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Status, challenges and prospects of food processing equipment fabricators in Ghana

Jonathan Ampah[a,*], Joseph Xavier Francisco Ribeiro[b], Kwabena Asiedu Bugyei[a], Francis Kumi[c], Joseph Oppong Akowuah[d], Hayford Ofori[e], Catherine Otchere[f]

[a] Food Technology Research Division, CSIR-Food Research Institute, P. O. Box M20, Accra, Ghana
[b] Mechanical Engineering Department, Kumasi Technical University, P. O. Box 854, Kumasi, Ghana
[c] Department of Agricultural Engineering, College of Agriculture and Natural Sciences, University of Cape Coast, Ghana
[d] Department of Agricultural and Biosystems Engineering, Kwame Nkrumah University of Science and Technology, PMB KNUST, Kumasi, Ghana
[e] Department of Agricultural Engineering, Ho Technical University, P. O. Box HP217, Ho, Ghana
[f] Agricultural Engineering Services Directorate, Ministry of Food and Agriculture, P. O. Box M82, Accra, Ghana

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ABSTRACT

To facilitate effective provision of government support to local fabricators and improve their exposure to prospective clients in order to boost their productivity, it is necessary to understand the challenges currently impeding existing businesses as well as prospects at play with a view to identifying and promoting some recommendations and suggestions. The study explored the status, challenges and prospects of food processing equipment fabricators in three regions of Ghana: Greater Accra, Ashanti and Volta. The research generated an updated database of fabricators, identified relevant challenges and prospects, and established a relationship between the education level of respondents and the types of food processing equipment fabricated. A total of 101 fabricators answered the structured questionnaire. Majority of respondents (81%) were married. 41% had junior high school and 20% senior high school education. Farming (31%) and trading (23.8%) provided the highest secondary sources of income to fabricators. 953 dependents were found to be direct beneficiaries of income generated from fabrication works. 33 food processing equipment were recorded with the fufu extruder and cassava grater obtaining the highest frequencies. 33.9% of respondents had not registered their businesses with the Registrar General's Department. Cross reference analysis depicted that education level of fabricators influenced the types of equipment fabricated; most especially in the fabrication of palm fruit boilers. The work recommends downward review of electricity and import tariffs of fabrication raw materials and machine spare parts, regular capacity building programs, and reduced requirements for company registration and association membership to boost productivity in the sector.

* Corresponding author.
E-mail address: joeampah1@yahoo.com (J. Ampah).

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Introduction

Background and objectives

The agricultural sector is the mainstay of the economies of most Sub-Saharan African (SSA) countries. Agriculture provides employment for a large percentage of the population of most African countries and contributes significantly to their Gross Domestic Product (GDP). In addition, agriculture employs 45% of the national labor force, far more than any other sector [1] with the production of crops being the largest activity with a share of 14.2% of GDP [2]. Furthermore, the agricultural sector contributed 31% and 18.7% to the GDP of Ghana in 2008 and 2018, respectively [2]. To a large extent however, the real potential of the sector and its benefit to the economy has barely been fully exploited. It is therefore imperative to strengthen the sector by providing access to support to boost the manufacturing of food and agricultural processing equipment for production and processing of finished and ready-to-use food products.

Earlier, food processing was developed to facilitate long-term storage (e.g., cooking, curing, smoking) and transport. In the 20th century, food processing targets increased palatability and production of indulgent products. The importance of food processing activities and its related effect on the economy need not be overstated. Food processing technologies are instrumental to reduction of food waste, food security strategies, fortification, enrichment and improved nutrition. Globally, food processing is big business which generates large amounts of foreign income for several countries. According to the 2016 Annual Survey of Manufactures, food manufacturing ranked third among the US manufacturing sector in terms of number of employees with total fringe benefits alone estimated at over $18 billion [3].

Ghana's agro-food processing sector is ranked the most important sub-sector of the manufacturing sector, with food and beverages representing the largest component of processed commodities [4]. However, enterprises in the sector remain less advanced adding relatively low value addition to agricultural produce, with relatively few linkages to markets and financial services partly due to their size and under-developed processes which lead them to often operate under capacity using inefficient technologies [5]. Though production of crops remains the largest activity (with a share of 14.2% of GDP), Ghana's agricultural industry is still characterized by low postharvest processing activities. Approximately 5% of raw materials harvested crops are processed and the remainder is consumed directly [6]. For example, the total contribution of the manufacturing sector (including activities by small, medium, and large food processing industries) to GDP, in 2017, was 4.5% [2]. Access to modern food processing equipment could immensely boost the activities of these firms but the related costs associated with purchase, installation, maintenance, training, and operation are prohibitively high for most small-scale food processing businesses which bring to bear the importance of harnessing and developing the expertise of the local fabrication sector to handle the changing food processing needs of local entrepreneurs.

Local manufacturers of food processing equipment in Ghana have the potential to provide alternatives solutions to mitigate the current challenges experienced by agro-processing companies. It is however difficult to identify their contribution to the solutions required and those identified are of poor quality. While there is enough information on equipment fabricators in countries such as Uganda [7] and Nigeria [8], there appears to be a dearth of information regarding the demographics, activities, challenges, and opportunities of food-processing equipment fabricators in Ghana. Aside the scarcity of information, available information is also scattered and outdated. Further, to better understand the absence and poor quality of some of the equipment surveyed, it would be prudent to carry out a survey of local equipment fabricators to get a grasp of the existing conditions in the sector. There is the need for Ghana and other middle-income countries alike, to harness fully the benefits of agro-processing for economic development. To achieve this, local manufacturers need to be empowered to provide the required solutions.

