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Pitfalls and potential pathways to commercialization of indigenous food crops, fruits, and vegetables in Africa

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ABSTRACT

All foods have local origins, but their commercialization and global acceptance remain challenging. Agricultural commercialization involves producing agricultural products for financial gain and market purposes beyond family consumption. Indigenous foods have vast societal benefits, including cultural, employment, medicinal, food security-related, nutritional, and financial. However, indigenous food consumption and demand are constantly declining because exotic foods are replacing them, despite recent campaigns for their increased commercialization. The study investigates the challenges associated with indigenous food commercialization, possible pathways to commercialization, and the role of the government in commercializing indigenous food. It offers a hypothesized structure and essential blueprint for sustainable indigenous food (crop) commercialization. The methodology involved a review of the literature using various search engines, scholarly sites, and print books, combining quantitative and qualitative research. Scaling indigenous food for sustainable commercialization beyond dependency on the wild product takes specific steps, including domestication, certification, and effective government-private collaboration. Policies to improve the sustainability of indigenous food are urgently required to save them from extinction and meet future demand. Many indigenous foods are hindered by low-status perception, poor value addition, inadequate knowledge of their potential, lack of market penetration, and global acceptability challenges. Indigenous food commercialization lacks a holistic and systematic approach involving careful planning, procedural steps, and an aggressive market-spreading mechanism for global adoption. An excellent strategic relationship between government and stakeholders is a prerequisite for indigenous food commercialization, but the onus is on the government to commit to indigenous food commercialization programs.

Contribution/Originality: This study postulates a four-fold pathway to the commercialization of indigenous foods: identifying their significance, domestication, value addition, and market/awareness promotion. The development of these four broad areas and cooperation between private and government actors drives global acceptance of indigenous food, but lack of government support slows it.

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1. INTRODUCTION

Indigenous food is ancestral cuisine of local origin that is naturally grown and consumed in an area. Indigenous food can include green leafy vegetables, fruits, crops, tubers, or animals (fauna) that are primary food sources for the local people (Nepfumbada, Dzinamarira, & Mashamba-Thompson, 2021). Indigenous food plays several societal, economic, and environmental roles, including in the health and nutritional value system. It is a cheap source of food diversity among rural people (Shackleton., Dzerefos, Shackleton, & Mathabela, 2000).

Indigenous foods are mainly grown and sold by rural inhabitants of developing countries, especially young people and women. Therefore, they serve as a channel of empowerment for the vulnerable, offering a more regular and stable income (Baldermann et al., 2016; Chivenge, Mabhaudhi, Modi, & Mafongoya, 2015). For instance, women in Kenya and Benin generate additional income by growing and processing these foods (Rampa, Lammers, Linnemann, Schoustra, & De Winter, 2020a). Recent research has shown that the potential economic benefits of indigenous foods include the provision of livelihood diversification strategies and business transformation for many households (Rampa et al., 2020a; Shackleton et al., 2000). It provides enormous opportunities for collaboration in the areas of logistic improvement, value chain development, genetic improvement, and domestic and export markets (Rampa, Lammers, Linnemann, Schoustra, & De Winter, 2020b). Ironically, few households obtain a significant income from trading indigenous foods due to market failure (Shackleton et al., 2000).

At the macro-economic level, indigenous food encourages tourism growth, which improves the economy of both the local community and the entire country (Fam, Syed Annuar, Tan, Lai, & Ingko, 2020). For example, the new yam festival of the Igbo people of Nigeria not only attracts many tourists to the local community but also stimulates recreational opportunities and contributes to its status as a modern, urbanized community (Onyeabor, 2016). The relationship between tourism and indigenous food is mutual; for instance, indigenous foods are known to play a supporting role, irrespective of a direct association between local food and tourism (Henderson, 2009; Santafe-Troncoso & Loring, 2021). Indigenous food stimulates economic activities through tourism, with most tourists willingly purchasing indigenous food even when unfamiliar with it Fam et al. (2020); Henderson (2009).

Although inflows of tourists and tourism result in job creation, market opportunities, community empowerment, and the spread of indigenous food, their lack negatively impacts the indigenous food system (Mnguni & Giampiccoli, 2019). Inadequate tourist patronage, for instance, limits the spread and recognition of the brown mussel, *Perna perna*, despite its massive potential (Lasiak & Dye, 1989). A dwindling tourist market resulting from poor tourism development not only impacts indigenous dishes but has a general spillover effect on the entire community (Mbaiwa, 2003).

One of the indigenous foods environmental advantages is that they are well adapted to local climatic conditions and natural environmental resources, leading to low input requirements for different kinds of cropping systems. They also display excellent resistance attributes to local pests and diseases, making them suitable for resilient agriculture and sustainable food systems (Omotayo & Aremu, 2020).

Indigenous foods also have a cultural dimension, playing a role in the locals' way of life (Kuhnlein, Erasmus, Spigelski, & FAO, 2009). They make a unique contribution to traditional marriage, festivals, and ritual performances as main cultural objects that are shared among the people (Unya, 2021). In other words, these foods are a means of defining the identity of the local people or ethnical group (Mnguni & Giampiccoli, 2019). Among the many functions of indigenous food is its use in traditional knowledge transfer and preservation of the indigenous culture (Martens, 2018). Due to the respect and value placed on the knowledge of indigenous foods by the local people, those who promote them earn respect and reverence as preservers of the cultural identity. Conversely, a decline in the adoption of indigenous food and knowledge bears the massive risk of eroding people's cultural knowledge (Rampa et al., 2020b).

According to Rampa et al. (2020a), indigenous foods provide affordable but healthy and nutritious sustenance to many people, especially the rural poor in developing countries (Rampa et al., 2020b). The health benefits of indigenous food stem from its nutritional value and bioactive compound potential (Aziz & Jalil, 2019). Some indigenous edible fruits are rich in moisture, protein, fat, crude fiber, ash, and minerals (Ca, Mg, Fe, P, K, and Na) (Kugedera et al., 2021; Saka & Msonthi, 1994). Hence, indigenous foods play an integral role in boosting the body's immune system while providing an excellent source of vitamins and micro and macronutrients to reduce malnutrition and support the food and nutritional security of local families (Richmond et al., 2021).

