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Jurnal Keteknikan Pertanian, Departemen Teknik Pertanian, Fakultas Teknologi Pertanian,
Kampus IPB Darmaga, Bogor 16680. Telp. 0251-8624691, Fax 0251-8623026,
E-mail: jtep@ipb.ac.id atau jurnaltep@yahoo.com. Website: ipb.ac.id/~jtep.

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Technical Paper

Mechanical Cocoa Podbreaker Utilization in Cocoa Handling to Improve Labor Efficiency

Penggunaan Pemecah Mekanis Buah Kakao untuk Meningkatkan Efisiensi Tenaga Kerja dalam Penanganan Kakao

Sukrisno Widyoto[1], Sri Mulato[2], dan Siswoyo Soekarno[3]

Abstract

One of initial step of primary cocoa processing, which determine the final quality and processing cost was pulping and pod breaker. Pod breaker is used to take out the cocoa bean and separate it from fruit crust and placenta. Presently, cocoa pod breaking and bean separating from crust fruit are still conducted manually and need many workers, as well. Indonesian Coffee and Cocoa Research Institute has designed and tested the cocoa pod breaker with double cylinder pod breaking mechanism and vibration table grader with bean separating mechanism. Testing result showed that cocoa pod breaker had maximum work capacity of 9000 cocoa pod per hour at motor rotation of 2,000-2,200 rpm. Highest percentage of crust chip included in bean was 1.1%, which was obtained at treatment input feeding opening of 80% and percentage of broken bean of 2.1%. While the lowest percentage of crust bean was 0.16% that is obtained at 20% input feeding opening with 1.7% of broken bean. Optimum work capacity of 4,950 cocoa pod per hour was obtained at 50% input feeding opening with 0.22% crust chip included in bean, and 1.9% of broken bean percentage.

Keywords: *cocoa, podbreaker, labor saving, production efficiency*

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Introduction

Rapid development of smallholder cocoa plant area need to be supported with infrastructure prepared and suitable processing methods for farmers in order to be able to produce the standardized cocoa bean as required by National Standard of Indonesia (SNI). Definite quality warranty, followed by its availability in enough quantum, and on time supply, as well as continuity were some prerequisite, which were needed to market the smallholder cocoa bean with reached price level

Cocoa palnts, which much cultivated in smallholder plantation were Forastero type, and in the world trading, they are mostly called as bulk cocoa (Wood and Lass, 1985). Cocoa pod consist of three main components, viz. Crust pod, placenta, and bean (Figure 1). Crust pod is the bigest component on cocoa fruit in which there is more than 70% weight of ripe cocoa fruit. Cocoa bean percentage in a fruit is around 27-29% only, while the rest is placenta as the bundler of 30-40 bean (Wood and Lass, 1985; Sri Mulato dan Widyotomo, 2001).

One of initial step of primary cocoa processing, which determine the final quality and processing cost was pulping and pod breaker. Pod breaking purpose is to take out the cocoa bean and separate it from fruit crust and placenta. Cocoa bean then put into clean container, while crust pod components and its placenta could be processed to be by-product as like livestock food, compost, biogas, and so on.

Until present, cocoa pod breaking and bean separating from cust pod were still done manually and need many workers (Wood and Lass, 1985). Cocoa pod breaker generally used in the field were machete or sickle. Field data showed that half bean was chopped manually and resulted around 3 – 6 % (Jones, 1987; Sri Mulato dan Widyotomo, 2001). Manual chopping could increase the number of damage bean, those broken bean could be infected by fungus, as well (Wood and Lass, 1985). After cocoa pod cut in half, cocoa bean was taken form half cut and placenta bundle with clean hand. Relative small of postharvest number, pod breaking by farmers usually is done by family member. Pod breaking work prestation was around 800-1.000 pod per person per day. It will not happen if smallholder cocoa processing is conducted in group and big capacity. Pod breaking need many workers. A unit

[1] Staf Pengajar Pusat Penelitian Kopi dan Kakao Indonesia
[2] Staf Pengajar Pusat Penelitian Kopi dan Kakao Indonesia. Email: iccri@jember.wasantara.net.id
[3] Staf Pengajar Jurusan Teknik Pertanian, Fakultas Teknolgi Pertanian Universitas Jember.