The objective of this paper therefore, was to fill the information gap by characterizing the equipment fabricators, assessing their challenges, identifying available prospects, analyzing factors which influence their activities and competitive abilities and recommend ways to improve the food processing equipment fabrication sector in Ghana. This paper highlights the role of the local equipment fabrication industry and its ability to satisfy the processing needs of large, small and medium scale food processing facilities in Ghana.

Brief history of food and agricultural policies in Ghana

In the colonial era, agricultural development plans by various governors were export-oriented with the prime aim of positioning the then Gold Coast (Ghana) as a supplier of raw materials to industries in Europe. Over time, this placed enormous stress on the production of raw materials for export. To lighten this stress, production of processed goods was encouraged by setting up factories within the country. Prior to independence, the development plans of the erstwhile Kwame Nkrumah-led CPP government in 1951 focused mainly on social services and infrastructure, which accounted for about 80% of government's annual investment [9–11]. Upon becoming a republic in 1960, a socialist and co-operative program for industry, and the mechanization and diversification of agriculture was adopted as a strategy for decolonizing Ghana's economy, which was to be driven by the Volta River (Akosombo) hydroelectric dam [10,12]. Further, under the leadership of Dr. Kwame Nkrumah, the 'import-substitution' strategy was implemented. The first national comprehensive agro-industrial policy was rolled out in 1962 under a seven-year plan (1963/64 to 1969/70) for national reconstruction and development. This became the earliest attempt to promote agro-processing in Ghana [13].

Between 1966 and the early 1980s, changes in government led to implementation of alternating socialist and capitalist policies on agricultural promotion. To facilitate this, the Agricultural Development Bank (ADB) was established in the late 1960s to extend credit facilities to small-scale farmers with the hope of liberalizing the economy and pushing for private sector-led growth [5,14]. Between 1972 and 1974, the agricultural sector also received a boost from the Acheampong-led administration with the introduction of policies such as 'Operation Feed Yourself' and 'Operation Feed Your Industries' which encouraged individuals to take up agricultural activities [5].

During the Rawlings-led NDC Administration, between 1991 and 2000, the Medium-Term Agricultural Development Program (MTADP) was the main policy document implemented aimed at providing a comprehensive framework for the enhanced growth of the agricultural sector. Other policies including the Agricultural Diversification Project (ADP, 1991–99), National Agricultural Research Project (NARP, 1991–99), Agricultural Sector Adjustment Credit (ASAC, 1992–99), National Livestock Services Project (NLSP, 1993–99), and the Fisheries Capacity Building Project (FCBP, 1995 to present) were implemented alongside. The Food and Agriculture Sector Development Policy (FASDEP I) of 2002 adopted a sector-wide approach to guide agricultural development and interventions. The second phase of the Food and Agriculture Sector Development Policy (FASDEP II) was aimed at promoting agro-based industrial development in the country [15].

The national Fertilizer Subsidy Program was reintroduced in 2008, as a temporary response to fluctuation in domestic food and fertilizer prices that year. The program subsidized all-size crop farmers, covering approximately 50 % of fertilizer prices, and was distributed in the form of fertilizer-specific and region-specific vouchers. Rather than dismantling the program after the price crisis, as originally planned, government support for the program was scaled-up from US$ 10.8 million in 2008 to US$ 63 million in 2012 [16].

The 'Agriculture Mechanization Services Enterprises Centres' (AMSECs) program launched in 2007, to respond to the dwindling level of agricultural mechanization in the country, provided credit facilities and assisted qualified private sector companies to purchase agricultural machinery at subsidized prices and interest rates. The equipment were then rented to rural farmers at affordable rates [17].

The 2011–2015 'Medium Term Agricultural Sector Investment Plan' (METASIP I) documented strategies and activities for the promotion of food-processing in the country and was replaced with METASIP II which ended in 2017. For example, it proposed the provision of at least one (private-sector-led) mechanization center set up in each district of Ghana by 2015 to provide diversified services to farmers and food processors; the generation of incentive structures for food-processing industries to implement food-grade processing technologies; and an increase in rural industrial processing of cassava (by 20%), oil palm (20%), shea nuts (40%), cashew nuts (30%), soybeans (30%), and groundnut (30%) by 2015 [6].

The National Export Strategy (NES) was implemented from 2013 to 2017 through the National Export Development Program (NEDP) with the goal of transforming the export sector by moving from traditional exports (gold, cocoa) to non-traditional exports, strengthening trade and export institutions. In 2017, MoFA released the Planting for Food and Jobs (PFJ) initiative (MoFA, 2017a). The sole aim is to ensure immediate and adequate availability of the selected crops (maize, rice, sorghum, soya bean, tomato, onion and chili pepper) in Ghana through improved productivity and intensification of food crops, and extended support to private sector service providers; and to provide job opportunities for the many unemployed youth in the agriculture and allied sectors [18].

From the discussion, it is apparent that Ghana's post-independence industrial development has evolved from an import substitution industrialization (ISI) strategy to a private sector-led industrialization. The pre-independence era was mainly made up of the domestic manufacturing sector [19]. While food-processing may involve global-to-local patterns and vice versa, research suggests that the industry in Ghana appears to be mostly concentrated on local-to-local patterns and dominated by informal-sector activities [5] with 3% of the domestic manufacturing sector classified as being medium-sized [20].

