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RESEARCH ARTICLE

The socio-economic impact of mitigating the challenges at the artisanal palm oil mills in Ghana

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Abstract

There has been tremendous demand for palm oil globally due to it varied used in the food, biofuel, and oleochemicals. Ghana is a net importer of palm oil despite producing some best yielding varieties. This is ascribed to operation of palm oil artisanal mills, which account for close to 80% of palm oil production. Artisans are bedeviled with enormous challenges in their processing activities but possess the key of increasing palm oil production by 6%, which is translated into 210,800 tons per annum. This review, being mindful of net importation reduction, focused on the efforts in addressing some of challenges at the artisanal mills in Ghana to achieving some sustainable development goals (SDGs) and placing emphasis on the social-economic impact. An average free fatty acid and oil extraction ratio for Ghana was 15.55% and 9.55%, respectively. This paper revealed that through policy, research and extension service most of these challenges could be mitigated. Top among the challenge facing artisans were oil extraction ratio and quality of oil production, which demonstrated a positive correlation with a better access to premium market and working conditions, an increase in income and purchasing power, achieving food and energy security and prevention of ecosystem depletion.

KEYWORDS
crude palm oil, free fatty acids, oil extraction rate

1 | INTRODUCTION

The global production of edible palm oil reached 81.6 million metric tons in 2019 and expected to increase to 264 million metric tons by 2050 (USDA, 2019). Increasing global demand is as a result of its primary use as food, biofuel, and oleochemicals. Africa and Asia are the largest consumers of the commodity with an estimated consumption of approximately 57 million metric tons per annum (Rhebergen et al., 2020). Understandably, palm oil forms 50% of food products on supermarket in the form of bakery products, personal care and cosmetic products, pharmaceuticals, and confectioneries due to its unique physical and chemical properties (Ofosu-Budu & Sarpong, 2013). For instance, the highly saturated nature of palm oil renders it solid at room temperature (25°C melting point) in temperate regions, serving as cheap substitute for butter or hydrogenated vegetable oils in the bakery industry. Again, health concerns associated with consumption of trans fats in hydrogenated vegetable oils may have also contributed to the increasing patronage of palm oil in the food industry. Lastly, availability and affordability of palm oil compared to other forms of edible oils may have also driven demand. Thus, for food and energy security, palm oil plays critical role in developing countries such as Ghana in attaining the Sustainable development goals (SDGs).

However, Ghana is a net importer of palm oil even though it produces some of the best high yielding varieties in the world. Palm oil importation in Ghana increased from 164,725 tons in 2018 to 203,000 tons in 2019, with an average increase of 23.9% per annum. This increase is as a result of higher consumption demand which accounted for 337 million USD in 2018. According to Morgans et al. (2018), majority of the palm oil produced in Ghana is from small holder artisanal mills (popularly called Kramers) lacking the requisite skills and technology to produce high quality oil and achieving high oil extraction rates (OER). This has therefore created the demand gap that is annually filled with increasing importations from Asia. Currently, Malaysia and Indonesia are leading producers of palm oil, which accounts for 86% of global production (Chew et al., 2021). Malaysia palm oil industry is worth $60 billion as a result of value addition to the palm fruit (Ali et al., 2015). Ironically, reports suggest that Malaysia's palm fruits were obtained from Ghana. Ghana's stagnation in the palm oil industry has largely been attributed to a lack of policy direction from central government, mismanagement of land, and improper processing technologies.

With increasing cognizance in climate change on the ecosystem and environment, palm oil producing countries are making frantic efforts to pursue sustainable development goals (SDGs) in their practices at both production and processing. Thus, efforts are being channel into maximizing revenue from the current hectares of palm oil plantation to eradicate poverty, increase edible oil production and ensure good health and well-being for mankind. In achieving this, the paper looks into the efforts in addressing some challenges at the artisanal mills in Ghana to achieving these SDGs focusing on the social-economic impact of these efforts. In other words, this manuscript reviews the enormous challenges facing artisans in the palm oil industry in Ghana and offers practical solutions to these problems.