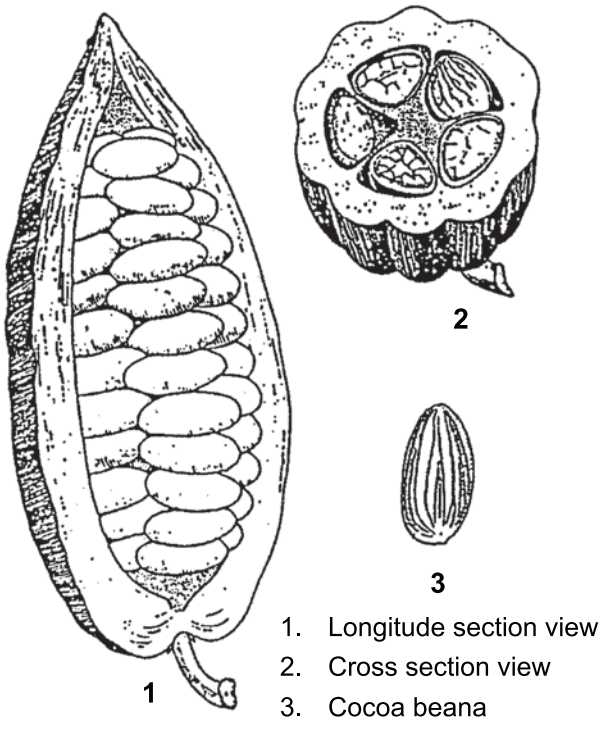

Figure 1. Longitude and Cross section view of bulk cocoa.

of cocoa processing with 5 ton capacity of wet bean need cocoa fruit supply of 50,000-60,000 fruit (Sri Mulato *et al*., 1997a, Sri Mulato *et al*., 1997b). If pod breaking is done manually, number of breaking workers was estimated around 60-75 person. For plantation location, where the workers number was limited and cocoa fruit material needed at once, pod breaking could be helped using pod breaker machine that capable to break as much as 6,000-8,000 fruit per hour (Figure 2).

Mechanically cocoa fruit breaking was not done yet intensively, either in main cocoa producer country of Africa or Latin America. Papua New Guinea had tried to do mechanically cocoa pod breaker, but it was not followed up with some technical consideration (Wood, 1982). In this research, it was tried to do cocoa pod breaking and bean separating mechanically using double cylinders in which each cylinder was reverse rotated (McCabe and Smith, 1956), and bean separating was done using vibration table system (Widyotomo dan Sri Mulato, 2005). Cocoa pod breaking and bean separating machines (*mechanical cocoa podbreaker*) were designed for 4-5 ton of cocoa fruit per hour or equivalent with 7,000-10,000 fruit per hour, and it was expected to be an integrated with a cocoa processing unit that has been designed in previous research.

