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Good Agricultural Practices Could Help to Attain Environmental Sustainability in Ginger Production in Nigeria

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ABSTRACT This review was undertaken to identify the specific market requirements of major international buyers of Nigerian ginger (*Zingiber officinale*) and how adoption of good agricultural practices (GAP) could help to attain these standards. The paper carefully discussed the standards and compliance requirements for Nigerian ginger meant for export, review the activities of the agencies responsible for monitoring and ensuring compliance with the standards and concluded by evaluating how good agricultural practices (GAPS) could help to attain environmental sustainability in ginger production. Given that the GAPs certification is the precondition for admission of produce's sale in the international markets, adoption of GAPs such as soil and water resources management, improved land use management, restoration of degraded land, biodiversity conservation, integrated pest and fertilizer management amongst other agronomic practices would be necessary to attain these standards. However, current challenges in the adoption and application of GAP in ginger value chain in Nigeria include poor farming and marketing practices, lack of knowledge of the principles, practices and protocols of GAPs, lack of awareness on the availability of premium prices for organically - produced ginger, inadequacy of organic farm inputs, availability of diverse country specific standards, make it difficult for farmers to meet the GAP standards. These challenges notwithstanding, organization of Nigerian ginger farmers into easily accessible and manageable clusters/cooperatives is one of the major ways of addressing the challenges of adoption of GAPs in the ginger value chain.

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Nigeria is the third-largest producer of ginger in the world after India and China (Olife *et al.*, 2021). Available global production data indicated that India is responsible for 35% followed by China (18%) and Nigeria (11.5%) of the global and 77% of the total African production (Project Horizon, 2021). Several reports indicated that Nigerian ginger has superior quality compared to the ginger produced from the other parts of the World indicating ever increasing demand for the Nigerian ginger in the global market (Ikwelle *et al*., 2003; CBI., 2021) owing to increasing global population and multiple use of ginger as an ingredient in the food, drink, snacks and pharmaceutical companies particularly during the winter when ginger is consumed for prevention and treatment of sore throat or flu (CBI, 2019; SureChain, 2020; CBI, 2019; Lete and Allue, 2016). In Nigeria, ginger is mostly produced in Kaduna, Nassarawa, Benue, Niger and Gombe states. However, Kaduna state is the main ginger producing area of the country (FAO, 2017). Ginger is harvested on about 71,847 ha compared to Cameroon and Ethiopia 6,648 ha and 3,559 ha respectively (CBI, 2019). Despite the potentials of Nigeria in ginger production – availability of suitable land and favourable climate, increasing global demand, huge market gap, comparable locational advantage of Nigeria to the major global markets, higher oil and aroma quality of Nigerian ginger, Nigerian benefits from the ginger value chain is below optimum as a result of non –