The analysis of selected indigenous edible fruits in Malawi showed the presence of different rich nutritional components of the highest order, including 17.0% protein for *Trichilia emetica*, 31.2% fat for *Strychnos spinosa*, 45.3% fiber for *Azanza garckeana*, 11.2% ash for *Ximenia caffra*, and 88.2% carbohydrate for *Parinari curatellifolia*, respectively (Saka & Msonthi, 1994). In South Arica, *J. Flava*, an indigenous nutrition-rich leafy vegetable eaten locally, contains mineral concentrations exceeding 1% of the plant's dry weight, far higher than typical mineral concentrations in mainstream edible vegetables. Thus, *J. Flava* has been shown to stimulate 96% antioxidant activity (Odhav, Beekrum, Akula, & Baijnath, 2007).

Durian (*Durio zibethinus Murr*) is an indigenous food with substantial health benefits eaten by the people of Asia, particularly in Malaysia, Thailand, and Indonesia (Aziz & Jalil, 2019). Durian has been shown to reduce cholesterol and blood glucose levels through extracted anti-proliferative and probiotic effects in vitro models (Aziz & Jalil, 2019). It also provides nutritional compounds such as thioesters, esters, and thioacetals (Aziz & Jalil, 2019). A study in Nigeria by Nnamani, Oselebe, and Agbatutu (2009) using three indigenous leafy vegetables (*Zanthoxylum zanthoxyloides hermes*, *Vitex doniana sweet*, and *Adenia cissampeloides zepernick*,) showed that these indigenous vegetables have mineral values that exceed 1% dry weight. They contain high levels of macro and micronutrients Ca, Cu, and Mg, respectively Nnamani et al. (2009). In Zambia, traditionally fermented indigenous milk was experimented with

as a treatment for severely malnourished babies (Rampa et al., 2020b). Indigenous food helps synthesize microhybrid and nanocomposite food health material (Apaliya et al., 2022; Malhotra, Shenoy, Acharya, Shenoy, & Mayya, 2011). Hence, indigenous foods are used to combat food insecurity and nutritional and non-nutritional diseases (Sarkar, Walker-Swaney, & Shetty, 2020). However, the food insecurity challenge is on a constant upward trajectory in Africa, especially among Indigenous people in rural areas. Many households are faced with food insecurity though some of the households consume indigenous food at least one to four times a month (Nengovhela, Taruvinga, & Mushunje, 2018). According to Masekoameng and Molotja (2019), Van der Merwe, Cloete, and Van Der Hoeven (2016), and Vorster, Badham, and Venter (2013), despite the report that South Africa is a food-secure country at the national level, many rural households are ravaged by food insecurity, hunger, and malnutrition. As noted in other African countries, millions of households in South Africa have limited access to sufficient nutritionally safe food (Van der Merwe et al., 2016). This is despite the significant role of indigenous food in contributing to food security, nutritional value, income, and employment. For example, since ancient times, the people of Africa have consumed a wide variety of indigenous fruits and food crops, some of which have gained substantial recognition in the commercial market, like the case of *marula*, *uninga* (sesame) (*Sclerocarya birrea subsp. caffra*) (Mokgolodi, Ding, Setshogo, Ma, & Liu, 2011; Shackleton, Kirby, & Gambiza, 2011). However, in recent times, most people no longer consume or cultivate indigenous food crops or indigenous leafy vegetables, leading to continuous food insecurity in Africa, despite the rich supply of indigenous food available in sub-Saharan Africa. Until recent times, African indigenous vegetables were part of the food systems in sub-Saharan Africa for generations as the region is home to more than 45,000 species of indigenous foods, of which more than 1,000 can be eaten as green leafy vegetables (Muhanji, Roothaert, Webo, & Stanley, 2011).

As is the case in most developing nations, a significant number of diverse indigenous foods, including fruit and vegetable species, have been abandoned in favor of foreign exotic crops (Pichop, Abukutsa-Onyango, Noorani, & Nono-Womdim, 2014; Shackleton et al., 2000). The reasons for the abandonment and slow recovery of indigenous foods include government laws and policies (Pichop et al., 2014). Distinct indigenous political/legal orders and authorities determine the sovereignties of indigenous food across diverse landscapes (Daigle, 2019). These policies, laws, and authorities sometimes cause bottlenecks to indigenous food sovereignty and its potential positive impact on the food system (Santafe-Troncoso & Loring, 2021). International law and the existing policies on food sovereignty also significantly impede the indigenous food system by impacting its market access and commercialization (Grey & Patel, 2015; Reinten & Coetzee, 2002).

1.1. Commercialization

Every food crop, fruit, nut, or vegetable originates somewhere, but commercialization and global acceptance remain challenging. For example, maize (*Zea mays*), commonly referred to as corn, was first domesticated from a wild grass in central Mexico 7000 years ago (Ranum, Peña-Rosas, & Garcia-Casal, 2014). Rice (*O. sativa*) was developed from the Asian wild progenitor *Oryza rufipogon*, also called brown beard rice (Khush, 2000). The origin of *O. rufipogon* can be traced to East and South Asia, where it was distributed from Pakistan to China, Indonesia, and other parts of the world (Khush, 2000). Though different species of rice originated in different countries, most species are from Asian countries, including China, Thailand, Malaysia, the Philippines, and Pakistan (Wang et al., 2020).