1.1 | Challenges facing artisanal palm oil mills in Ghana

In Ghana, the artisans in palm oil productions are bedeviled with enormous challenges in their processing activities but possess the potential of eradicating rural poverty especially among women when given the needed attention. Over the last decades, artisanal palm oil processing has not been transformed much from simple basis steps such as bunch quartering (cutting), fruit loosening and boiling to pound, and scooping of oil from the surface. These processing steps were manually executed until quite recently where pressers such as spindle, screw, and hydraulic pressers were introduced. In recent times, mechanization of palm oil extraction using screw press has seen a sudden rise due to its availability, cheaper price, and easy operation. A critical assessment of artisan's operation revealed that much could be done to improve working conditions, creating job opportunities through the establishment of value chain system, reducing importation of edible oil and increasing revenue generation without the need for further expansion plantation, which comes other environmental un-friendly ecosystem issues such as fertilizer, weedicides, herbicides, and water application for crop cultivation.

The government of Ghana seems to be promoting Roundtable on Sustainable Palm Oil (RSPO) agenda but is however limited in the implementation process as many of the oil palm plantation is owned by smallholder farmers accounting for about 80% of the total plantation. As a result, Ghana has not seen rapid expansion and intensification over the last few decades as have been observed in Malaysia and Indonesia (Cattau et al., 2016).

A keen evaluation of these challenges could be mitigated through three channels: policy, research, and extension. The effects on these challenges are revealed in the quality of oil that are released on the market accompanied by environmental pollution and unstable pricing. Top among the challenges facing artisanal mills as depicted in Figure 1 are low oil extraction rate (OER) and free fatty acid (FFA) release, which directly correspond to quality of which oil could be classified as edible or non-edible. Other quality issues facing the artisanal mills include adulterations, unwholesome water usage, unhygienic processing conditions, and techniques. Other challenges that are associated with policy are lack of certification and regularization, unstable pricing and inadequate storage facilities.

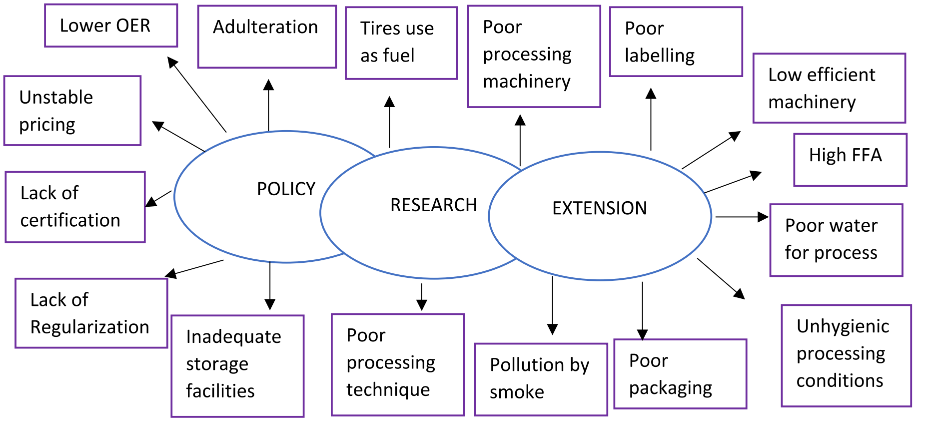

FIGURE 1 Challenges facing artisanal palm oil mills in Ghana

2 | OIL EXTRACTION RATE

With increasing awareness in climate change on the ecosystem and environment, palm oil-producing countries are making efforts to adopt sustainable development practices in the production and processing of the oil palm. One efficient strategy is to increase the OER at the artisanal mills, which account for between 60 and 80% of Ghana's crude palm oil (CPO) production (Osei-Amponsah et al., 2018). Research by Oil Palm Research Institute (CSIR-OPRI, Kade, Eastern Region, Ghana, 2021), suggests that 20 tons of fresh fruit bunch (FFB) per hectare could yield 4 tons of crude palm oil (CPO) with an oil extraction rate (OER) of 25%. OER measures the efficiency of palm oil mill and expressed as the ratio of weight in term of mass between the crude palm oil (CPO) extracted to the fresh fruit (Equation (1)) bunches processed (Corley & Tinker, 2008).

$$\textit{Oil Extraction Ratio, OER}\,(\%) = \frac{\textit{total oil produced}}{\textit{total FFB processed}} \times 100\%. \quad (1)$$

However, OER of 25% is hardly achievable at local artisanal mill due to factors such as poor processing techniques, poor oil extraction efficiency at the mills, fruit variety, bunch ripeness, rainfall, sunshine, fertilizers, pests, planting material, pollination, palm age, trash content, and loose fruits at the plantation stage (Gourichon, 2019). Machinery deficiencies in the form of sterilizer condensate, empty bunches, fruit lost in unstripped bunches, press cake fiber, nuts, and sludge play critical role in lowering OER at the artisanal mills. Similarly, procedures for oil loss analysis are fairly well established at the kernel oil in the milling process, which include factors related to pressing, the press cake characteristics, nut/fiber separation, nut cracking, kernel/shell separation, and the type of kernel separation (hydro-cyclone, clay bath) (Chew et al., 2021; Osei-Amponsah et al., 2018).