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compliant with the produce quality by major ginger importers. Importing countries, companies, and civil societies are increasingly demanding producers of agricultural produce such as oil palm, soy, cocoa and ginger to demonstrate their commitment to reducing their environmental impacts (Jopke and Schoneveld, 2018) thus producers of agricultural produce are expected to maintain soil fertility, water quality, erosion control and minimize pests and disease (Jelsma *et al*., 2017) all these practices are summarily referred to as good agricultural practices (GAPs) (Lee *et al*., 2012; Gnych *et al*., 2015; FoBSKI, 2017). Good Agricultural Practices (GAPs) are collection of farm practices and or off – farm activities which are undertaken in the production and handling of food and non – food agricultural produce with adequate consciousness of environmental, economic and health of the producers, consumers as well as other users of the produce (FAO 2010; Lefebvre *et al*., 2015). Or Good Agricultural Practices (GAP) are principles, protocols and guidelines set for producing / achieving production of safe food and quality produce which are free from physical (soil particles, dirt), chemical (pesticides, heavy metals) and biological (microbial contamination) residues / impurities without compromising environmental and workers' safety (Saravanakumar, 2021). GAPs cover a range of activities such as maintenance of soil fertility, water resource and irrigation management, cropland management, degraded land restoration, animal production and welfare, integrated pest management, integrated fertilizer management and conservation agriculture (Fig. 1), attainment of produce quality and traceability, premium price, sustainable ginger supply chain (integrity) and in fact, in meeting the requirements of the importing countries for procurement (FAO 2010). GAP has potential of contributing to improved land use efficiency, decreasing greenhouse gas emission, reducing environmental degradation and thus helping to reduce agricultural encroachment onto forested land by limiting conversion of ecologically significant lands (Foley *et al*., 2011; Henderson *et al*., 2015). The aim of introducing and applying GAPs in agricultural value chain is to ensure that the agricultural supply chain is safe, regenerative and sustainable on a long - term basis (Ali, 2014) while also improving the produce traceability, quality, market value and by extension the livelihood of the growers (Poole and Lynch 2003; FAO 2010) and conservation of the natural resource base upon which the agricultural production depends in the first instance (Muhammad *et a*l., 2014). Observance of Good Agricultural Practices (GAP) which encompasses Good Environmental Practices (GEP) and Good Social Practices (GSP) in agricultural value chain would be helpful in protecting the workers' rights and dignity as defined by the International Labour Organization (ILO) convention.

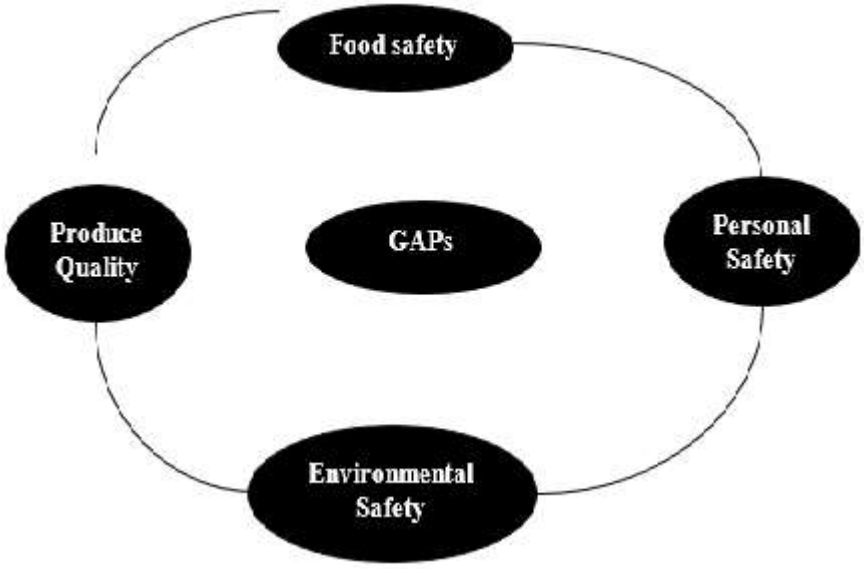

Fig. 1: Schematic diagram of the objectives of Good Agricultural Practices (GAPs)

Smallholder farmers particularly lack the requisite knowledge, required resources and the will power to facilitate compliance with GAP principles and protocols (Prokopy *et al*., 2008; Brandi *et al*., 2015) thus minimizing the access of their produce to the global market (Henson and Humphrey, 2010; Jaffee et al., 2011; Lee et al., 2012). Nigeria ginger smallholder farmers are the fastest growing are mostly confronted by these compliance barriers (Jelsma *et al*., 2017; Schoneveld *et al.,* 2019a; Schoneveld *et al*., 2019b)