Methodology

Study area

A desktop study was carried out initially to identify areas of interest related to challenges, opportunities and types of equipment generally found in Ghana. Both qualitative and quantitative approaches were used to gather information from the local fabricators and entrepreneurs in the Ashanti, Volta and Greater Accra Regions. Due to time pressures and increasing preferences for convenience foods, Ghana's urban population is moving away from consuming meals that require long preparation times and towards already-processed foods [21]. The Greater Accra and Ashanti Regions were selected because they have recorded the highest population booms [22], and inflow of urban migration in recent times. Also, the presence of major food processing companies in the Volta Region due to its proximity to the Tema harbor for marketing and export purposes played a key role in its selection for this study.

Data collection

A structured questionnaire consisting of both open and close-ended questions was designed to obtain data from respondents who are actively involved in fabrication of food processing equipment. Questions mainly focused on extracting personal information, challenges related to material, inputs, finance, basic engineering skills, awareness of government intervention and other opportunities available within the fabrication sector.

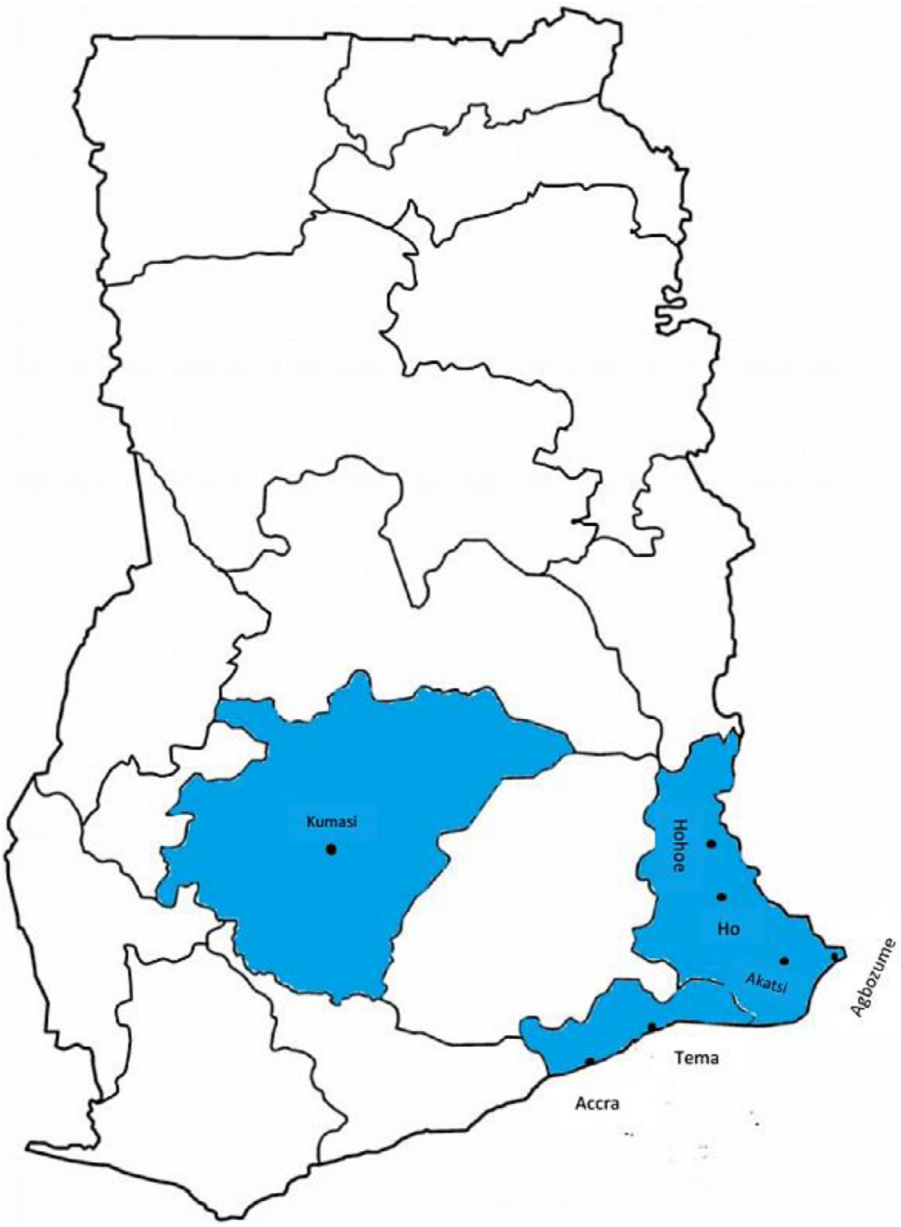

Fig. 1. Map of Ghana showing areas study was conducted.

Data analysis

In total one hundred and one (101) completely answered questionnaires were used in the statistical analysis. The data was analyzed using IBM SPSS Statistics for Mac, Version 26 (IBM Corp., Armonk, NY, USA) and Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA).

Results and discussion

Personal characteristics of food processing equipment fabricators in Ghana

The study area and number of respondents are outlined in Fig. 1 and Table 1, respectively. Almost all the respondents were males (99%) with only one (1%) female. This suggests that food processing equipment fabrication in all three regions is male dominated. Research carried out on drying equipment in some selected countries in West Africa supports the finding [23]. Male domination in this field of work could be explained by the tedious, strenuous nature as well the physical

Table 1
Respondents distribution per study area.