Currently, Ghana's OER stands 8–10% (average of 9.0% displayed in Table 1), fallen short of the recommended 18–23% when compared with Malaysia, the world leading producer of palm oil (Hashim et al., 2012). Improvement of oil extraction rate in Ghana is therefore crucial in increasing the production of crude palm oil by 6.0%, which translates into 210,800 tons of CPO per annum. Hence, increasing the OER prevents further land usage and forest degradation thus achieving the sustainable development goal number 12 and 13 responsible for consumption and production and climate action, respectively.

2.1 | Quality challenges at palm artisan mills

Over the last decades, artisanal palm oil processing has not progressed beyond basic traditional methods. Traditionally, crude palm oil production involves manual processes such as bunch quartering (cutting), fruit loosening, boiling to pound, rewetting, and scooping of oil (Chew 2021; Osei-Amponsah et al., 2014). Recently, mechanization of palm oil extraction using screw press has seen a sudden rise due to availability, cheaper price, and easy operation. While mechanization ensures efficiency and oil quality improvement, manual processing methods at the artisanal mills produces oil of inferior physicochemical and organoleptic properties. Generally, oil quality is determined by its physical properties such as smoking point, color, viscosity, impurities, and chemical characteristics like iodine, free fatty acids, peroxide, dirt, moisture contents, and bleachability index (Chew et al., 2021; Mahlia et al., 2019).

2.1.1 | Free fatty acids

Palm oil is composed of fatty acids esterified with glycerol that can be broken down into FFA through a series of complex chemical reaction pathway. Hence, FFA quantities in crude palm oil play a critical role in determining their overall quality for international markets (Teng et al., 2020). A standard crude palm oil quality is estimated to possess, free fatty acid (≤5%), moisture (≤0.1%), dirt (≤0.01%), and (>3) for bleachability (Paterson, 2020). Categorization of oil in international market has been based in FFA; high quality (1–5%), good quality (5–10%), and poor quality (above 10%). FFA content however is generally affected by light, oxygen, enzymes (lipase), heat, and certain metals. Hence, artisanal mills with inferior machinery and limited knowledge in postharvest handling of palm fruits produce poor quality oil with high FFA content. Table 2 depict the average FFA of selected towns in Ghana that produce palm oil

TABLE 1 Oil Extraction rate of Ghana and Malaysia for selected years

Year	Country	Oil Extraction Rate (%)	Reference
2021	Malaysia	20.01	(MPOB, 2022)
	Ghana	9.12	(Sarpong et al., 2021)
2020	Malaysia	23.00	(MPOB, 2022)
	Ghana	9.98	(Sarpong et al., 2021)
2019	Malaysia	19.92	(MPOB, 2022)
	Ghana	-	
2018	Malaysia	19.58	(MPOB, 2022)
	Ghana	-	
2017	Malaysia	19.85	(MPOB, 2022)
	Ghana	-	
2016	Malaysia	19.98	(MPOB, 2022)
	Ghana	-	
2015	Malaysia	19.83	(MPOB, 2022)
	Ghana	-	
2014	Malaysia	19.19	(MPOB, 2022)
	Ghana	-	

TABLE 2 The average free fatty acid (FFA) of selected town in Ghana producing palm oil in large quality

Towns	FFA content (%)
Asuom	11.4
Otumi	10.0
Subi	10.6
Kade	15.9
Kusi	21.6
Takrowase	23.8

Source: Osei-Amponsah et al. (2012).

in large quantities. Over the years, results from local oil have shown that quality control of FFA levels has not been effective in meeting customer preferences of ≤5%. Quality assessment of palm oil for household consumption is largely dependent on good taste, smell, and deep red color (Zhang et al., 2020).

However, high FFA content affects consumer preferences due to rancidity with such oils mostly traded for soap making.