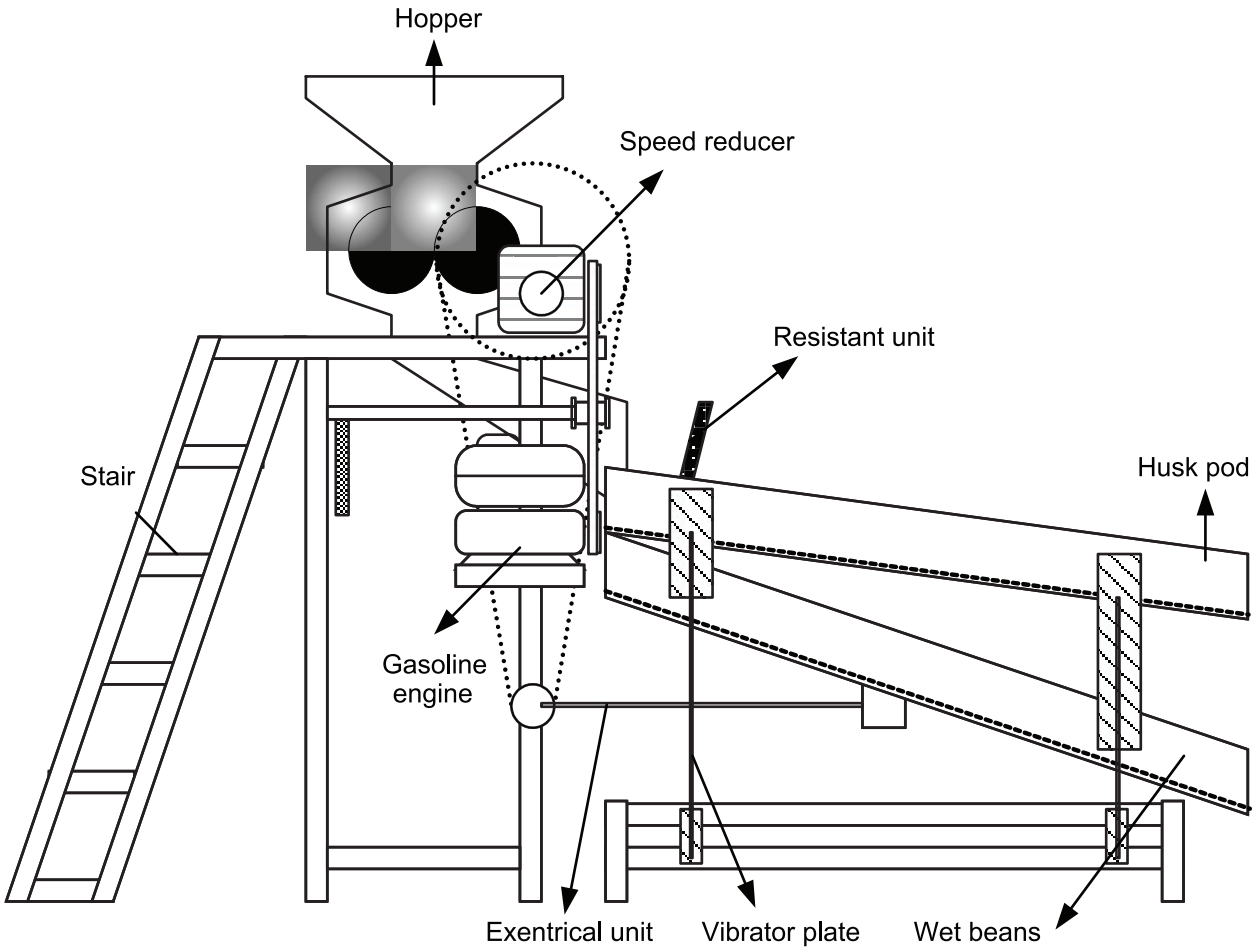

Figure 2. Mechanical cocoa podbreaker

MATERIALS AND METHODS

Cocoa fruit used as research material was Forastero type that have exactly ripe and harvested from Kaliwining Trial Field, Indonesia Coffee and Cocoa Research Institute. Kaliwining plantation is located at above sea surface of 45 m with climate type C-D (*Smith-Ferguson*). Tool used were mechanical cocoa podbreaker, stopwatch, analytical balance, etc.

Research activity steps was conducted with flowchart as shown in Figure 3. In the testing, cocoa pod breaker was operated at fixed motor rotation, viz. 2,000-2,200 rpm. Yield fruit size distribution was observed thoroughly to know the relationship between research materials with machine performance. Observation parameter of this research were breaker cylinder rotation speed and feeder opening percentage. Feeder opening percentage (*hopper*) could be set and it was done with opening variable of 20%, 50%, 60%, 80%, and 100%. Technical analysis of mechanically pod breaking process was conducted at machine work capacity based on feeder opening percentage, broken bean percentage, and crust shards percentage include in bean.