Location	Frequency
Accra	13
Tema	12
Kumasi	48
Ho	11
Hohoe	7
Agbozome	4
Akatsi	6
TOTAL	101

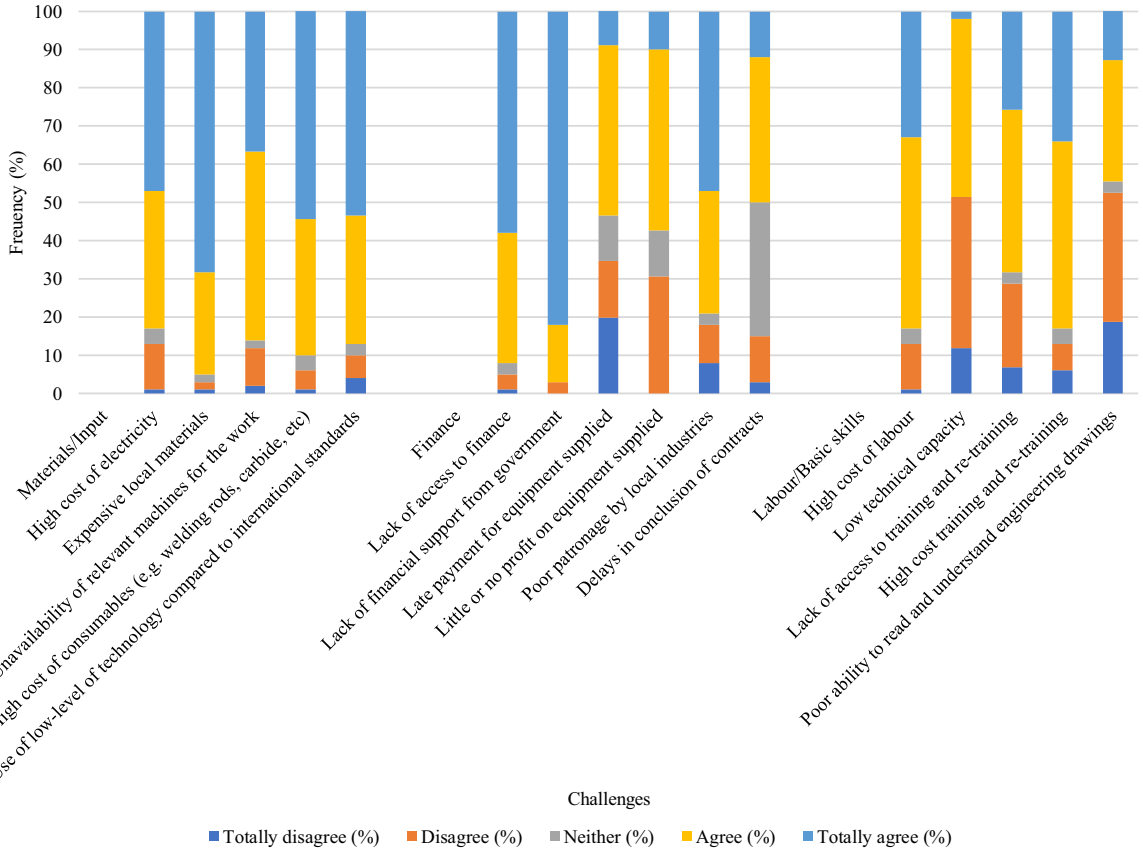

Fig. 2. Challenges faced by fabricators in Ghana.

manpower required in executing some of these works. Also, unlike research carried out on drying equipment fabricators only [23], the current work considered all other food processing equipment such as grating, mixing, milling, slicing and baking equipment among others. Majority of respondents (81%) were married, with 18% single and 1% widowed. Half of respondents who were married fell within ages 31-to-40-years.

Fig. 2

Majority of respondents (40.6%) had attained the Junior High School level certificate (JHS) as the highest level of education, followed by the Senior High School certificate (SHS) (19.8%). Primary school leavers and those who pursued artisanship recorded 3% each representing the least numbers. Generally, it can be inferred from the survey that more than half of all respondents (53%) had at least SHS education and as such should be able to understand and communicate basic engineering principles used in fabrication works and have better understanding of financial dealings. Similar findings are presented by Adebowale et al. [23] who reported that 97% of all respondents had at least primary school level of education. The data analysis showed that few (3%) fabricators were not formally educated but rather studied under apprenticeship. Majority of fabricators practiced farming (31%), trading (23.8%) and food processing (16.7%) as secondary occupations.

Business and employment characteristics of food processing equipment fabricators in Ghana

Business registration

Fifty-nine (59) fabricators representing 58.4% provided information of business registration. Out of this number, 66.1% had registered their businesses with the Registrar Generals Department suggesting that their business names could not be used by another for a different venture and hence paid annual renewal fees. Only two fabricators (3.4%) had registered with the Association of Ghana Industries (AGI).

Membership of associations

Overall, 39.6% declared that they were members of relevant associations including the Ghana Chamber of Commerce and Industry (GCCI), Institution of Engineering and Technology-Ghana (IET, Ghana), Cassava Stakeholders Forum, Ghana National Association of Garages (GNAG) and the National Society of Black Engineers (NSBE). Majority (60.4%) of respondents answered in the negative with respect to joining any relevant association. This finding could be as a result of the perception of respondents who consider these associations the preserve of a few in society. Lack of association may be accountable for distorted communication channels and the lack of one voice in engaging government on issues of importance to fabricators. Interestingly, the results showed that 95.2% of respondents were not registered with any agro-based association in Ghana. Due to the potential of effective key players in and outside the sub-sector to provide avenue for market expansion, it would be prudent for fabricators to improve interaction between with allied agencies within their sub-sector.

Number of workers in the sector

Interactions with respondents (97 respondents only) estimated that 561 workers could be directly employed within this industry. The minimum number of workers that a fabricator had was 1, while the maximum was 38. The average number of workers per fabricator was 6. The study revealed that approximately 962 people both directly and indirectly receive their income from this sector in 7 cities across Ghana; alluding to the need for government and other allied agencies to support the sector to ensure sustained employment and a comfortable livelihood for fabricators.