Postharvest handling of oil palm fruit bunches at the artisanal mills has been a major source of increased FFA contents in crude palm oil. FFA in CPO is primarily attributed to lipase activity in the oil palm fruit mesocarp, which increases through bruising during harvesting, transporting, and processing of unsterilized fresh fruit bunches (Azeman et al., 2015; Kurnin et al., 2016; Limbardo et al., 2017; Purnomo et al., 2020). Fresh fruit bunch (FFB) sterilization therefore plays critical role in artisanal oil mill processing. Traditional artisanal mills in Ghana have been reported to store fresh fruit bunches to loosen fruits before processing. Kushairi et al. (2019) identified that the processing practice that mostly affects CPO quality is duration of oil palm fruit storage before processing. A diagnostic study showed that loosened fruits are stored for a period of 7–21 days (Osei-Amponsah et al., 2018). Storage periods of 12–26 days were estimated in about 10 communities of the same district (Teng et al., 2020), while Mahlia et al. (2019) observed 14 days (excluding the number of days bunches were kept at the farm in the Ashanti Region). These practices by artisanal mills further introduce impurities and dirt that require washing of fresh fruits and crude palm oil.

Efforts through government policy are being channeled to artisans for the reduction of FFA in their production through provision of efficient extraction machines, FFA testing kits, quality assurance training, and monitoring. Also, government has tasks research institutes to breed lesser lipase releasing variety of oil palm to reduce FFA generation at the artisanal mills which will help artisans meet the FFA standards. Again, the artisans are being encourage to form association to foster a union which would be managed under corporation village enterprise by government to serves as channel for services provision (MASDAR, 2011).

2.1.2 | Unwholesome water usage

Most artisanal mills in Ghana resort to unwholesome water usage. Artisanal mills are generally sited close to community streams with/without illegal mining activities ("galamsey") or annexed to neighboring houses with clean water for processing. Currently, it is estimated that over 60% of all freshwater bodies in Ghana has been polluted by "galamsey" through deposition of heavy metals and poisonous chemicals such as cyanide, mercury, and lead. Various stakeholders are calling for the abolishment or regularization of galamsey as well as the restoration of abandoned sites across the country (Yeleliere et al., 2018). Indeed, several policy initiatives have been taken to stop illegal mining, but these efforts appear ineffective as galamsey operations are on the rise polluting several fresh water bodies in the country (Figure 2).

2.1.3 | Other quality challenges

The use of car tires as fuel for oil processing and adulteration of oil with Sudan dye has also contributed to the diminishing quality of crude palm oil in Ghana. The use of Sudan dye is banned in Ghana and in many other countries in the world yet continues to be a challenge for

FIGURE 2 Water being used by artisans for palm oil processing which has been polluted by operations of small-scale miners

regulatory bodies (Morgans et al., 2018). Recent research by the food and drugs authority (FDA) indicated 98% ($n = 50$) of palm oil sampled in Ghanaian markets possess the banned Sudan IV dye (Mahlia et al., 2019) also identified the presence of Sudan IV dye in palm oil from seven regions in Ghana with most palm oil recording inferior quality parameters. The processing equipment is also hardly ever cleaned (perhaps once or twice during the lean season when the machine is not frequently in use), leading to accumulation of dirt and oil in the equipment. Therefore, improving the quality of palm oil at the artisanal mill level will ensure reduction of poverty, improvement of health, and general improvement of livelihood of the general populace in Ghana.

3 | SOCIO-ECONOMIC IMPACT THESE CHALLENGES

3.1 | Socio-economic impact on increasing OER

First, oil quality and quantity are improved through high OER leading to livelihood improvement of farmers and processors. CPO is estimated to be increased by 210,800 tons of CPO per annum, which translates into an increased revenue of 147.8 million dollars. This would be a direct revenue accrued to these small-holder farmers, thus raising their per capita income and purchasing power needed for employing extra labor.

Again, an increased OER will lead to reduction in importation of CPO thereby boosting the economy of the country. Currently, over 65% of CPO production by artisans in Ghana are of poor quality due to high Free fatty acid (FFA) and moisture contents. Together with other undesirable quality traits such as poor organoleptic properties, high contaminants (heavy metals) and adulterations of banned addictive, most of the CPO produced are not able to penetrate the EU market. As a result, CPO production in Ghana ends up in the "black" (informal) markets for the production of soaps, detergents, cosmetics, candles, lubricants, glues, and printing inks. The unregulated nature of these markets limit revenue inflow for farmers and processors while leaving a deficit of CPO needed in the country for human consumption.