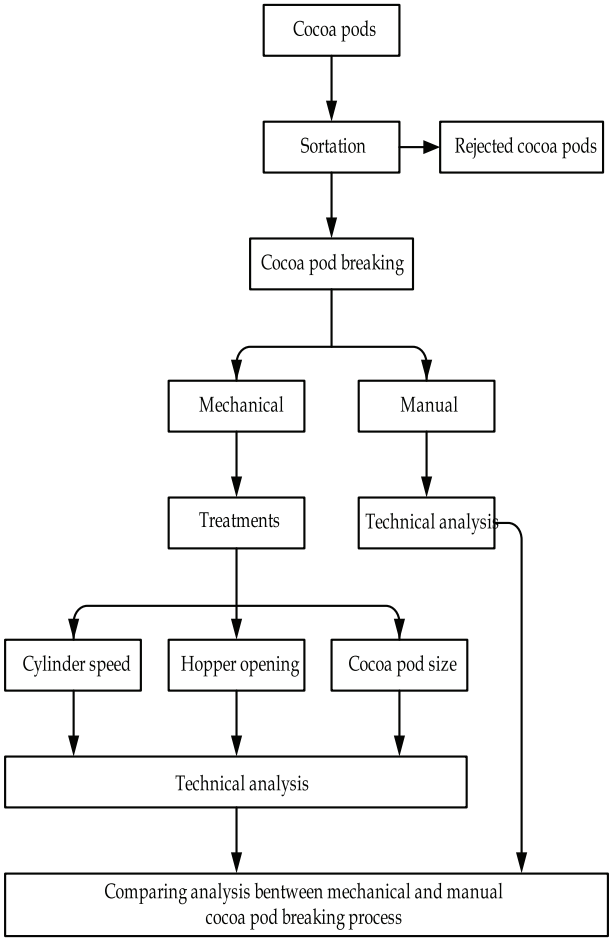

Figure 3. Research activity steps

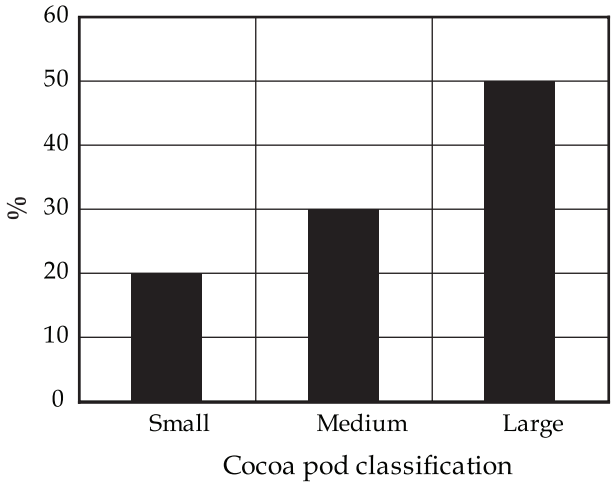

Figure 4. Harvested cocoa fruit size distribution

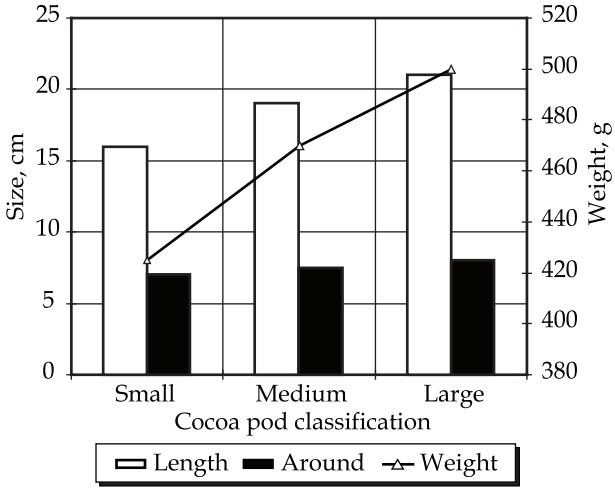

Figure 5. Total average of cocoa fruit dimension and weight as seed source

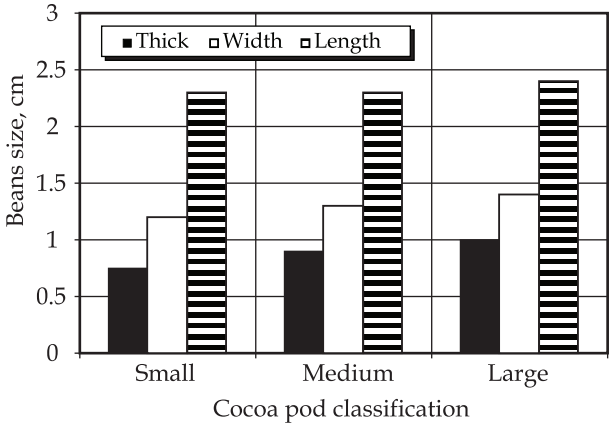

Figure 6. Total average of wet cocoa bean as seed source

Results and Discussion

Steps of cocoa pod breaking were initiated with raw material preparation, ripe fruit separation from unripe and disease infected fruit. Analysis result of physical characteristic of cocoa fruit in this research was shown in Figure 4, 5 and 6. Size distribution analysis result of harvested cocoa fruit as seed resources showed that 18%, 32%, and 50% of cocoa fruits was respectively included into small, medium, and big classification. While the average circumference of cocoa fruit with small, medium, and big sizes were 300 mm, 450 mm, and 550 mm, respectively. This information was needed to determine the optimum gap of double cylinder, which would be used for breaking cocoa pod.

Pod breaking mechanism was happened in between two rotating cylinders with reverse direction. The two cylinders size was same, viz. 150 mm of diameter and 250 mm of length, and rotated with reversed direction at speed of 20-25 RPM. The cylinder was moved by the Spark Ignition Engine (gasoline engine) of 5.5 HP. Cocoa fruit was fed manually into breaker cylinder by setting the sliding feeding port of Hopper with feeding rate between 8,000-10,000 cocoa fruit per hour. Gap between cylinders was set so as the cocoa kernels are not damage during the pod breaking process. Tangential force of cylinder surface would push the cocoa fruit come into the gap, and longitudinal force would break the cocoa