Types of food processing equipment fabricated in Ghana

Table 2 presents the distribution of agro-processing equipment fabricated in Ghana. In all, 33 processing equipment were identified. Each fabricator responded positively to manufacturing more than one equipment. These equipment (from highest to lowest order of number of fabricators who engage in their production) were namely; fufu extruder, cassava grater, corn milling machine, bread mixer and kneader, rice mill, pepper mill, tomato paste machine, palm oil extractor, hammer mill, palm nut and kernel cracker, feed mixer, maize sheller, cassava press and fruit juice extractor.

More than half of respondents were found to fabricate cassava graters (51.5%) and fufu extruders (55.4%); implying a high demand for the two. The observed phenomenon may also be attributed to the ability of cassava to thrive across the different ecological zones in Ghana and its high consumption. Popular products from these processes are fufu and gari commonly regarded as staple foods of Ghanaians. The coffee dehusker, pod crusher, homogenizer, palm nut sheller, chicken grill, honey press, groundnut dehusker and meat roaster recorded 1% each perhaps hinting of low interest in such equipment.

Challenges experienced by food processing equipment fabricators in Ghana

Earlier research identified some challenges facing fabricators. However, researchers did not provide details on the degree to which these challenges practically influence their work. The current research gives an overview of the specific challenges and discusses the impact of these challenges on their work.

Respondents totally agreed that challenges relating to expensive local material, lack of financial support from government and general lack of access to financial aid stood out strongly in the sector. The average percentage of fabricators who were in total agreement to these three challenges was 69.4 %.

Materials and inputs

Electricity

Respondents disagreed to a high degree (70%) that frequent power cuts posed a challenge to their activities. However, 83% either agreed or totally agreed to the fact that high cost of electricity is a challenge that needed to be addressed because it takes up a chunk of their income. Literature indicates that power-related challenges are not restricted to only Ghana. Study of selected fabrication workshops in Nigeria revealed that the sector is still facing challenges due to unreliable power supply as well as its high cost [8]. Studies on the status of agricultural equipment fabrication in Ekiti and Ondo States in Nigeria noted that the erratic supply of electricity, high tariffs, coupled with low literacy level and high cost of fuel posed challenges to fabricators and contributed to the poor development of the sector [24].

Raw Materials

Most respondents (95%) were in total agreement that the high cost of raw materials is a significant challenge in their work. They opined that high and rising cost of raw materials limited access to quality materials which translated to high prices of their products. They attributed lack of patronage of their products to high prices of their products. The high cost

Table 2
Distribution of processing equipment fabricated in Ghana.

No.	Type of equipment	% of respondents (n=101)
1	Cocoa mill	2
2	Cassava grater	51.5
3	Bucket elevator	2
4	Maize dryer	3
5	Feed Mixer	12.9
6	Corn milling machine	45.5
7	Fufu extruder	55.4
8	Tomato mill paste machine	22.8
9	Pepper mill	22.8
10	Cassava press	11.9
11	Coffee dehusker	1
12	Fruit juice extractor	10.9
13	Poultry feed mill	2
14	Rice mill or dehuller	30.7
15	Bread kneading machine	32.7
16	Maize sheller	11.9
17	Palm oil extractor	19.8
18	Cashew nut cracker machine	3
19	Boiler	3
20	Digester	5
21	Crusher	1
22	Homogenizer	1
23	Slicer	3
24	Palm nut sheller	1
25	Maize planter	2
26	Chicken grill	1
27	Oven	9.8
28	Honey press	1
29	Groundnut dehusker	1
30	Meat press and grinder	3
31	Meat roaster	1
32	Thresher	2
33	Palm nut and kernel cracker	13.9
33	Hammer mill	13.9

of construction materials was also identified as a major challenge for fabricator in Nigeria [8] and Kenya [25] which could be attributed to high tariffs on imported raw materials [26].

Relevant machines and low-level technology

Approximately 86% of respondents recognized the lack of relevant high-tech machines such as vertical directional drilling machines, CNC drilling and milling machines and laser cutter for fabrication works as a challenge. 89% of respondents responded in agreement to the use of low-level technology for their work. Respondents indicated that both factors limited their ability to fabricate food processing machinery to the required standards for the industry.

These findings are contrary to the production phenomena in countries like the USA, Germany and France among others which are currently integrating advanced technologies to improve the performance of their equipment and to increase their global market shares. On the other hand, the findings are similar to those observed in studies carried out among 27 agro-processing industries in Asia [26]. Companies studied revealed that utilization of obsolete production equipment and low-level technologies were linked to lack of quality standards for processes and products, lack of innovative marketing and management skills. It was also observed that the presence and persistence of these challenges translated to declining competitiveness, significant postharvest losses, and high cost of production [26].

Access to modern machinery and new technology would play a pivotal role in improving the quality of churned out food processing equipment by fabricators. Tax exemption/reduction on these machineries by the Government of Ghana (GOG) may also make it affordable for fabricators to purchase them.

Poor finishing

Good finishing is critical to the aesthetics of a product and adds value to it. Appealing aesthetics facilitates increased sales. For these reasons, enormous amounts of investments are made by many companies to achieve high and quality aesthetics. Against this background, however, a contrary finding was made in this study. Products identified by this study lacked the aesthetics which could make it competitive compared to similar items imported from other countries. In some instances, it appeared poor material selection and improper weldments were to blame for poor finishing [7].