The origin of wheat can be traced to the South-Eastern part of Turkey (Shewry, 2009). Oats, the world's fourth most important cereal, originated in Europe, although earlier research suggested that the naked Oat (*A. nuda L*) came from China, where it was widely grown (Sampson, 1954). The oldest grain cultivated by humans, barley, is believed to have originated in Abyssinia (Ethiopia) and Southeast Asia (Harlan, 1968). All these food crops have been commercialized; however, the commercialization of many indigenous African crops remains problematic, despite the rich and plentiful indigenous food available in sub-Saharan Africa. Agricultural commercialization involves producing agricultural products for financial gain and market purposes beyond family consumption. It is a gradual developmental process between transformation and evolution, which includes subsistence production and semi-commercial and entirely commercial production to achieve various goals (Yaro, Teye, & Torvikey, 2017). The challenges of indigenous food commercialization can be linked to several different factors.

Both developed and developing nations want to commercialize indigenous food (Sebastian & Donelly, 2013; Settee & Shukla, 2020). Indigenous peoples of North America, Australia, Canada, and India have championed the promotion and commercialization of indigenous food, but the challenges of controlling and commercializing indigenous food remain unabated (Ghosh-Jerath et al., 2021; Sebastian & Donelly, 2013; Settee & Shukla, 2020; Whyte, 2016). Even more worrisome is the increasing speed with which indigenous food is being replaced by exotic food, especially among urban dwellers (FAO, 1990). The rate at which exotic food is replacing indigenous food might drive indigenous foods in sub-Saharan Africa to extinction. This has hindered the growth and development of indigenous foods, despite the desire of many smallholders and rural dwellers engaged in indigenous food farming to see them commercialized (Agea, Obua, Waiswa, Okia, & Okullo, 2010). Moreover, these indigenous food stakeholders are challenged by limited practical procedures to follow when commercializing indigenous foods. It is yet more challenging as research and development targeting indigenous food commercialization is costly and laborious (Coetzee, Jefthas, & Reinten, 1999). However, the available research addressing indigenous food commercialization shows that the characteristics of the local agriculturist, especially smallholder farmers' socio-economics, are vital factors in indigenous food commercialization (Agea et al., 2010; Zondi, Ngidi, Ojo, & Hlatshwayo, 2022).

The numerous pitfalls of indigenous food commercialization result in poor income generation and harnessing of indigenous food. These challenges make it difficult to commercialize indigenous food, including leafy vegetables, roots, and tubers such as cocoyam (*Xanthosoma sagittifolium*) (Lewu, Adebola, & Afolayan, 2010; Quaye, Adofo,

Agyeman, & Nimoh, 2010). This has resulted in research into the various roles and significance of indigenous food, including food security and nutritional value (Odhav et al., 2007; Van Rensburg et al., 2004; Venter, Vorster, & Steyn, 2005). However, these studies have not achieved the aim of commercializing most indigenous leafy vegetables and food crops (Zondi et al., 2022). Consequently, factors affecting the commercialization of indigenous leafy vegetables and food crops have been investigated (Akinola, Pereira, Mabhaudhi, De Bruin, & Rusch, 2020; Belcher & Schreckenberg, 2007; Janke, 2018; Nkosi, Mostert, Dzikiti, & Ntuli, 2020; Reinten & Coetzee, 2002). Ironically, however, a step-by-step guide to the commercialization of indigenous food has yet to be developed. Despite most governments and stakeholders promoting the commercialization of indigenous food, especially in developing countries, they do not know what step/program to prioritize at each stage of indigenous food development. The wrong approach to the commercialization of indigenous food has led not only to the wastage of resources but to slow progress and low investment in indigenous food development (Adebooye & Opabode, 2004). Hence, this research aims to review the literature on the various factors affecting the commercialization of indigenous leafy vegetables and food crops while investigating how the commercialization of previously indigenous food was achieved. This paper also aims to create awareness and guide governments, policymakers, and stakeholders along the path to developing and commercializing indigenous food.

1.2. Specific Objectives

Specifically, the objectives of the study are:

To highlight the challenges affecting the commercialization of indigenous foods.

To identify practical steps for the commercialization of indigenous crops.

To investigate the contribution of some African governments to the commercialization of indigenous foods.

2. METHODOLOGY

The reviewed literature was collected using various search engines, scholarly sites, and print books. The review employed a mixed-method approach, combining quantitative and qualitative research. Data from the Food and Agriculture Organization (FAO) were used for the quantitative discussion to explain the quantity of one of the exotic crops produced by different countries for commercialization. The data were also used to compare and contrast the quantity of any indigenous food production with exotic food. The PRISMA procedure (www.prisma-statement.org) for a systematic review was used. Theses and dissertations on indigenous food were excluded, restricting the review to published articles and books.

3. SYNTHESIS OF LITERATURE BY OBJECTIVE

In this section, the relevant literature is reviewed according to each specific objective. This includes investigating the different factors impacting indigenous food. It further discusses the necessary steps toward the commercialization of indigenous food.

3. 1. Challenges Affecting the Commercialization of Indigenous Foods

This section presents a discussion of the challenges affecting the commercialization of indigenous foods. These include low status, limited information, lack of an approved and reliable production system, and lack of suitable markets and facilities to process, preserve, or add value.

3.1.1. Challenge Associated with Low Status of Indigenous Food

Indigenous foods are affordable for the poor because of their low prices and constant availability (Rampa et al., 2020b). However, the low prices, among other things, result in their low status (Rampa et al., 2020b). For example, small indigenous fish found in Bangladeshi fresh waterways are eaten whole with organs and bones by mainly the rural poor, resulting in the diet of the poor being associated with these fish (Thilsted, Roos, & Hassan, 1997). These fish species include darkina (*Esomus danricus*), dhela (*Rohlee colio*), and mola (*Amablypharyngon mola*). The organs and bones of the 10 cm long Bangladeshi indigenous fish species contain large quantities of calcium, iron, zinc, and vitamin A (Thilsted et al., 1997). In Africa, most indigenous foods are linked with the historical food consumption and sociocultural habits that shape the lifestyles of the poor (Kuznesof, Tregear, & Moxey, 1997). The association of indigenous foods with the rural poor, the nature of their harvest and processing, and the lack of additives have a negative impact on their status (Cloete & Idsardi, 2013). These and many other complex constraints have also influenced the psychology, perceptions, and disposition of the rich toward the consumption of these indigenous foods, despite their nutritional benefits (Afari-Sefa, Tenkouano, Ojiewo, Keatinge, & d'A Hughes, 2012). These have, in turn, affected the commercialization of indigenous foods by making them unattractive for investors, especially commercial farmers (Hunde, 2017). Moreover, the low prices of indigenous food make its commercialization less attractive than it would ordinarily be (Rampa et al., 2020b). Ironically, however, if the prices of indigenous foods increase disproportionally, these nutritious foods will become less affordable for the poor (Rampa et al., 2020b).