Furthermore, the oil palm boom has contributed to economic growth, but it has also led to negative environmental effects. Numerous studies identified oil palm as a driver of deforestation and land-use change, as well as associated losses in biodiversity and ecosystem functions. The expansion of oil palm since the mid-1970s has heavily transformed tropical landscapes. One major outcome has been deforestation of tropical forests, with strong impacts on biodiversity and ecosystem functions. During the last 40 years, oil palm accounted for 47%, 16%, and 3% of total deforestation in Malaysia, Indonesia, and Africa, respectively (Chew et al., 2021). Oil palm plantation has caused severed deforestation in Indonesia, island of Borneo, and Ghana, an average forest loss of 350,000 ha per annum (Chew et al., 2021). Beside forest degradation, there is stronger and positive correlation between oil palm plantation and regional biodiversity declines in species such as birds, amphibians, fishes, plant, and belowground-living species (Dharmawan et al., 2020) due to the monoculture nature of plantation.

Others also argue that why the standing forest if man can translate the resources into revenue generation? This is because palm oil development has created economic growth for rural areas in most west African countries especially Ghana and Indonesia, thus stimulating new income source and improving livelihood of small-holder farmers (Dharmawan et al., 2020; Osei-Amponsah et al., 2018). Studies from Indonesia revealed oil palm cultivation has the potential of generating higher income, profit, and returns on capital; reduces income volatility; and has positive effects on labor market (Cahyadi & Waibel, 2016). Therefore, it would be empirically prudent to protect the forest reserves and maximize revenue generation from the oil palm plantation through increasing OER. Increasing OER has the ability to increase revenue to small holders without the need for further expansion of oil palm plantation and the extra application of fertilizer, energy and water for crop cultivation.

3.2 | Socio-economic impact on FFA

The poor quality of CPO production in Ghana as a result of FFA releases drastically lower pricing systems, which in some cases fall below US$340 per ton. The rippling effect is generally transferred to small-scale farmers who depend largely on these local oil processors for income, thereby worsening the living conditions of these individuals. During peak seasons, there is a glut of palm fruits that are sold cheaply to artisanal mills for oil processing. Most of these palm fruits are either over matured or stored for longer periods, which negatively affect FFA release of oil produced. Hence, lower prices are quoted by local oil processors for palm fruits. The inferior oil produced creates demand for edible oil in the Ghanaian market, which is duly filled with importation at premium prices. Therefore, farmers and artisans stand a better chance of receiving premium on their produce when FFA production is reduced. This would present a better financial empowerment to artisans' especial women involved in CPO production and also play an important role in ensuring food security, thus achieving sustainable development goals (SDGs) 1 and 2, which highlight eradication of poverty and zero tolerance for hunger respectively. Again, the role of FFA reduction in contributing to achieving SDGs 8, which speaks to decent work and better working conditions would be achieved. FFA reduction intended to provide better working conditions through the improvement and provision of better working tools, equipment, and wholesome water to enhance production and increase income generation. Improving quality through FFA reduction envisages artisans' ability to produce their brand of products that can be sold in local and foreign markets when giving the needed support, skills, and training in the medium term. Also, reducing FFA will not only improve within the scope it is currently in but has the potential to create more microbusiness and small business in the edible oil market and pharmaceutical industry when premium price is generated through sales of quality CPO.

The current value chain players of poor-quality CPO production are foreigners mainly Togolese and Nigerians who are currently trading the commodity with artisans for soap production and other non-edible uses. This enterprise has taken the value chain players from the local market to foreign markets where effective trading system has been established with weakening effect on the job opportunities for the local community. Quality production through FFA reduction has the potential of reversing this scenario, where the value chain establishment of the commodity would be seen on the local market to strengthen the local trading system for retailers and consumers alike.