Majority of respondents (82%) admitted to having produced poorly finished equipment compared to imported products. Respondents attributed these observations to poor finishing skills, lack of equipment and utilization of low technologies for fabrication. Access to training programs aimed at imparting good product finishing skills, access to finishing equipment as well as utilization of high technologies for fabrication are crucial to production of competitive agro-processing products. As

an intervention, the various associations could collaborate with GOG to organize training programs for relevant stakeholders in the sector whilst assisting them to purchase the required equipment through innovative financing schemes.

Imported food processing equipment

The proliferation of cheap imported processing equipment dominated the focus group discussions. Respondents mentioned that it appeared majority of these equipment came from China. It did not come as a surprise when 88.7% of respondents admitted that the phenomenon posed a great challenge to their businesses. Respondents attributed the phenomenon to the preference of customers for imported equipment which were significantly cheaper than theirs. A close examination of the products also revealed that customers preferred them due to their superior aesthetic quality and affordability, even though they may not be of the highest standard or quality. Another reason for their affordability could be that manufacturers could leverage their economies of scale to reduce the price. Studies in Nigeria revealed that the issue of preference for imported equipment was also a challenge to fabricators [8].

To overcome challenges associated with importation, adaptation of equipment from other parts of the world by fabricators through collaborations with other producers, most especially in the tropical areas of Asia and Latin America may prove useful. Adaptation can also be applied to the choice of raw materials whereby a machine that was originally designed for one type of product can be used to process another that is relatively similar [27].

Lack of access to finance

Out of the 101 respondents, 59.4% operated bank accounts. Respondents mostly saved at Fidelity Bank Ghana (9.9%) and GCB Bank (9.9%). Others also saved at Stanbic Bank (7.9%), Atwima Mponua Rural Bank (5.9%) and Multicredit Savings and Loans (5%). From the interviews, access to finance (loans) was a challenge despite their relationship with their respective banks. They attributed this to the high requirements that needed to be met before loans could be granted. Others cited the high interest rates as a limiting factor to accessing loans from their banks. Those who had no relationships with banks cited the banking sector crisis as reason to avoid the financial institutions.

Lack of access to finance is generally a big challenge to farmers, fabricators and processors, and included the fear of taking loans due to unfriendly follow up by the loaning agents, fear of their assets being auctioned due to inability to repay loan, bureaucracy in the government procurement process and high registration fees [25]. From interview notes, a means to promote the use of bank accounting services may be the introduction of deposit-free bank accounts as well as the creation of online checking accounts with mobile money compatibility. To counter the fear associated with loans, financial institutions could liaise with metal sheet producing companies both in-country and in other West African countries with the agreement to supply needed raw materials at minimum transportation cost and limited interest-free period. It is important for fabricators to register their businesses and form cooperatives to serve as guarantors to access loans. Establishment of credit unions may provide avenue to offer loans at comparatively lower rates to improve access to finance.

Technical skills, cost of labor and skills training

Majority of respondents (83%) bemoaned the high cost of labor in Ghana. Furthermore, 46.5% cited the unavailability of quality labor. In Ghana, over 70% of food processing occurs informally, posing challenges for technical innovations and knowledge transfer, in addition to quality control [5]. The lack of training therefore may be accountable for the poor readability of engineering drawings, poorly finished works and the absence of standard equipment drawings. Aside technical skill training, business development training is also important. There appears to be an apparent disconnect between local product development and uptake by local food-processing firms, which further reduces technology adoption in the sector. Policy makers may need to focus on better ways of facilitating the flow of agricultural technology from private discovery to public use, taking into account hindrances to technology transfer and the role of equipment fabricators.

A large number of respondents (68.3%) also expressed concern about the lack of access to training and retraining programs and the high cost (83%) of the few ones accessible. Throughout Africa's mechanization history, there have been a number of efforts to establish tractor assembly plants, many of which have failed. Government assembly plants in Nigeria and Tanzania lacked the technical capacity and managerial efficiency to compete with imports [28]. However, the Nazareth Tractor Assembly Plant, established during the Derg regime, is still operating in Ethiopia and has the potential to assemble roughly 300 tractors per year, accounting for 46% of tractors that entered the Ethiopian market between 2005 and 2010 [29].

Lack of support from industry regulators

96.9% of respondents totally disagreed to receiving adequate government support with respect to provision of a suitable platform for organization and participation in trade shows and promotion of locally made equipment among others. Studies carried out in Kenya with respect to support from industry regulators such as Kenya Industrial Research Development Institute (KIRDI) and Kenya Intellectual Property Institute (KIPI) [25] supports the views held by fabricators in the three Ghanaian Regions under study. The lack of space to display and popularize products, accompanied with high staff turnover rate of skilled personnel who would move on and start their own fabrication business once fully trained were also challenges identified.

It was identified that agricultural mechanization centers poorly engaged tractor services with sufficient intensity. Also, the direct importation of agricultural machinery by governement institutions created problems relating to affordability and the introduction of user-unfriendly machinery [30]. The issue of lack of spare parts as well as their poor arrival time to

areas of need has been found to have an impact on potential yield especially in cases where farmers plant without the proper land preparation practices. The lack of tractor spare parts during the peak planting season in Ghana was found to be the biggest hinderance to tractor owners' ability to meet their full capacity during hire [31]. To help bridge this gap, there is the need for better work cohesion between Ministries, agencies and private stakeholders including freight forwarders and the Ghana Ports and Harbours Authority to prioritize the shipment of spare parts and crucial machine components for increased productivity in the sector. To improve postharvest mechanization of a major crop such as maize, tractor-mounted maize shellers need to be promoted to improve utilization capacity [32]. In Ethiopia, a number of threshing machines for maize, wheat, rice, sorghum and multiple crops were developed in partnership with government research and engineering agencies in the 1980s, and are still in use [33]. In recent years there has been the adaptation of the ASI thresher from the Vietnamese model and a mini-combine harvester for rice from the Philippines [34]. The provision of resources urgently needed by the private sector such as research on mechanization adoption, investment in public goods, development of a favorable policy environment, capacity building operation of machinery were some of the highlighted gaps that require leading roles by government and allied agencies in order to find workable solutions.