Another reason for the low status of indigenous foods is a lack of scientific knowledge of their nutritional components, as well as a lack of effective processing and preserving technologies (Rampa et al., 2020b). Positive changes in the financial and socio-cultural status of Indigenous people affect indigenous foods in several ways but result more in the low price of indigenous food. For example, when the financial condition of Indigenous food consumers improves, they opt for exotic foods at higher prices. The low price of indigenous food is thus the result of low demand (Asogwa, Okoye, & Oni, 2017).

3.1.2. Lack of Information on Indigenous Food

So far, there has been inadequate research and innovation to bring indigenous foods to the fore of global acceptability while showcasing their holistic roles (Swiderska & Ryan, 2021). This is particularly relevant in Africa and developing nations on other continents where malnutrition and hunger are part and parcel of many households (Akinola et al., 2020). The various research areas where information on indigenous food is inadequate include value chain addition, domestication, commercialization, awareness campaigns, nutritional benefits, conservation, cultivation methods, breeding, pre-breeding, exploitation, adaptation ability, efficient use, medicinal value, economic value, genetic components, and genetic modification (Gerrano, 2021; Mbhenyane, 2017). The poor rural households making the most use of indigenous food do not have the essential research knowledge, technology, and facilities to research, improve, process, and preserve indigenous food (Kuyu & Bereka, 2020). Therefore, the limited empirical information and poor strategic drives of indigenous food development are evident in the skewness and trend of indigenous food information in Africa.

3.1.3. Lack of Consumption and Production Data on Indigenous Food

The extant research, using a study done by Mbhenyane (2017) as an example, has reported that households, especially those in rural areas, depend on indigenous food, without giving the exact number of people depending on indigenous food. This trend of scanty research, which states the average number of people depending on specific indigenous foods, is unlike commercialized exotic foods, for which data are available concerning the proportion of production, utilization, consumption, and number of people depending on these foods (Ranum et al., 2014). For example, Table 1 shows the production level of selected exotic crops in different countries, but the production level of indigenous food crops is not available.

Table 1. Production of selected exotic crops across a ten-year interval.

Country	Maize production tons		Rice production tons		Wheat production tons	
Year	2008	2018	2008	2018	2008	2018
USA	305911450	364262150	9241170	10152890	68016096	51305540
China	166032097	257348659	193352875	214078796	112464292	131446596
Brazil	58933347	82366531	12061465	11808412	6027131	5469236
Mexico	24320100	27169400	224371	283763	4019400	2943445
Argentina	22016926	43462323	1245800	1367968	16486532	18518045
India	19731400	28752880	148036000	174716730	78570200	99869520
Ukraine	11446800	35801050	100700	69210	25885400	24652840
Indonesia	16323922	30253938	57661000	59200534	-	-
France	16037988	12580430	111523	71430	39006372	35424140
Canada	10592000	13884800	-	-	28619200	32351900
South Africa	12700000	12510000	3000	3074	2130000	1868000

Source: FAOSTAT (2022).

The lack of data on the production, utilization, consumption level, and number of people depending on specific indigenous foods not only creates barriers to investment but also greatly impedes their commercialization. In general, the lack of documentation is gradually eradicating the adoption of indigenous food, while a high level of illiteracy also impedes its commercialization, especially in developing countries (Asogwa et al., 2017).

3.1.4. The Lack of an Approved and Reliable Production System

The lack of a clear guide to best production practices is another pitfall hindering indigenous food crop development (Wang et al., 2014). A majority of research and research-related institutions have focused primarily on exotic staples and export crop cultivation mechanisms, including the performance of maize/bean and maize/pumpkin intercrops under different planting and weeding combinations. However, there appears to be a dearth of indigenous crop domestication procedures and cultivatable development processes (Wang et al., 2014).

Research points to the fact that most research institutions, especially those in Africa, do not have separate variety release systems for indigenous crops (Afari-Sefa et al., 2012). Thus, the evaluation criteria, such as value for cultivation and use (VCU), developed explicitly for cereal and other exotic crops, are being misused for indigenous vegetable quality control and foundation seed development (Karanja et al., 2012). This, among other things, could be linked to the lack of research in more discrete areas that fall under indigenous food development regarding the cropping, spacing, and weed patterns that result in the best yields (Grivetti & Ogle, 2000). Some indigenous food cultivation, production, and productivity challenges start with the unavailability of improved seeds (Adebooye, Baidu-Forson, & Opabode, 2005).

3.1.5. The Lack of Formal Markets

A high market potential could imply a risky opportunity for those (small farmers and entrepreneurs) who want to upscale indigenous food businesses because a more robust commercial company might hijack them. Still, a lack of suitable market conditions is one challenge that hampers the commercialization of indigenous foods and the potential economic benefits thereof (Rampa et al., 2020b). Again, most indigenous food markets are associated with

poor logistics processes amidst a bottleneck system in which middlemen exploit rural and urban dwellers (Rampa et al., 2020b). This is when deficient storage and transport facilities combine with a lack of physical market structure in shops or supermarkets to bring about the failure of indigenous foods to reach formal market channels. This has restricted most indigenous food sales to door-to-door and roadside selling in farming communities or peri-urban areas, which are more informal markets. Moreover, a lack of up-to-date and future market information also impedes the commercialization of indigenous foods (Rampa et al., 2020b).

