Processing and Marketing Risk Factor of Cocoa Industry in Nigeria

E.T. Akinlabi 1,2*, O. J. Adelakun 2, I. P. Okokpujie 2 and S. A. Akinlabi 2,3

1Mechanical Engineering Department, University of Johannesburg, South Africa.
2 Department of Mechanical Engineering, Covenant University, Ota, Ogun State, Nigeria
3Department of Mechanical and Industrial Engineering, University of Johannesburg, South Africa.
Corresponding Author; Esther.Akinlabi@covenantuniversity.edu.ng; etakinlabi@gmail.com

Abstract- Cocoa (Theobroma cacao) is cultivated mainly for the cocoa beans which can undergo further treatment into various products which includes cocoa powder, liquor, butter and cake. The major challenges experienced by cocoa industries are inconsistency in production, low yield, pest and disease infestation, high cost of acquiring equipment, increase in production sustainability when considering modified varieties, cost of managing crop, organizing chain and cost of quality. This research aim at studying the process of cocoa beans production in other to provide suitable solution for sustainability of the production process. An evaluation method was applied to the analyzed the various processing steps involved in production stage and the plant layout before assessing the marketing risk factors. The result from the evaluation shows that price fluctuation has the highest ranked followed by processing risk factors, due to negligence of majority of cocoa farmers in maintenance and scheduling operation on their machines using kruskal-wallis test. This study identified risk factors, made comparison and proffer solutions to majority of uncertainties common with processing and marketing of cocoa in Nigeria, as well as the detailed steps and the plant layout in other to boost the standard and morale of every individuals considering cocoa processing across any part of the country. Structuring and developing cocoa beans market will help to reduce global prices fluctuation on the international markets and which will enhance the marketing framework.

Key words: Cocoa beans, marketing risk factor, plant layout

1. Introduction

Cocoa processing in Nigeria is an essential source of raw material and revenue asset to governments of cocoa producing states. Cocoa (Theobroma cacao) is cultivated mainly for the cocoa beans which can undergo further treatment into various products which includes cocoa powder, liquor, butter and cake [1]. As a result of the tremendous increase in cocoa production, there is an urgent need for machinery that will perform the processing of the cocoa bean to consumable asset in the Market, a situation where the bulk of the cocoa beans is fast developing as a result of its profitable value and its potential health benefits found [2]. Investment in cocoa processing machinery for processing is crucial for the growth of the economy especially for most states in Nigeria with about 17% of its annual cocoa production which is about 250,000 tones are processed locally [3]. Nigeria been the fourth largest producer of cocoa after Cote D’ivoir. Cocoa beans are widely used all over the globe because of the tremendous benefit of its final product which when processed obtained chocolate liquor, cocoa powder and cocoa butter [4]. In addition, it is also applicable in cosmetic and pharmaceutical. Cocoa beans can be
processed into final products by first of all undergoing post-harvest processing on farms, including removing the cocoa beans from the pod, cocoa beans fermentation, drying, roasting, cracking and grinding to give a powdery mass from which fat is expressed Walker [5]. The major step in the production of chocolate liquor or cocoa powder is by roasting so as to help eliminate undesirable compounds and provide pleasant flavor [6].

Cocoa shell has great economic importance in terms of revenue generation. This cocoa shell can be used as food additive, raw material for production of fibers, used as adsorbent for pollutant and studies shows the cocoa shells replacing a part of a usual animal diet because it contains theobromine, which may have a negative effect on some human species [7]. Cocoa husk much can also be used to prevent weed in some vegetable crops in organic production system. Cocoa shell production of ethanol was examined after fermentation time and yeast concentration with result clearly showing an excellent source of ethanol with good potential for biogas production [8]. Cocoa have also been used to treat different health problems, chocolate drinks produced from cocoa can be used to cure bronchitis and also given to children to defend against stings from deadly insects [9].

The major challenges experience by cocoa industries are inconsistent production, low yield, pest and disease infestation, high cost of acquiring equipment, increase in production sustainability when considering modified varieties, cost of managing crop, organizing chain cost of quality control in meeting numerous customer satisfaction [8], [9]. One of the factors responsible for decline in cocoa production in south western Nigeria is aging cocoa farm [10]. However, the objectives of this research work is to identify the challenges facing cocoa processing, the risk factors in production, marketing and make comparison for solutions by applying the detailed step involved in cocoa processing with the plant layout.