pod become three fraction, viz. cocoa pod, placenta, and wet kernels. Cocoa pod, kernels, and placenta were then passed through two levels of vibration sieving machine. The fraction of cocoa pod broken with relatively big diameter would not pass the first (top) level of sieving machine, then they were collected and directed to exhaust port. Sieving vibration would cause the cocoa kernels loss from cocoa pod or placenta, and then pass through the holes of top level sieving machine, but they would keep at second level of sieving machine. Cocoa kernels that were kept on second level of sieving machine would slide and be collected through funnel of second sieve. Small broken pod with size less than kernels' size would pass through second sieve and collected on lowest container. Cocoa kernels resulted from cocoa pod breaker could be directly fermented as like cocoa kernels pulped manually.

Performance evaluation of mechanical cocoa pod breaker at double cylinder rotation speed of 110 RPM and feeding rate treatment variation (%) resulted the regression formula of $y = 81.25x + 887.5$ with correlation coeficient value (r) 0.9608 (Figure 8). This result showed that as big as feed port opening, the work capacity of pod breaking process would increase, as well. High work capacity did not guarranty the quality of the best products, because the product quality was related to the percentage of broken kernels and pod chips, which were included on kernels. Work capacity of cocoa pod breaking manually was around 800-1,200 fruit/person/day (Wood & Lass, 1985). In the previous research (Sri Mulato & Widyotomo, 2001), cocoa pod breaking was done using two cylinders with reverse rotation and worked continuously with capacity of 9,000 fruit per hour could prevent the kernels cut or broken.