3.1.6. Other Factors Influencing Indigenous Food

The influence of Western culture is another leading factor influencing the erosion of indigenous foods (Asogwa et al., 2017). The argument is that not only Africans' indigenous foods but also their tastes and lifestyles are negatively affected because they are invariably being modified to suit Western culture (Asogwa et al., 2017).

Many households involved in indigenous food preparation are rural and poor; as they do not have the requisite modern technology and facilities to process, preserve, or add value to the food, they have to rely on indigenous knowledge, which involves time-consuming methods (Kuyu & Bereka, 2020). Time has become another significant constraint to food preparation in this modern world with its growing population, making many people abandon foods that are time-consuming to prepare, such as indigenous foods, for convenient and easy-to-prepare foods (Asogwa et al., 2017). The lack of modern technology and facilities to promote value addition results in the failure of improved and reliable indigenous food production practices.

While inflows of tourists and tourism result in job creation, market opportunities, community empowerment, and the spread of indigenous food, its lack, on the other hand, negatively impacts the indigenous food system (Mnguni & Giampiccoli, 2019). For instance, it has been noted that inadequate tourist patronage limited the expansion and recognition of the brown mussel, *Perna perna*, despite its massive potential (Lasiak & Dye, 1989). A dwindling tourist clientele arising from poor tourism development not only impacts indigenous dishes but has a general spillover effect on the entire community (Mbaiwa, 2003).

3.2. Steps to the Commercialization of Indigenous Food Crops

Every commercialized agricultural product, including indigenous food, passes through some essential stages (Pingali & Rosegrant, 1995). These stages are necessary to meet sustainability and market requirements (Østerberg et al., 2017).

3.2.1. Unveiling the Economic Importance of Food Crops for Commercialization

The first step to commercializing a food crop is associated with the priority placed on the crop when unveiling its economic importance (Akinnifesi et al., 2006). This encompasses revealing its contribution to food security, nutritional content, bioactive compounds, ethnobotany value, domestication trails, perception, and local people's acceptance (Cooper, 2015; Frankel, Brown, & Burdon, 1995; Piperno, 2017). This has resulted in the evolution of some crops, supported by research and development investment for domestication, including the crops formerly known as wild maize and wheat (Bushnell, 1976; Cooper, 2015).

3.2.2. The Role of Domestication in Commercialization

The second step that leads to the commercialization of a food crop is domestication. For some food crops, their economic importance, environmental challenges, over-exploitation, and the need to conserve biological resources led to their domestication (McNeely, 1988). Moreover, the desire to meet market demand (commercialization) led to the domestication of wild crops, including today's exotic crops, such as maize, which was the foundation of crop transformation (Johannessen, Wilson, & Davenport, 1970). The process of plant domestication means placing plant species under human control through hereditary restructuring and modification of the plant by carefully selecting genetic alterations in response to human needs (Abbo, Lev-Yadun, & Gopher, 2012). It aims to increase the crop yield potential, eliminate or reduce undesirable traits, and increase the market value (Abbo et al., 2012; Brush, 1998).

3.2.3. The Role of the Spreading Mechanism in Commercialization

Another vital step in the commercialization of a crop is the ability to spread it globally. Maize, for instance, originated in Mexico but spread to the United States, where its major transformation took place due to the awareness of its significance (Ranum et al., 2014). Maize is cultivated worldwide, with the United States being the primary producer (Dragomir et al., 2022; Ranum et al., 2014). As such, most commercialized exotic crops are internationally recognized on all continents (Muhanji et al., 2011). The awareness and spreading of domesticated crops or their products lead to their acceptability, which created a high demand for these crops or agricultural produce.

The introduction of exotic crops such as wheat, barley, maize, and rice during the era of colonization helped to spread awareness of these exotic crops across many countries (Raschke & Cheema, 2008; Theoharides & Dukes, 2007). As the growth of exotic crops gained momentum through colonization, they have been described as invasive plants that impacted indigenous crops (Lockwood, Cassey, & Blackburn, 2009). Their introduction through colonization was not limited to Africa but occurred in many parts of the world (Weber, 1998).

Aside from the colonization era, many countries gained knowledge of exotic crops during the world wars due to the high proliferation of domesticated exotic seeds and ornamental crops associated with the world wars, especially during and after World War II (Marsh, 1998). The knowledge of the benefits of these crops led to their adoption and consumption, consequently promoting their commercialization (Friedmann, 1993). Friedmann (1993) further described the spread of exotic crops during this era as a response to farm politics and the introduction of agricultural

support programs that undermined the postwar food regulation system and governed agro-food relations that aided the spread. However, while the commercialization of crops via war and colonization is no longer viable, an effective trade mechanism between people, tribes, or nations is a vital channel for the commercialization of crops and food (Maseko et al., 2017; Masekoameng & Molotja, 2019).

Brassica rapa L. subsp. (*brassicaceae*) is an annual leafy vegetable that originated in China but found its way into Africa as a result of trade between the two continents (Maseko et al., 2017). During the introduction of *Brassica rapa L* in Africa, the Vhembe District of Limpopo Province in South Africa was the origin of its cultivation for commercial purposes (Maseko et al., 2017). Recently, the commercialization of uninga, an indigenous crop that was going extinct, started among the Ndau people of south-eastern Zimbabwe. The commercialization of uninga is thriving due to its current high market demand through trade agreements, especially in Mozambique (Muyambo & Shava, 2021).

In the modern world, the commercialization of food is achieved via the mechanism of awareness campaigns. Unfortunately, such campaigns are among the few available ways to spread indigenous foods besides trade. These ways include research, newspapers, agricultural exhibitions, cooking competitions, plot demonstrations, and demonstrations using song, dance, and narratives in strategic places (Abukutsa-Onyango, 2010).