2. Methodology
The process involves sieving the beans into a smaller units to obtain most favorable separation and removing all irrelevant materials such as stones, strings, wood pieces, soil particles, nails, dirt and infestation by cleaning before breaking to loosen the shell from the kernel to avoid excess of fine particle and then winnowing to obtain kernels from the remains by blowing the lighter broken shell are then channeled to the winnowing section where stream of air remove the lighter broken shells [11].

Cocoa bean pass through various stages of equipment to form a product from harvesting, cleaning, fermentation, drying roasting, and grinding to liquor which is then squeezed into cake and butter and can as well be grounded into powder [12]. The flow chart in Figure 1, shows the gradual process involved in processing cocoa bean to cocoa butter, cocoa cake and cocoa powder. Firstly, the beans are selected before moving to the next stage of cleaning before been sterilized for the purpose of improving the flavour and colour after which it can be roasted or be alkalized which means to be less acidic for the purpose of removing the acidic bitter taste of the cocoa bean before grinding and then pressed to the final form of liquor, cake or powder based on desire.
Figure 1: Flow chart of the sequential steps for production of cocoa product

**Harvesting and cleaning:** Manual harvesting is carried out using hand tools to remove the pod from the trees. Pods are then exposed using a hand tool to separate pod from beans. If harvesting is not done on time, the pods turn out to be over-ripped and that may result in making the beans develop inside the pod. When beans stick together, it leads to poor drying and mold development and risk damage to the seed coat (shell) during germination, or the subsequent loss of the radical during drying or storage [13]. While the cleaning involves eliminating what accompany the delivered raw cocoa like sand, dust, iron parts and other foreign substance [14].

**Fermentation and drying:** Cocoa beans gotten from the pods can be placed in container and then covered with the leaves of banana to start the breaking down using bacteria that lasts for few days for the purpose of developing the aroma, colour and flavor which happens to be the main determinant for the quality of cocoa powder, cocoa beans can be dried using available means of dryer to prevent deterioration from bacteria, the drying process must be thorough so that moisture content is below 8% over a certain period of time [15].

**Roasting:** The purpose of roasting is to ensure that the nibs which is the kernels are dried in order to removed unattractive flavour, developed colour, and loosening the shell [16]. Temperature of roasting is about 145°C and it actually depends upon the type of nibs processed, method, material and finish products expected. There is need to expose nibs to high temperature so as to minimize the number of micro-organism thereby improving shelf life and making it durable [6].
Grinding and pressing: Cocoa beans kernel called the nibs is grounded to paste through the heat generated when the temperature is above 34 °c thereby causing the butter available in the nibs to melt to liquor [6]. In other to separate cocoa butter from liquor, there is need to make use of hydraulic press with high pressure to release the butter from liquor [17].

Cocoa butter: Cocoa butter is extracted from the cocoa bean, as edible vegetable fat, which is also called theobroma oil and has a pale yellow in colour. Cocoa butter is used for manufacturing chocolates, pharmaceutical product, ointments, toiletries, and cosmetic product such as moisturizing creams and soaps. [11].

Cocoa powder: Cocoa powder are gotten from cocoa butter through the application of high pressure to the roasted cocoa beans and may undergo further treatment with chemical solution so as to improve its colour, texture and flavor. Its application is in ice creams, chocolate cakes and drinks [18].

Cocoa liquor: Cocoa liquor is in form of a liquid made from cocoa bean by grinding to paste through heat generated causing the temperature to rise further thereby melting the paste to liquid called liquor [19]. Figure 2, shows the plant layout of a cocoa processing company and all the activities that is performed in the process.

The type of plant layout in Figure 2 is a process layout because the product moves from one section to another till the product is properly developed

![Figure 2: Cocoa processing plant layout](image)

3. Result and Discussion
Comparison between production and marketing risk in a cocoa processing industries located in Ondo state was analyzed in other to suggest solutions for improvement. Table 1, shows the
assessed risk of processing in cocoa in which pest and disease has the highest rank which is due to lack of exposure to resistant varieties. The fourth and fifth ranked on the list of assessment that is a major concern are expensive input and the cost of maintenance. Analysis clearly shows from the table that majority of cocoa producers do not carry out regular check which is called scheduling operation on their machines as a result of the cost and this affect the effectiveness of the machine with time. Expensive inputs in the likes of alkalizing and sterilizing agent is as result of lack of exposure to extension service that will make it available when needed at a minimal cost if producers collectively agreed. Production cost, agrochemicals, productivity and technical knowledge are also factors responsible for processing risk and are due to lack of exposure.