Cocoa pod breaker machine would perform

Figure 7. Manually Cocoa pod breaking and bean separating

more effective if cocoa fruits have classified based on uniform size before breaking process. The classifying process was done in order to minimize the broken bean by setting the gap between two cylinder on the machine (Figure 9). The highest percentage of pod chips included in kernels of 1.1% was obtained at variation of 80% feed port opening with broken kernels of 2.1%. While the lowest percentage of pod chips included in kernels of 0.16% was obtained at feed port opening of 20% with broken kernels percentage of 1.7%. Optimum work capacity of 4,950 cocoa fruit/hour was obtained at feed port opening percentage of 50% with 0.22% of pod chips included in kernels, and broken kernels percentage of 1.9% (Figure 10). The amount of cut kernels due to manual cutter were around 3-6% (Jones, 1987). Besides, increasing the amount of defect kernels, injured kernels would easy to be infected by fungus (Wood & Lass, 1985). Morover, mechanical cocoa pod breaking resulted the kernels percentage included in pod was less than 2%, pod chips percentage included in kernels was 4%, so this aspect is still need to be further perfected (Sri Mulato & Widyotomo, 2001).

Conclusions

Testing result showed that cocoa pod breaker had maximum work capacity of 9000 pod per hour at motor rotation of 2000-2200 rpm. Highest percentage of crust chip included in bean was 1.1% , which was obtained at treatment input feeding opening of 80% and percentage of broken bean of 2.1%. While the lowest percentage of crust bean was 0.16% that is obtained at 20% input feeding opening with 1.7% of broken bean. Optimum work capacity of 4,950 cocoa pod per hour was obtained at 50% input feeding opening with 0.22% crust chip included in bean, and 1.9% of broken bean percentage.

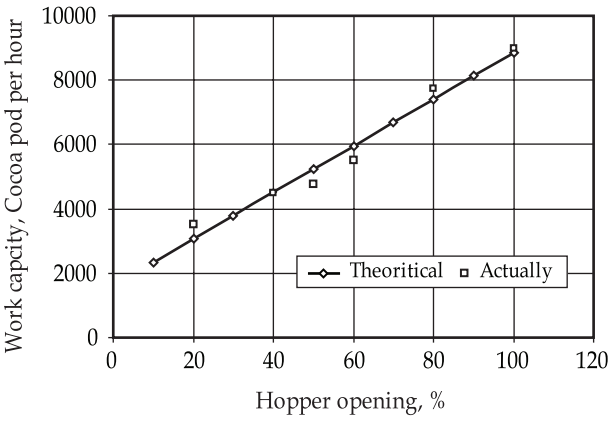

Figure 8. Work capacity of cocoa pod breaker with feeder opening variation

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Figure 9. Wet cocoa bean resulted by mechanical cocoa pod breaker

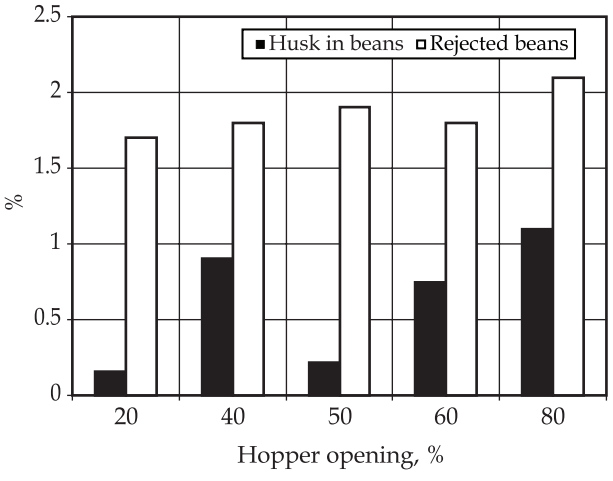

Figure 10. Percentage of crust shard inside bean and broken bean

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