The effectiveness of trained partner groups and extensive messages conveying the benefits of the crop through social media, radio, and TV cannot be overstated. The use of radio broadcasting media is significant as this type of message delivery is less costly (HarvestPlus, Lusaka, Zambia, & Simpungwe, 2017). However, while there is relatively much research exposing the benefits of indigenous food from Africa to the world, the same cannot be said for the media, particularly broadcast media (television media). Unlike the high level of broadcasting that exotic foods have enjoyed and their constant support through awareness campaigns in world-class media, few indigenous foods have been marketed in the media (Abukutsa-Onyango, 2010). Aside from being more locally based, awareness campaigns for indigenous foods have not regularly taken place through broadcast media (Muhanji et al., 2011). Meanwhile, the introduction of foods into the Western education curriculum significantly helped in the spread, adoption, and sustainability of exotic foods. Similarly, Abukutsa-Onyango (2010) suggested that effective curriculum development for indigenous foods is necessary at various learning institutions.

3.2.4. The Importance of Value Addition in the Commercialization of Indigenous Food

Value addition, which entails processing, preserving, and packaging, is crucial in commercializing agricultural produce. All commercialized foods have undergone various stages of value addition, including genetic improvement, processing, preservation, and packaging. For example, at the domestication and production levels, maize has undergone different genetic improvements, leading to high-oil corn, green-eared corn, sweet corn, popcorn, baby corn, and quality protein maize (Yadav & Supriya, 2014). Maize's value-added products at the processing, preserving, and packaging levels include baked products, savory snacks, health foods, infant foods, and various traditional foods (Yadav & Supriya, 2014).

In the case of rice, it is notably consumed by more than half of the world's population (Gnanamanickam, 2009). It has undergone value addition that includes processing its waste (husk) into micro silica used to prepare advanced materials like SiC, Si_3N_4, elemental Si, and Mg_2Si for economic benefit (Chandrasekhar, Satyanarayana, Pramada, Raghavan, & Gupta, 2003). In another development, improvements that encapsulate rice production's value-added equipment have been made beyond mechanical threshers, winnowers, harvesters, and combine harvesters to include a suitable combine machine for drying and segregating immature rice grains (Samaddar et al., 2017). Brown rice, ready-made mixes, and noodles are rich products that have not only been commercialized at the regional level but have penetrated the global market due to their value-added contribution (Samaddar et al., 2017). Meeting the increasing demand and commercialization of wheat would not have been achieved by conventional plant breeding methods, irrespective of their role in growth. As such, the value-added application of recombinant techniques helped to overcome the obstacles to translating the full potential of the genomic era to wheat breeding to improve wheat quality and yield (Bhalla, 2006).

All commercialized exotic crops have gone through various stages of value addition (Macauley & Ramadjita, 2015). However, many indigenous foods lag considerably in various areas of value addition. Indigenous crop value addition in the agronomic evaluation under different growing conditions is a fundamental challenge impeding the commercialization of indigenous crops and African leafy vegetables (Lewu et al., 2010). The lack of value-addition ensures that indigenous food crops, including vegetables, suffer from low acceptability status (Rampa et al., 2020b; Zobolo, Mkabela, & Mtetwa, 2008).

4. FRAMEWORK OF INDIGENOUS SUSTAINABLE FOOD (CROP) COMMERCIALIZATION

Based on the literature, the author hypothesized the structural stages necessary for the sustainable commercialization of indigenous food, irrespective of the socio-economic characteristics of the farmer involved. The structure organogram presented in Figure 1, if followed meticulously, will result in commercialization. Other variables do play a role; these in-between variables include government policy, training/capital development of stakeholders, certification, financial support, research, and development. Constant exploitation of indigenous food from the wild could never result in commercialization; it will instead lead to extinction due to over-exploitation. Hence, the necessary starting point is aggressive research and development, which will lead to domestication after the economic potential of such indigenous food has been discovered.

Figure 1 illustrates the commercialization of indigenous foods, using a plant as an example. It shows that all plants originate from the wild, and the commercialization process starts by identifying their significance (value). This includes identifying its nutritional, medicinal, food security, and commercial values. The realization of this

significance will create over-exploitation pressure on the wild progenitor or product. To reduce the pressure of over-exploitation and meet market demand while ensuring sustainability, domestication becomes a necessity. After domestication, the next necessary step is value addition; this could take the form of yield improvement, nutritional improvement, genetic improvement, preservation of production, packaging, etc. However, value addition may take place alongside the promotion of the market value of the plants by implementing market awareness strategies for its global acceptance, which must be completed to achieve commercialization. Each stage in the commercialization process requires government and private sector corporations to collaborate to commercialize the indigenous food.

Before the worldwide spread of maize, its hybrid technology was originally developed and domesticated in the United States (Byerlee, 2020). Based on the demand for maize and its market context, diffusion of this hybrid technology from the United States to Latin America, Europe, Asia, and Africa was observed in the years up to 1970 (Byerlee, 2020). A good spreading mechanism, involving promotion, awareness, and marketing, is necessary for local and international commercialization. On the other hand, various types of value addition, including breeding and genetic modification, lead to better climatic adaptability, improved yield, and early maturity. Value addition also involves processing, branding, and packaging, which are needed for global acceptability and commercialization.