3.3 | Socio-economic impact on improving other quality challenges

General improvement of other quality parameters of palm oil such as wholesome water usage, banned usage of Sudan IV and burning of used car tires for fuel. These activities have direct effect on quality, organoleptic properties, wholesomeness, and color of the processed oil. Again, there is health implication to artisans when these processing activities are not terminated. Banning these acts will have a direct another socio-economic impact on better working conditions, saving water bodies and reducing carbon emission. For unwholesome water usage, the majority of the artisan mills in Ghana are located near freshwater bodies (80%) on the outskirts of inhabited areas which several are now considered as unwholesome due to activities of galamsey affecting quality and quantity of fresh water. Few of the mills are annexed to home yards and neighboring houses. These galamsey operators beside introduction of heavy metals also disturb the chemical, physical, and biological variability of freshwater bodies, leading to environmental and health hazards to humans and the ecosystem. Beside unwholesome water usage by artisan, other quality potentially harmful activities by of artisans is the use of spent car tires for the fuel used for the boiling, which comes with serious environmental pollution to humans (Osei-Amponsah et al., 2014). Smokes from these spent car tires generate thick smoky sots, which is accompanied with release of carbon monoxides, cyanides, sulfur dioxides, butadiene, and styrene, which poses greater danger to environment and public health. Another study by Morgans et al. (2018) revealed a greater correlation between release of these smokes with higher eye infections such as pterygium, pinguecula prevalence among these artisans especially women since they are exposed to several risk factors that play important roles in their ocular morbidities. Also, the disposal of effluent directly onto the earthen floors of the mills possess greater challenges to quality assurances and safety of the final product thus affecting product registration query from Food and Drug Authority and Standard Authority. The disposed effluent leaches into nearby streams and water bodies, thereby polluting surface water. Again, activities by artisans that raises quality concerns is the used of old packaging containers disposed by heavy industries, which may contain toxic substances such as cyanide leading to adulteration of product. Furthermore, in order to obtain a bright red CPO color, which attract most customers, some artisans adulterate the oil with Sudan IV dye: a textile dye banned in Ghana and in many other countries in food production. Traces of Sudan IV dye was detected in the European countries from palm oil produced in West Africa, which trigged a ban of palm oil and their product from West Africa especially from Ghana and has dwindled the foreign income in the exporting of the product. Finally, processing equipment is hardly cleaned, leading to accumulation of dirt and oil in the equipment.

To mitigate these quality related challenges, it has been proposed to government and other non-governmental agencies to established satellite milling centers with needed processing machineries to monitor, regulate, and license artisanal operations to ensure quality and reduce these environmental hazards and prevent the degradation of ozone layers in the ecosystem by the practices of good manufacturing practices at these centers. Through the adherence to standardization, quality assurance practices, and strict monitoring processes at these production centers, safety, and quality of CPO production will be guaranteed. These satellites milling centers could potentially generate premium products for farmers that would be processing their FFB at these centers for better market accessibility.

In terms of competitive advantage, this mitigation strategy that has been recommended to government and non-governmental agency presents a peculiar solution for artisans in the palm oil processing industrial to eliminate some challenges they face daily in their operations. This will enable them implement a value-creating strategy which other companies will be unable to duplicate. By addressing these concerns, artisanal mills operators may differentiate and distance themselves from competitors, improve financial performance, and enhance milling reputation when it comes to mitigating challenges facing them. However, to wholistically achieve this competitive advantage for these artisans in Ghana, two major considerations must be given attention. These are the government services utility function and the business aspect of the milling (Tampubolon & Pasaribu, 2017). For developing countries such as Ghana, injection of capital and cutting-edge technology developed in other countries and general improvement of macroeconomic environment will flourish the operations of artisanal millers to have a greater competitive advantage.

4 | CONCLUSION

Several challenges are facing palm oil artisans in Ghana, which could be mitigated through policy, research, and extension services by government and other agencies. The focus of this review was to highlight the socio-economic impact of oil extraction rate and quality challenges facing palm oil artisans in Ghana. The overall aim for the chosen challenges was to reduce the net importation of palm oil by increasing the quantity and quality of palm oil without the need for further expansion of oil palm plantation and the extra application of fertilizer, energy, and water for crop cultivation. It became obvious from the review that Ghana stands a chance of increasing the production of crude palm oil by 210,800 tons per annum when oil extraction rate is increased by 6% at the artisanal mills across the country. This has a direct impact on revenue generation, thus raising their per capita income and purchasing power of artisans. The socio-economic impact on improving quality of palm oil was also discussed where it became obvious that artisans stand a better chance of gaining access to premium market for their products. Also, conscious effort of quality improvement has a direct correlation with better working conditions for artisans to achieve food and energy security, and prevent depletion of the ecosystem thus achieving some SDG goals.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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