because of they are scattered, not organized and their overreliance on the middlemen for market access (FoKSBI, 2017; Jopke and Schoneveld, 2018) thus posing risks to their produce integrity (Gnych *et al*., 2015; Jopke and Schoneveld, 2018). Smallholder ginger farmers in Nigeria rarely receive financial support and requisite training required to comply with GAP, compared to their counterparts from other parts of the World (Prokopy *et al*., 2008; Brandi *et al*., 2015) and these barriers to compliance with GAP would minimize the produce quality and market access (Henson and Humphrey, 2010; Jaffee *et al*., 2011; Lee *et al*., 2012). Adherence to the GAP in ginger value chain would ensure achievement of premium market price, traceability as well as global acceptability for the Nigerian ginger. Adherence to GAPs is advantageous in imporoving the livelihood of the producers for instance, GLOBAL GAP certified agricultural produce attracts additional USD 1,100 - 1,500 per tonne above the prices for the conventionally grown produce. Specifically, organically certified dry splits, powder and ginger oil fetch additional USD 2,500 - 3,000; USD 7,000 - 8,000 per tonne and USD 1.8 per ml compared to conventionally grown ginger (CBI, 2019; Otaiku, 2020) as the international market price for organically grown ginger ranged between $6,000 and $7,000 USD while the conventional ginger was sold for $3,500 (CBI, 2019; Otaiku, 2020; Nigerian Ginger Farmers Association, 2021). So also, in 2017 in Nigeria, the market price for organically grown cashew nut was $4000 per ton while the conventional cashew nut was only sold for $2400 / tonne. More recently ie between 2015 and 2016, the European Union rejected 64 food items including cowpea imported from Nigeria due to higher concentrations of the impurities (glass fragments, faeces of rodents, and dead insects) above the maximum allowable limits by the European Union (Ogunfuwa, 2017). So also, the adoption of improved agricultural practices through the use of organic manure and agroforestry increased the market value of Myanmar ginger to about $6,000/ha indicating that the GAP produced ginger better valued than the conventional ginger (Flaming *et al*., 2019). Food safety concern is an integral part of food security which has gained prominence as a way of protecting the consumers from the hazards of foodborne illnesses and increasing competitiveness in the global export markets thus has formed the major requirements by food importing countries. Food safety hazards may occur at different stages of the food production, processing, storage, distribution and packaging. Therefore, most food importing countries now request the producing countries to implement GAP as a prerequisite for procurement to ensure the quality and safety of their produce. Despite this need, enough attention has not been drawn to the adoption of GAP in the ginger value chain in Nigeria. Therefore, this review is undertaken to identify the specific market standard requirements of the major international buyers of Nigerian ginger and how adoption of good agricultural practices (GAP) could assist to attain these standards.

Standards and Compliance Requirements For Nigerian Ginger Meant For Exportation: Since India, Germany, Morocco, the UAE and Egypt are the major destinations for the Nigeria ginger, with a combined trade value of USD 23 million in 2018 (CBI, 2019), the general standards for ginger in these countries are summarized as UTZ, Rainforest Alliance, Fairtrade, Organic, Global G.A.P, Organic, BRC, HACCP, FDA, Halal, ISO, IFS, European Spice Association (ESA), ASTA, USDA, NOP, EC834/2007,889/2008, ECO CERT (Paschall and Seville, 2012).

Table 1. General Country - specific Conformity Standards for Ginger

Country	Quality Requirements for Production and Imports
India	The Food Safety and Standards Act, 2006 The Legal Meteorology Act, 2009, and the Legal Metrology (Packaged Commodities) Rules, 2011 Plant Quarantine (Regulation of Import into India) Order, 2003 The FSS Packaging and Labelling Regulation, 2011 FSS (Contaminants, Toxins and Residues) Regulation, 2011
Germany	ISO 1003: 2018 applies
Morocco	ISO 1003: 2018 applies
United Arab Emirates	Emirate Conformity Assessment Emirate Quality Mark Regulation Halal Regulation Organic Product Regulation
USA	Same as above Hawaiian grade standards
UK	BS EN 17474: 2020 BSISO 16928: 2014 BS ISO 1003: 2008
Pakistan	ISO 1003: 2018 applies
Netherlands	EU Product Safety Standards
Japan	ISO 1003: 2018 applies
Germany	The General Food Law Quality Minima Document – (ESA) for Ginger