Table 1: processing risks of cocoa in Ondo State using the kruskal-Wallis test.

| Factors responsible for processing risk | Ranking | Mean |
|---------------------------------------|---------|------|
| Expensive inputs                      | 5       | 91   |
| Cost of Maintenance                   | 4       | 76   |
| Production cost                       | 3       | 72   |
| Productivity                          | 2       | 71.5 |
| Technical knowledge                   | 1       | 65.5 |
| Pest and diseases                     | 7       | 105.5|
| Agrochemical                          | 6       | 91.5 |

Where 7-1 = highest to lowest risk facing cocoa production, 91-105.5=lowest mean to the highest mean.

Table 2, shows the assessed marketing risk factor in Ondo state in which the pricing system has the highest ranked with a mean value = 93.7 due to inflation arising from its production, cost of making the product available through different means of communication and technology followed by the pricing system is the last two ranked which are market information and product price constituting another uncertainty in which effort is needed to know where the product will be channeled through adequate study and observation in deciding the price that will be convenient at different locations.

Table 2: Marketing risks of cocoa in Ondo State using the Kruskal-Wallis test.

| Marketing risk source            | Ranking | Mean |
|----------------------------------|---------|------|
| Marketing cost                   | 3       | 71.9 |
| Product price                    | 2       | 70.5 |
| Market information               | 1       | 60.2 |
| Inflating pricing system         | 4       | 93.7 |

The result in Table 1, will serve as guideline for new generation of cocoa industries and other cocoa processing company in Nigeria. From Table 2, it can be clearly seen that pest and disease have the highest ranking followed by agrochemicals, expensive input and the cost of maintenance which is a vital key area towards ensuring proper functioning in cocoa processing industry while in Table 2, representing the marketing risk analysis where its highest ranked is in price fluctuation connoting the change in price over a certain period of time. Kamphius, [8].
Most of the cocoa farms in Ondo operating under low productivity is due to the ageing of trees producing cocoa. Walker [5]. Reasons why the farmers were subjected to more risks to the sector is as a result of noticed black pod causing damages to cocoa bean which is prevented through the provision of good management practices in cocoa plantations. Majority of the cocoa beans from Africa have low standards in meeting international safety of food requirement and as result subjected to rejection [10]. One of the key factors responsible for low value of the cocoa beans production, observed from Ondo State is due to the adoption of crude implement in the treatment of cocoa beans, because in most cases farmer cannot produce high quality beans in meeting global standard without having the required capital and a good quality research skills to acquire processing equipment and machinery, if this research skills are acquired it will help to enhance the production of cocoa beans, and also the economic development of the state [19-22]. In cases where production is at the peak, numerous advantages are harnessed by countries interested in cocoa production.

Figure 3 shows the study of cocoa beans production for a period of six years from 2012/2013 to 2017/2018, which confirm the inconsistency of production of cocoa bean over the years, due to several factors alighted in Table 1 and 2.

![Figure 3: Six years’ study on cocoa beans production, showing the inconsistency in production process in Nigeria](image)

4. Conclusion
Majority of uncertainty common with processing and marketing of cocoa in Nigeria are significant and have been identified among the farmers in Ondo State providing guide to every individual that consider cocoa processing across any part of the country and beyond. In other to be successful, well-developed cocoa beans market is required to reduce global prices fluctuation and dependence on international markets as well as the Intervention of the government in setting a marketing scheme framework.
5. Recommendation

Measures should also be taken towards adequate investment in cocoa processing technology so as to encourage certain percentage of cocoa farmer producer in Nigeria. The government of Nigeria should make a decree that would benefit those moving the product to other part of the states and country producing cocoa. Enhance practices against cultural practices are important in the production of cocoa to reduce the threats of loses. Cocoa farmers should be assisted financially and empowered with adequate provisions of farm input that will allow them to meet international standards.

Acknowledgements

The author used this medium to appreciate the Covenant University Management for their financial support towards the publication of this research work.