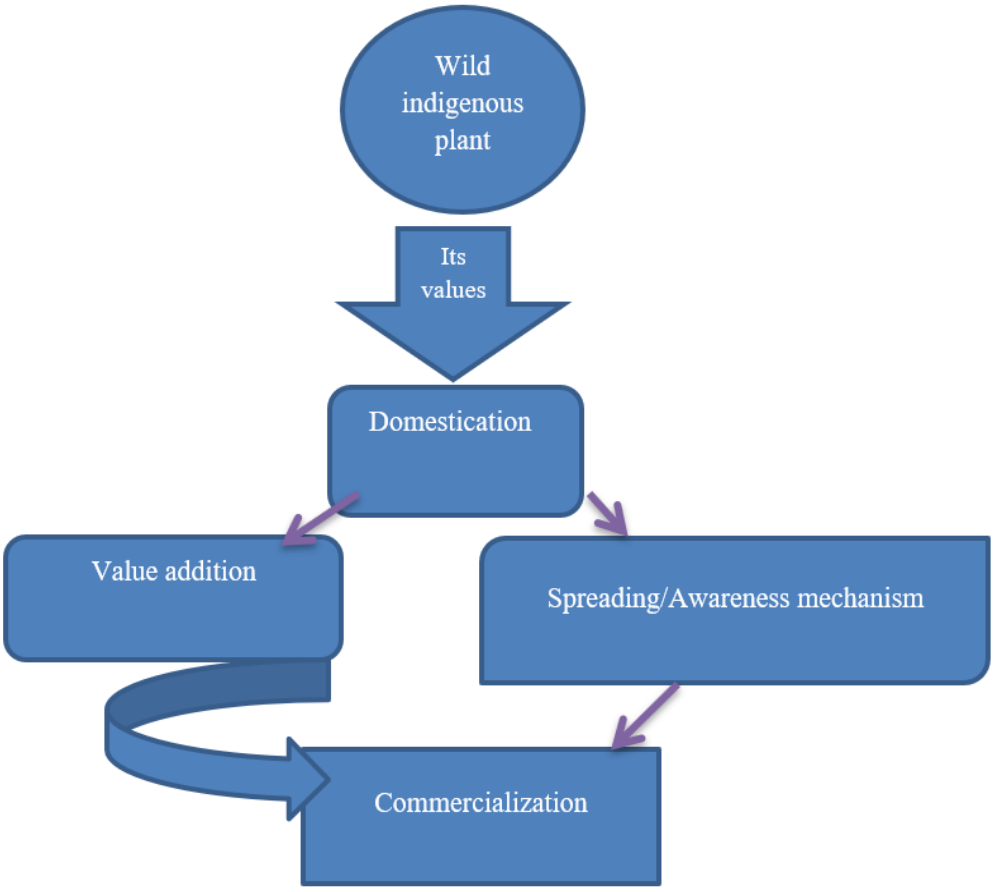

Figure 1. Framework of indigenous food commercialization.

5. THE COMMERCIALIZATION OF *SCLEROCARYA BIRREA* (MARULA)

Sclerocarya birrea (marula) is one indigenous fruit plant that has been commercialized in recent years. Analyses of various studies show that certain essential activities were carried out to ensure the commercialization of *S. birrea* (marula). These essential activities have been summarized and captured in the figure showing the empirical structure of indigenous food commercialization. The commercialization of *S. birrea* followed developmental strategies stemming from its economic importance in the areas of food security, nutritional value, health, and income generation, leading to domestication, value addition, and promotion (Bationo-Kando et al., 2016).

Sclerocarya birrea (marula) is a deciduous tree crop with economic importance that is indigenous to southern Africa (Cádiz-Gurrea, Lozano-Sánchez, Fernández-Ochoa, & Segura-Carretero, 2019). *Sclerocarya birrea* (marula) contributes to food security in that the people of southern Africa widely consume its fruit. It has a rich nutritional content. The bark of the tree is used for medicinal purposes. It helps the local people to improve their income generation.

Sclerocarya birrea (marula) has been domesticated from varieties of wild parent species to ensure domestic and cultivated offspring with desirable features to meet specific human needs. Part of its early domestication involved establishing orchards in southern Africa and Israel that were resilient to environmental factors and supplied both fresh fruit and fruit for the canning and beverage industries (Nerd, Aronson, & Mizrahi, 1990; Weinert, van Wyk, & Holtzhausen, 1990). While *Sclerocarya birrea* (marula) is naturally adapted to the climatic and environmental

conditions of southern Africa, four orchards were established for its domestication and to optimize the postharvest physiology of the fruits at different locations in the Negev Desert of Israel (Nerd & Mizrahi, 1993). To ensure its maximum performance when domesticated, the best soils were used for its propagation, although it grows in a wide variety of soils, preferably well-drained sandy or alluvial soil cuttings (Voget, Steele, & Streit, 2006).

Sclerocarya birrea (marula) offers multiple nutritional benefits due to its abundant quantities of copper, calcium, iron, potassium, phosphorus, and magnesium. It also contains other elements, including zinc, manganese, and sodium, although these elements are lower than the maximum level needed for adequate productivity and growth (Aganga & Mosase, 2001). The leaves, bark, root, and fruits are used in food and traditional medicine (Mariod & Abdelwahab, 2012). The extracts from different parts of *S. birrea* contain a significant amount of total phenolic compounds and radical-scavenging capacities (Mariod & Abdelwahab, 2012).

The edible portion of *S. birrea* seeds has a 36.4% protein content. However, the protein standard is below the best standard recommended by the World Health Organization (WHO) because it contains lower amounts of some essential amino acids, such as leucine, lysine, phenylalanine/tyrosine pair, and threonine (Glew et al., 2004). However, Mariod, Ali, Elhussein, and Hussien (2005) argued that all the essential amino acids are present in fair amounts, excluding tryptophan. It also has high ascorbic acid content (Hillman, Mizrahi, & Beit-Yannai, 2008).

The fresh juice produced from marula has, on average, four times more antioxidants than the juice of either orange or pomegranate, so it is rich in antioxidants (Hillman et al., 2008). The fruit juice comprises sesquiterpene-hydrocarbon found in plants and is reported to have bacteriostatic properties (Mariod & Abdelwahab, 2012).

The white kernel seed in *S. birrea* is rich in oil content (53.5%), including oleic, palmitic, myristic, and stearic fatty acids (Mariod, Matthaus, & Eichner, 2004). In an evaluation of oil extracted from marula seed cake (MSC) (*Sclerocarya birrea* subspecies *caffra*) compared with commercial protein supplements (soya bean meal (SBM) and sunflower cake (SC)), it was discovered that MSC is as good as SBM and better than SC as a protein supplement for goats fed grass hay (Mlambo, Dlamini, Nkambule, Mhazo, & Sikosana, 2011).

