 2005 to 2014 was noted despite of the expansion of the industry in terms of area. Although area expansion was observed yearly, the volume of production at 0.5 to 1.0 kg per tree per year is way below the targeted 2 kg per tree per year set by the industry to beat the 2020 Cacao Challenge (CIDAMI, 2017). This initiative of the industry aimed at producing at least 100,000 metric tons of cacao beans by 2020 to address the global shortfall of 1 million metric tons by strengthening the strategies towards the attainment of high production of cacao.

According to the reports of the Department of Agriculture, the market of cocoa beans was very attractive in the recent years. The Global growth rate of chocolate consumption is at 3.0% per year with China and India growing at 8% (PCTIR, 2015). The increasing worldwide demand for cacao is due to the increasing awareness for health benefits of chocolate, expanding range of applications in food, beverage, cosmetics and pharmaceuticals, and the increasing disposable income of middle class who can afford to purchase cacao-based products. It is considered one of the most important perennial crops in the planet, with an estimated world output of 3.5 million tons in 2006 (ICO, 2007). It is predominantly grown in the tropical areas of Central and South America, Asia and Africa (Boominga et al., 2018). Cacao is commercially exploited for seed output mainly destined for chocolate manufacturing. However, derivatives and byproducts of cacao can also be transformed in cosmetics, fine beverages, jellies, ice creams and juices (De Almeida and Valle, 2007).

The challenge therefore is on how to translate strategies for increased cacao production into tangible and workable farm practices. Other than expanding more plantations, improvement and innovations in the traditional cultural practices such as variety selection, planting, shading, pruning, fertilizer application, weed control, pest and disease control, harvesting, and other post-harvest processes must be considered in order to increase the farm yields. Hence, it is with this reason that formative and supportive propping are introduced as an innovation to the existing cultural practices in cacao production. This is an added activity only in the cacao farm while observing the existing cultural practices in cacao production.

The main objective of the study therefore was to investigate the impact of formative and supportive propping to the production of cacao after they are introduced and integrated in the common cultural practices. Specifically, it answered the following questions:

1- What are the step-wise methods in conducting the formative propping as additional cultural practice to increase cacao production?
2- How is supportive propping done to ensure upright position and weight control of the cacao tree after being introduced with formative propping?
3- In what way does formative and supportive propping increase the cacao productivity?
4- What are the other benefits of formative and supportive propping as an innovation in the existing and traditional cultural practices in raising cacao?

2. Materials and Methods

This research made use of a case study where two half hectares of land were used separately as demo farms. Case study (Torrentira, 2015) reveals a phenomenon peculiar to the study at hand like the application of innovation to an existing norm or practice. The first half hectare (Demo Farm A) was planted with cacao and applied with the traditional cultural practices or the usual traditional procedures of cultural practices in raising cacao from cultivation, variety selection, planting, shading, weeding, fertilizer application, pruning, pest and disease control, to harvesting and other post-harvest practices. On the other hand, the other half hectare (Demo Farm B) was also planted with cacao, applied with the traditional cultural practices but with the integration of formative and supportive propping as an innovation. The pieces of lands are located at the Sitio Villa Hermosa, Wangan, Calinan, Davao City. This area is agricultural and had been subjected to many agricultural crops because of its rich soil characteristics and accessibility to abundant source of water which is the Calinan River.

Constant observation was conducted from the time when formative propping and supportive propping were applied. That is, 1 year after the cacao seedlings were planted. The observed changes in the demo Farm B were recorded until its bearing period or 2 years after planting to trace the improvement in farm yield. The observation lasted for 3 years to considerably compare the bearing behavior of both demo farms. The step-wise procedure in the conduct of formative and supportive propping was then developed. The record of harvests was then used to determine the impact of the innovative practice to the total farm yield.

3. Results and discussion

The observations and actual performance of formative and supportive propping as additional cultural practice were the bases in developing the results of the study.

3.1. Stepwise procedure of formative propping

The procedure begins one (1) year after transplanting of cacao seedlings to permanent soil. This should be approximately 1 to 1.5 meter in height. Hence, the formative propping as an innovation in cultural practices of cacao production is only applicable to new farms with at least 1 to 2 year old seedlings. This is due to the fact that the primary and secondary trunks of cacao play a big role in the formation of viable cacao canopy through propping. However, after achieving approximately one to 1.2 m in height, the orthotropic growth ceases and the plant emits plagiotropic branches. The number of plagiotropic branches varies from three to five, forming what is generally named the cup or crown of the cacao tree (De Almeida and Valle, 2007). It is also highly recommended to modify the property of the scion as a material required in grafting. In formative propping, a scion with at least 4-6 bud eyes will facilitate the growth of a number of primary and secondary trunks which will favor the formation of desired canopy. The following steps are to be considered:

Figure 1. 1-year old cacao tree

3.1.1. Preparing the materials

Materials needed are 2-3 meters tying ropes (preferably plastic twine or tie box) and pruning shear. It is important that the tying materials are ready for use so that the tying process will not be disrupted by the unavailability of the tying rope. Plastic twine as a tying material is more advantageous because of its durability although it is more expensive than the tie box. The pruning shear should be treated first with a fungicide before using it to avoid any fungus formation on the cut trunks.