Prospects in the food processing fabrication sector

Skills training

To improve competitiveness of locally assembled tractors over that of imported ones, authorities could consider removing or lowering duties on completely-knocked down (CKD) parts and provide training programs to develop local technical capacity [32]. These recommendations together with specialized training in the fabrication of spare part locally are in line with majority of recommendations provided by respondents with respect to the type of government intervention and support that can boost the processing equipment fabrication sector. Respondents further suggested a good working relationship between government and private sector to court interest and investment, consequently enhance attractiveness of the sector. Other areas of opportunity for the fabricators include retraining of technicians and engineers on new methods of equipment fabrication and tax waiver/reduction on imported raw materials [26].

Utilization of high technology

To combat challenges related to low technology use, Giroux and Marouze [27] proposed a competence-based qualification program in automation technology and process control with a view to; provide knowledge and upgrade skills through training, master adequate tools, machinery and automation technology, transfer appropriate manufacturing techniques, disseminate technical and entrepreneurial information, and contribute to quality assurance among others. However, on the contrary, Adoption of mechatronics as a solution to poor quality standards would be impractical due to the knowledge that most countries in Sub-Saharan Africa have not developed their technology to the level as to incorporate mechatronics into the local fabrication sector.

Quality finishing

Giroux and Marouze [27] recognized the lack of well-adapted small-scale food processing equipment in developing countries most especially in the secondary processing of solid and liquid foods. They further proposed two solutions: importation of externally designed equipment and adapt it to suit the prevailing conditions; and build local capacity to design and fabricate new equipment adapted to the requirements of local users. Some crucial requirements to be considered by fabricators when producing equipment for customers were as follows: adaptation of the equipment to the socioeconomic and sociotechnical environment of the user with respect to price, operating cost, available energy source, capacity and maintenance cost; executing a detailed functional analysis of users' needs with consideration to qualitative and quantitative characteristics; microbiological and food safety requirements; equipment adaptability in relation to management of the process and control of raw materials variety (upstream) and market variability (downstream) [27]. These recommendations were presented after a quick market survey of existing equipment highlighted the lack of information on process variables and also the lack of possibility to change process parameters during processing. Giroux and Marouze's research in summary advocates for the consultation and detailed research of the equipment end-user; arguing that the design should not reflect only the perception of the fabricator but most importantly the end-user.

Increasing export potential through sustainable development goals

Over the years significant interventions in the sector have included the National Export strategy (NES) which targeted increased non-traditional exports, African Growth Opportunity Act (AGOA), A US initiative which allowed products to be traded in the US duty-free, the ECOWAS Common External Tariffs (CET) which sought to implement common tariffs among participating countries. More recently, the advent of the African Continental Free Trade Area (AfCFTA), presents a great opportunity to trading enterprises, consumers, and businesses on the African continent. As part of Ghana's efforts to meet the SDGs, it has presented several policies to support the agricultural sector including PFJs, RFJs, Planting for Export and Rural Development, Greenhouse Villages, and AMSEC intended to address the declining growth in Ghana's agricultural sector. It is expected that these policy incentives will open up the country's agricultural sector including the equipment fabrication sector for investment.

Table 3
Equipment fabricated and corresponding education level of fabricators.

Education level	JHS		SHS		Technical University		University	
Equipmentfabricated	***n***	**%(*n*=42)**	**n**	**%(*n*=20)**	***n***	**%(*n*=16)**	**n**	**%(*n*=17)**
Cassava grater	27	64.3	10	50.0	5	31.3	7	41.2
Maize dryer	0	0	0	0	1	6.3	2	11.8
Feed Mixer	2	4.8	2	10.0	4	25	4	23.5
Corn milling machine	22	52.4	9	45.0	5	31.3	7	41.2
Fufu machine	32	76.2	11	55.0	5	31.3	6	35.3
Tomato mill paste machine	12	28.6	7	35.0	0	0	3	17.6
Pepper mill	11	26.2	3	15	1	6.3	4	23.5
Cassava press	9	21.4	2	10.0	0	0	1	5.9
Fruit juice extractor	4	9.5	1	5	4	25	1	5.9
Rice mill or dehuler	10	23.8	8	40	4	25	6	35.3
Bread kneading machine	19	45.2	4	20	2	12.5	6	35.3
Maize sheller	5	11.9	2	10	2	12.5	2	11.8
Palm oil extractor	5	11.9	4	10	6	37.5	4	23.5
Boiler	0	0	0	0	2	12.5	1	5.9
Digester	1	2.4	0	0	3	18.8	1	5.9
Oven	4	9.5	3	15	3	18.8	0	0
Groundnut dehusker	0	0	0	0	1	6.3	0	0
Thresher	0	0	0	0	1	6.3	1	5.9
Palm nut and kernel cracker	7	16.7	4	20	2	12.5	1	5.9
Hammer milling machine	5	11.9	2	10	1	6.3	3	17.6

One district one factory (1D1F) initiative

The 1D1F program is critical to GOG's industrial transformation agenda aimed at establishing local manufacturing facilities through small and medium-sized enterprises. Properly implemented the program has the capacity to expand the local economics, create job opportunities, increase export earnings from refined raw materials, and reduce reliance on imports. Given that Ghana's government is implementing policies to modernize the agriculture sector, it is important to complement these efforts with policies that encourage the consumption of indigenous foods in both the raw and processed form. Policies that encourage the role of fabricators in adding value to food products to increase shelf-life and reduce postharvest losses would be critical in improving the sector. It is, therefore, envisaged that the period where most farm produce will be left to rot due to lack of storage or processing facilities will be a thing of the past.