Despite its inherent nutritional content, value has been added to its products in several ways, including through genetic improvement, processing of the product into sesame paste and mixed sugars, biscuits, margarine, and liquor (Amarula), which is traded worldwide (Akinnifesi et al., 2006).

Different laws and policies have been enacted, including those governing wild food uses, indiscriminate harvesting of *Sclerocarya birrea*, and Indigenous rights to benefit from *Sclerocarya birrea* (Wynberg, Cribbins, et al., 2002; Wynberg, Laird, Botha, & McHardy, 2002). In southern Africa, customary – rather than statutory – laws are employed and enforced to exploit and protect *S. birrea*, where the resource rights are secured (Wynberg & Laird, 2007). However, in 1992, at the United Nations' Biological Diversity Earth Summit Convention in Rio de Janeiro, the international policy and principle for the conservation, sustainable use, management, and commercialization of marula was signed (Wynberg, Cribbins, et al., 2002). Article 15 of the Convention allowed countries providing genetic resources to benefit from the commercialization of their genetic resources, including a fair share of the profits generated, as well as non-monetary benefits such as technology and participation in the research and development process (Wynberg, Laird, et al., 2002).

6. THE ROLE OF THE GOVERNMENT

The government plays a crucial role in all stages of indigenous food development and commercialization. Early transformation, distribution, and commercialization of cocoa palm, for instance, were facilitated by the United States government (Cook, 1901). The commercialization of palm oil in Malaysia was achieved through strategic US–Malaysia relationships (Yacob, 2019). Scientists from the United States government embedded in local institutions linked to local seed systems and farmers helped develop maize cultivars for better domestication before its spread (Byerlee, 2020). In the case of maize development in the United States, the private sector played a secondary role; a handful of US public institutions headed the development and promoted its spread (Byerlee, 2020). Besides financial support, research, and development, the restructuring of domestic maize commercialization in Mexico was due to policy decisions of the government to support private agents in the maize market (Appendini, 2014).

The Implementation of the indigenous African leafy vegetable (ALV) program in Kenya, jointly supported by a group of government ministries, non-governmental organizations, and local, national, and international institutions from 1996 to 2006, resulted in a tremendous increase in the consumption and adoption of indigenous vegetables (Maundu, 2014). This collaboration enabled some farmers in Kenya to navigate market constraints impeding the supply of indigenous vegetables to the local, national and international markets (Ngugi, Gitau, & Nyoro, 2007). To improve nutritional health and food security in South Africa, the government has encouraged the consumption of indigenous food. To achieve this objective, the government established the indigenous food crop program for commercialization through the Agricultural Research Council (ARC) (Gerrano, 2021). Hence, the ARC has embarked on developing new cultivars as an essential means of enhancing indigenous crop production. However, very little or no success has been achieved in the areas of indigenous food development due to a long period of neglect (Gerrano, 2021). This is because the governments of developing countries, especially those in Africa, have not provided sufficient support for the development of indigenous food (Mbhenyane, 2017).

The neglect of indigenous food development is evidenced in poor legislation and certification of most indigenous crops and food. Owing to national and international food standards, agricultural products are not allowed to be sold in formal and export markets if not certified.

A lack of product certification could impede consumer" acceptance of that product because some consumers, especially those in urban areas, do not trust the microbiological safety of an un-certified product. Moreover, most supermarket outlets demand formal certification of indigenous food.

A project on the development of infant formula achieved essential milestones and was sold in supermarkets after certification and approval by government agencies in Benin. In Uganda, a bottleneck was overcome to achieve a high level of acceptance and sales of certain indigenous vegetable seeds when granted legal recognition and certification (Rampa et al., 2020a). Ironically, these supermarkets increasingly attract poor consumers besides the middle and upper classes (Figuié & Moustier, 2009). This means that poor households that would have ordinarily purchased uncertified food are indirectly promoting the consumption of certified food. Therefore, to support the upscale of indigenous food beyond household consumption and the informal market level, a certain degree of certification and formalization is required to comply with formal quality standards. More challenging is the rate at which government agents (extension service providers) who are meant to promote the spread of agricultural knowledge rarely promote indigenous foods (Muhanji et al., 2011).

7. CONCLUSION

Africa has a rich variety of indigenous foods, including leafy vegetables and crops. However, most of these indigenous foods have not been commercialized, meaning that their holistic benefits are poorly harnessed. The lack of domestication of some African indigenous crops and leafy vegetables has resulted in them being exploited to extinction, especially leafy vegetables that form trees, of which the tender leaves are consumed. Among other things, the lack of approved and reliable production systems, the low status of indigenous food, and poor knowledge of its nutritional benefits affect the popularity of indigenous food. A lack of documentation and information about the number of people demanding specific indigenous foods prevents investors from being attracted to them. Although numerous factors impede the commercialization of indigenous foods, the systematic procedures that will lead to their commercialization have not been aggressively and consistently followed. Unlike many other indigenous food crops, some fruits and leafy vegetables are being successfully promoted for commercialization; for instance, the significance *of S. birrea* was unveiled, ensuring its domestication and value addition and setting in motion a collaboration among the government, research institutions, and international organizations, leading to the application of good policies and laws by the government – all of which together resulted in its commercialization.

The commercialization of indigenous food crops, fruits, and leafy vegetables is possible, but there has been little effort in this regard in terms of domestication, value addition, strategic procedures, working policies, holistic government support, and both local and international collaboration. Once the government effectively collaborates with the private sector, non-governmental organizations, research institutions, and international organizations, it will be a milestone achievement that will allow substantial economic benefits to be reaped from indigenous food.

8. RECOMMENDATIONS

Domestication, value addition, and aggressive and consistent awareness campaigns/promotion through effective communication are necessary for the sustainable commercialization of indigenous food. This also includes the use of local and international media, especially broadcasting media. Most importantly, there should be huge domestication and value-addition drive for selected indigenous foods based on their economic value – since there is a wide variety of indigenous foods. The government needs to promote effective collaboration with the private sector, non-governmental organizations, research institutions, and international organizations.

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