3.1.2. Initial pruning of unnecessary branches and stems

Carefully detach small stems and unnecessary chupons through the use of pruning shear or cutting knife. These stems and branches are obstacles to the upright formation in propping. Hence, detaching them will provide ease in pulling the stems towards the center.

Figure 2. Initial pruning of the unnecessary branches and stems of cacao tree

3.1.3. Identification of the first set of cacao trunks for propping

After initial pruning, the final set of trunks and stems which will be tied are identified. They usually range from 8 to 16 primary and secondary trunks. Depending on the extent of vegetative growth, tertiary trunks may also be identified in the first set of stems to be tied towards the center.

3.1.4. Propping of the trunks towards the center in an upright vertical position

Identify first the strongest and standing trunk. Usually, this is the primary stem that has first emerged during grafting. Begin by tying the rope either by half hitch knot or taut line hitch whichever is comfortable to the farmer.

Figure 3. Propping of the trunks towards the center in an upright vertical position

Select the second trunk, at least nearest to the first trunk, pull it towards the first trunk and tie the extending rope around it. Do not cut the rope. Select another trunk, tie the rope continuously and pull it towards the center. Do this until the first layer of tied trunks is created. Second layer of tying is done for the rest of the trunks outside the first layer. Be sure to maintain at least 3-5 inches of distance from each trunk. Notice that the direction of each trunk by this time is upright position as they are being controlled and pulled towards the center of the cacao tree.

Figure 4. Pulling of the secondary and tertiary stems towards the center using a rope

3.1.5. Formative re-propping

After 6 months to 1 year, depending on the rate of vegetative growth after the first propping, formative re-propping shall be conducted by transferring the tie of the rope just below or above the previous tie. This should be done to avoid choking of rope around the trunk and adjust the formation in such a way that each trunk supports each other in an upright direction rather than bending down. Adjustment of distance between each trunk should be done as well to maintain the 5-10 inches distance from each other. This time around, the tree is expected to have 6 to 12 primary stems standing upright formed in the re-propping. Careful adjustment of distance should be made to ensure balance in the vegetative growth.

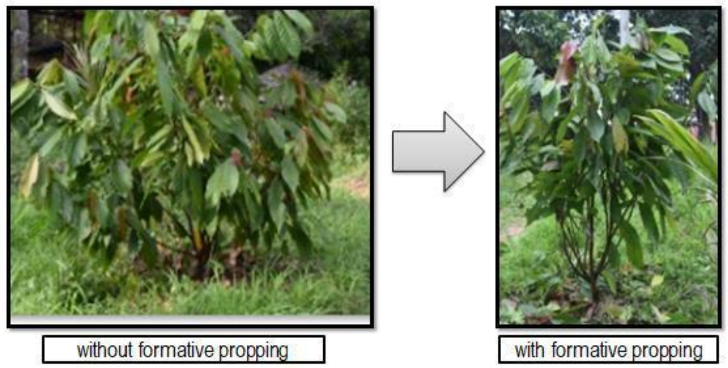

Figure 5. Image of cacao tree before and after formative propping

3.1.6. Regular monitoring and joining of the emergent stems.

Regular monitoring of formative propping shall be made at least every six months depending on the rate of vegetative growth of the cacao tree. Once a new chupon is developed from one bud eye (usually as secondary up to tertiary stems) careful evaluation shall be made if such new stem possesses viability to join in the group of formed stems through propping. Once viability is established, the new stem shall be joined in the formation by tying it along with the rest of existing stems. Still a distance of at least 5-10 inches or more shall be considered away from the existing stems.

3.1.7. Establishment of the permanent canopy

Later on, the bunch of formed stems, trunks and leaves in one cacao tree shall form a canopy. This time, 30 per cent of the sunlight penetrates the environment behind the trees while the 70 per cent of the sunlight is maintained above the cacao trees where leaves are abundant. Continuous monitoring shall be conducted throughout the life duration of the cacao tree. Pruning is still conducted as practiced to decongest unnecessary branches.