Reference

[1] Alshekhli, O., Foo, D. C., Hii, C. L., & Law, C. L. (2011). Process simulation and debottlenecking for an industrial cocoa manufacturing process. Food and Bioproducts Processing, 89(4), 528-536.
[2] Beg, M. S., Ahmad, S., Jan, K., & Bashir, K. (2017). Status, supply chain and processing of cocoa-A review. Trends in food science & technology, 66, 108-116.
[3] Quiroz-Reyes, C. N., & Fogliano, V. (2018). Design cocoa processing towards healthy cocoa products: The role of phenolics and melanoidins. Journal of functional foods, 45, 480-490.
[4] Afoakwa, E. O. (2014). Cocoa production and processing technology. CRC Press.
[5] Watts, M. J. (2013). Silent violence: Food, famine, and peasantry in northern Nigeria (Vol. 15). University of Georgia Press.
[6] Taleb, T., Corici, M., Parada, C., Jamakovic, A., Ruffino, S., Karagiannis, G., & Magedanz, T. (2015). EASE: EPC as a service to ease mobile core network deployment over cloud. IEEE Network, 29(2), 78-88.
[7] Babalola, F. D., Ayinde, O. E., Chirwa, P. W., & Thiam, D. R. (2017). Risks and coping strategies of production and marketing of cocoa in Ondo State, Nigeria. Agroforestry systems, 91(2), 211-220.
[8] Kamphuis, H. J. (2017). Production of cocoa mass, cocoa butter and cocoa powder. Beckett's Industrial Chocolate Manufacture and Use, 50-71.
[9] Beckett, S. T. (2018). The science of chocolate. Royal Society of Chemistry.
[10] Matissek, R., Reinecke, J., von Hagen, O., & Manning, S. (2012). Sustainability in the Cocoa Sector-Review, Challenges and Approaches. Modern Ernahrung Heute, Official Journal of the Food Chemistry Institute of the Association of the German Confectionery Industry, 1-27.
[11] Panak Balentić, J., Ačkar, D., Jokić, S., Jozinović, A., Babić, J., Miličević, B., ... & Pavlović, N. (2018). Cocoa shell: A by-product with great potential for wide application. Molecules, 23(6), 1404.
[12] Edoh Adabe K. and N.-S. L., (2014) Cocoa: Production and processing. CTA.
[13] Segun, O. P. (2014) An Assessment of Investment in Technology in Cocoa Processing Industry in Nigeria. vol. 5, no. 10.
[14] Umaharan, P. (2018). *Achieving sustainable cultivation of cocoa: Genetics, breeding, cultivation and quality*. Burleigh Dodds Science Publishing.

[15] Ogunsina B. S., Adeyemi M. A., Morakinyo T. A., Aremu O. J., Bamgboye A. I., (2017) "Direct energy utilization in the processing of cocoa beans into powder", pp.213-218.

[16] Dand R., (2011) “Environmental and practical factors affecting cocoa production,” in The International Cocoa Trade, pp. 65–93.

[17] Fayomi, O. S. I., Okokpujie, I. P., & Udo, M. (2018). The role of research in attaining sustainable development goals. In *IOP Conference Series: Materials Science and Engineering* (Vol. 413, No. 1, p. 012002). IOP Publishing.

[18] Dand R., “Cocoa bean processing and the manufacture of chocolate,” in The International Cocoa Trade, 2011, pp. 268–289

[19] Okokpujie, I. P., Fayomi, O. S. I., & Leramo, R. O. (2018). The Role of Research in Economic Development. In *IOP Conference Series: Materials Science and Engineering* (Vol. 413, No. 1, p. 012060). IOP Publishing.

[20] Okokpujie, I. P., Fayomi, O. S. I., Ogbonnaya, S. K., & Fayomi, G. U. (2019). The Wide Margin Between the Academic and Researcher in a New Age University for Sustainable Development. *Energy Procedia*, 157, 862-870.

[21] Yekini, S. E., Okokpujie, I. P., Afolalu, S. A., Ajayi, O. O., & Azeta, J. (2018). Investigation of production output for improvement. *International Journal of Mechanical and Production Engineering Research and Development*, 8(1), 915-922.

[22] Dunmade, I., Udo, M., Akintayo, T., Oyedepo, S., & Okokpujie, I. P. (2018). Lifecycle impact assessment of an engineering project management process—a SLCA approach. In *IOP Conference Series: Materials Science and Engineering* (Vol. 413, No. 1, p. 012061). IOP Publishing.