Education level of respondents and the types of food processing equipment fabricated

Table 3 shows a cross-analysis between the education level of respondents and the types of equipment fabricated. From the engineering point of view, equipment with working processes involving monitoring of temperature and pressure related parameters are more technical, requiring a high level of precision and engineering acumen in its fabrication and testing compared to those that execute only primary processing activities such as slicing, cutting and grating.

From the analysis, equipment such as boiler and digester which must be built to withstand high temperatures and pressures were fabricated by those with Technical University and Mainstream University degrees. Out of the 8 fabricators of these equipment, only 1 had the lowest education level of JHS. On the contrary, cassava graters which require basic assembly and an understanding of basic electrical wiring had 75.5% of fabricators being JHS and SHS graduates; the rate of cassava grater fabrication was higher among JSS graduates (64.3%) than University graduates (41.2%). The overall percentage of JHS and SHS graduates represents thrice that for university graduates. A similar trend was found among corn milling machine fabricators who had 72% of fabricators to be JHS and SHS graduates. 79.6% of fabricators who produced fufu extruders were JHS and SHS graduates. The rate of fufu extruder fabrication was higher among JHS graduates (76.2%) than University graduates (35.3%). 13.6% of fabricators who produced tomato milling and paste machine were university graduates. A similar development was observed for the pepper mill which recorded 26.3% for university graduate fabricators. More than 30 equipment were recorded for this study and cuts across crops such as cocoa, cassava, plantain, maize, tomato, pepper, pineapple, rice, palm nut and cashew nut among others.

Conclusion

This work investigated the status, challenges, and prospects of food processing equipment fabricators in Ghana. The study has presented salient characteristics of fabricators which can be used by stakeholders in the industry for policy planning and implementation. The research finds that despite the important role they play in the food industry, activities of local fabricators are declining due to factors including high cost of electricity, high cost of raw materials attributable to high import tariffs, lack of access to relevant machinery used in the fabrication process, utilization of low technologies, poor aesthetics of finished fabricated equipment, proliferation of comparatively cheaper food processing equipment, lack of access to finance, and lack of skills training. This research has also provided current demographic data of equipment fabricators and

common locally fabricated equipment which previously was outdated and scattered. Fabrication works was found to be male dominated and the education level of majority of respondents was at the JHS and SHS level. The cassava grater (51.5%), fufu extruder (55.4%), corn milling machine (45.5%), rice mill (30.7%) and bread mixer and kneader (32.7%) recorded the highest fabrication frequency among the over thirty equipment. It is evident that the challenges facing the equipment fabrication sector requires national attention in order to obtain a lasting remedy.

Recommendations

Based on the findings, the study suggests the following recommendation:

Electricity

From the study, it was highlighted that fabricators had challenges with the high electricity tariffs for their activities. As a solution to this challenge, fabricators need to invest in solar power. Other researchers have previously indicated the need to exploit renewable energy sources including solar and wind to supplement hydro and thermal sources of energy [4]. Recent popularisation of solar energ utilization through government interventions in providing affordable solar power solutions may be considered with the chief aim of reducing total reliance on the national grid resulting in lower operational costs eventually. Further, the benefits of economies of scale could be exploited to woo investors to inject resources with agreeable payment plans.

Finance

Financing is core to all business activities including manufacturing of agro-processing equipment. To reduce the challenge of access to finance, there would be the need for fabricators to form strong associations or for individuals to join already existing associations. Strong local and national associations would provide a strong voice and guarantee which will facilitate access to funding from institutions including the rural banks, rural enterprises project and the national board for small scale industries (NBSSI) through which the government of Ghana (GOG) can confidently route financing. Further, it is necessary for fabricators join other agencies including the Association of Ghana Industries (AGI) which has made inroads attracting financing for projects which benefit its members.

Training

There is the urgent need for government to collaborate with its agencies and development partners to offer training programs to the fabricators to expose them to new technologies, equipment and provide new skills to enhance their activities. Additionally, the training would resolve engineering challenges related to materials selection, design, improved finishing and aesthetics, food safety, entrepreneurship, and branding.

Government could achieve this by equipping the technical training institutions including the technical universities, the GRATIS Foundation and ITTUs scattered across the country. This win-win initiative would provide skills to fabricators and equipment for their institutions which can be used to train the future generation of engineers. As iterated, formation of strong association could help access such interventions from government or its development partners.

Support from industry regulators

The Food and Drugs Authority (FDA), Ghana Standards Authority (GSA) are the major industry regulators. These bodies house the standards for food production and standardization. A good collaboration between the fabricators and the authorities would ensure production of standardized equipment. Collaboration between fabricators and the National Vocational Training Institute (NVTI) Centers, NBSSI and Council for Technical and Vocational Educational Training (COTVET) have the potential to provide avenue for the provision of high technology equipment for fabrication of made-in-Ghana equipment, implementation of training and retraining strategies, improved partnership with developed countries in the area of technology transfer, impartiality in the award of government contracts to local fabricators, accessibility to business financing for expansion purposes, and the provision of marketing and advertising avenues to help boost the client base of local fabricators.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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