However, minimal pruning shall be conducted to avoid stress among the trees. Therefore, every cacao tree shall maintain 8 to 16 primary, secondary and tertiary stems from the base. These stems are at least 4 to 8 inches from the ground.

3.2. Supportive propping

Having established the canopy of the cacao tree, abundance of leaves and trunks and branches is maintained. This number of trunks will facilitate the generation of a number of cacao flowers which will in turn develop into cacao fruits or pods. Since the number of trunks and healthy leaves will optimize the development of more cacao pods, the entire canopy will weigh very heavy. The base of the cacao tree usually cannot carry the entire body weight of the cacao. With this condition, sometimes aggravated by wind, the cacao tree usually reclines or breaks and falls down.

Figure 6. Image of an inclined cacao tree due to weight of stems, pods, and leaves

This situation emerged because of the control of body weight of the cacao tree in the formative propping. It is therefore suggested to prepare the cacao tree with another innovation of the cultural practices of cacao production. This is called in the study as supportive propping. This, however being optional, will only be applicable after evaluating and concluding that there is a high probability of the cacao tree to fall down. The following steps shall be considered in applying the supportive propping:

3.2.1. Materials needed

The procedure will require a bamboo pole (3-10 ft) and a tying rope as the need arises. The bamboo pole to be used should be 2-3 inches in diameter radius and may be 3-5 feet in length depending on the height of the cacao tree to be supported by propping. The bamboo pole may be fresh or dried.

3.2.2. Cutting of the bamboo pole

The bamboo pole shall be cut according to the desired height or length. Cut the top most of the bamboo pole in a letter U shape. This will enable the bamboo pole to hold the cacao trunk powerfully. It is strongly suggested to cut the U-shape above the node of the bamboo pole, if possible).

Figure 7. U-shape cut at the edge of the bamboo pole

3.2.3. Propping using the bamboo pole

Carefully place the bamboo pole below the trunk of the cacao. Be sure to select the strongest trunk of the cacao tree where the pull of gravity is found. Use at least bamboo poles to support the weight of the canopy of the cacao.

Figure 8. Position of the bamboo pole in the application of supportive propping

3.2.4. Regular monitoring of the support prop

Once supportive propping is established, it is necessary to check the sudden change of weight of the cacao tree. If necessary, one additional bamboo pole may be put to strengthen the hold of the base of the cacao tree. Proper supportive propping will help the cacao tree to maintain its upright position. This will facilitate even distribution of sunlight around the canopy and will also protect the cacao pods from being destroyed. The supportive propping is only an addition and only necessary when needed. Usually, when the cacao tree has established its upright position, it will not break and fall down.

3.3. Benefits of formative propping in cacao

Formative propping, based on observation, has plenty of benefits to the production of cacao. They are enumerated as follows:

3.3.1. Increased production of cocoa pods

In formative propping, potential stems and branches are cultured and maintained to develop a space for additional flowers and fruits. According to David (2005), a healthy cocoa tree produces at least 25 pods per year which provides approximately 1 kg of dry cocoa. But in formative propping, at least 8-16 primary to tertiary stems are maintained per tree with at least 2-12 pods per branch depending on the size of the branch. That means, an average of 88 cacao pods is produced in one year or at least 3.52 kilograms of dried cacao beans per tree per year. Therefore, a one hectare land with at least 1,111 cacao trees at a 2m x 3m distance (Asare and David, 2011) introduced with formative propping can

produce up to 3.910 tons of dried cacao beans per year. This is way behind the 200-300 kilos per hectare a year for old variety of cacao or 1 to 2 tons of dried cacao beans per hectare per year for new varieties (Cascaro, 2012 and Asare and David, 2011). Changes in canopy coverage significantly modify the microclimate of the crop area, a less stressful environment being generated under closed canopy conditions, influencing the sap flow density of cacao trees (Jimenez-Perez et al., 2019).

3.3.2. Minimal pruning activity

Pruning is conducted regularly (at least quarterly) for the purpose of eradicating unnecessary branches of the cacao tree or to maintain at least 4-5 lateral or fan branches. But in formative propping, most of the branches are needed to develop the canopy that is needed to produce more cacao pods. Hence, less pruning activity is needed except for cases of pest and disease infestation. However, the farmer must be able to check the balance of the dense of canopy in order to keep the cacao tree healthy. Pruning then is done if necessary only. Since each stem is evaluated to contribute in the fruiting range, excessive pruning is avoided. Pruning may still be conducted but for excess leaves and unnecessary branches and new chupons only in excess of the maximum 18 primary and secondary to tertiary stems.

3.3.3. Reduced soil evaporation through self-shading

Shade has a very substantial effect on the growth and productivity of the cocoa tree throughout its development into a mature tree (ICO, 2008). Young cacao trees need 30% of direct sunlight while the 70% is shade. When it matures (about 4 years old), it will need 30-40% shade and 60-70% sunlight. This production requirement is being provided by formative propping. Note that formative propping induces the assembly of a healthy canopy of leaves and branches. This in turn will formulate self-shading for the cacao tree. Shade influences the microclimate beneath the canopy of the cacao farm by reducing the amount of solar radiation that reaches the leaves. Hence, the self-shading will maintain humidity in the surrounding and reduce the excessive evaporation in the soil. It also keeps the soil cooler in hot weather. In a study conducted by Jimenez-Perez et al. (2019), it was found out that differences in soil water potential between 10 and 60 cm depth in closed canopy were recorded during the dry season. There was a lower sap flow density and daily water use in open canopy.

3.3.4. Maintained soil fertility through self-shading

Shading retains the organic matter and therefore improves soil fertility. A soil that is exposed to sunlight normally becomes dehydrated and too much exposure will kill the good bacteria that helps in the decomposition of organic matter. But with formative propping, the self-shading helps retain the moisture in the soil which can facilitate the activity of the microorganisms in the decomposition process. This will maintain the fertility of the soil which will then help the cacao tree nourish itself for the nutrition it needs for higher productivity.

3.3.5. Production of healthy cacao leaves

According to Somarriba et al (2018), shaded leaves of cacao exhibit greater amount of chlorophyll concentrations that those directly exposed to solar radiation. Full exposure to direct sunlight causes leaf transpiration and water stress. This in turn will prohibit the leaf to expand. According to Niether et al. (2018)

the subsequent decline in productivity is attributed to excessive leaf transpiration and increase of soil evaporation. In contrast, shaded leaves show higher relative water content and fewer stomata per unit leaf area than unshaded leaves. Hence, healthy leaves are produced which in turn will help generate more flowers and cacao pods.

3.3.6. Minimal weeding practices

Since the environment below the canopy is shaded, weeds cannot grow or have little chance of growing. Limiting the sunlight to penetrate below the canopy will inhibit the growth of the weeds that are considered competitors of the cacao plant in the source of soil nutrients and water. As such, weeding as a practice to control the growth of undesirable and unnecessary plants will be minimized if not eliminated. This will benefit the farmer by minimizing the cost of laborer to conduct weeding or the cost of herbicides to control the weeds.

3.3.7. Maintained Temperature beneath the canopy

Maintained temperature the canopy. According to Daymond and Hadley (2004), temperature is one of the main limiting factors for cacao production, since temperature stress affects the seasonal variation in seed yield. Factors like soil water deficit and leaf respiration, due to high air temperature and high radiation, can be causes for the intensive leaf fall in the middle and upper canopy layers of the cacao crown.

3.3.8. Ease in doing other cultural practices in the cacao farm

Since the inner environment behind the canopy of the cacao trees is well-shaded, it will be convenient to the farmers to perform other cultural practices without being exposed to the hazards of the sun. It will be very easy for the workers to perform fertilizing, spraying, limited pruning, minimal weeding (if necessary only), fruit sleeving, harvesting, and other post-harvest activities. Note also that in formative propping, the branches are controlled to grow vertically upward to develop a strong well-balanced framework of branches. Thus, the branches are restricted from growing horizontally which blocks the passage row between furrows. Since formative propping guides the branches to grow vertically upright, there is no chance for them to block the workers from passing through. This will facilitate easier performance of all the other cultural practices needed to maintain a productive cacao tree.

4. Conclusion

Introducing formative and supportive propping to new cacao farms will surely help hit the production targets of Cacao Challenge 2020 in the Philippines. This study provided the step-by-step procedure on how to apply formative and supportive propping into the cacao farm. The benefits of this innovation include Increased production of cocoa pods, minimized pruning activity, reduces soil evaporation through self-shading, maintained soil fertility through self-shading, production of healthy leaves, minimized weeding practices, maintained temperature beneath the canopy, and ease in doing other cultural practices in the cacao farm.

Given these benefits, the innovation will surely help the farmers increase their production especially that there is a proven shortage of cacao beans supply by 2020. To maximize the dissemination of this innovation, it is highly encouraged that the research output be adopted by the academe and collaborate with extension partners like the cacao farmers by replicating (Torrentira, 2019) the practice as demonstrated in Demo Farm B. In this way, the farmers will be given proper instruction and guidance about the procedure.

As an innovation, formative and supportive propping are only additions to the existing and traditional cultural practices applied in cacao production in order to increase productivity in a very natural way. The rest of the cultural practices in raising cacao from planting to post-harvest practices are still applicable. However, some of them may have to be minimized or limited.

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