Source: USDA, ISO, British Standards Institute

Moreso, there are also country specific quality requirements for ginger (Table 1) in addition to the general EU standards (Tables 2 – 4) on maximum levels of contamination (mycotoxins, salmonella etc.), maximum residue limit (MRLs) for pesticides, detergents, additives, etc. Other requirements mostly demanded by EU buyers include BRC, Rainforest Alliance, organic and fair - trade certifications. Specifically, ginger produce intended for sale in the EU market is required to adhere to EU regulation no.

396/2005 which specify the physical and the chemical parameters that the dried produce (ginger) must fulfill for it to be sold in the EU market.

Table 2. Tolerance level for pesticides residues in ginger under German Regulations

Pesticides	Tolerance limit (ppm)
Aldrin and dieldrin	0.1
Chlordane	0.05
Sum of DDT isomers	1.0
Endrin	0.1
HCH without Lindane	0.2
Heptachlor and epoxide	0.1
Hexachlorbenzol	0.1
Lindane	0.01
HCN and Cyanides	15.0
Bromides	400.0
Carbaryl	0.10
Carbofuran	0.20
Chlorpyifos	0.05
Methyl Chlorpyifos	0.05
Cypermethrin (sum of all isomers)	0.05
Deltamethrin	0.05
Diazinol	0.02
Dichlorvos	0.1
Diclofop methyl	0.1
Dicofol (sum of all isomers)	0.02
Dimethoate	0.5
Disulfoton	0.02
Dithiocarbamate	0.5
Endosulfan (Sum of all isomers)	0.5
Ethion	0.5
Fenitrothion	0.5
Fenevalerate (sum of all isomers)	0.5
Copper based pesticides	40.0
Malathion	0.5
Methyl bromide	0.5
Mevinphos	0.5
Omethoate	0.5
Parathion and paraoxon	0.05
Methyl parathion and methyl paraoxon	0.5
Phorate	0.05
Phosalone	0.5
Phosphamidon	0.05
Pyrethin	0.5
Quinalphos	0.01
Quintozen	0.01

Source: (Fikre and Kifle, 2013)

Table 3. Microbial Specification for Spice under German Law

Parameters	Standard Value (per gram)	Danger Value (per gram)
Total aerobic bacteria	10^5	10^6
Escherichia coli	Absent	Absent
Bacillus cereus	10^4	10^5
Staphylococcus aureus	100	1000
Salmonella	Absent in 25 grams	Absent in 25 grams
Sulfite – reducing clostrides	10^4	10^5

Source: (Fikre and Kifle, 2013)

These requirements include ash content: maximum 8%; acid insoluble ash: maximum 2%; moisture: maximum 12%; volatile oil: minimum 1.5 ml/100 gr. and SO_2: maximum 150 ppm. While cleanliness as specified by the American Spice Trade Association (ASTA) for ginger include whole insects dead (by count = 4); excreta mammalian (3.0 mg/lb), excreta other (mg/lb); mould (% by weight), insect defiled/infested (i.e. more than 3% mouldy pieces and/or insect infested pieces by weight) (% by weight); and extraneous foreign matter (1% by weight).

Table 4. EU Standards for Ginger

Parameters	Limit
Aflatoxins, B1 (ppb)	<5
Aflatoxin, Total (ppb)	<10
Sulphur Dioxide (SO_2) (ppm)	<10
Moisture (%)	<12
Water Activity	<0.60
Oleoresin (%)	>6
Essential oil (%)	>2.5
Ash (%)	<8
Sand Content (%)	<0.5

Source: (Fikre and Kifle, 2013)

International Agencies Responsible For Monitoring Produce Compliance with Standards: British Retail Consortium *(*BRC*)* is an internationally recognized benchmark for assisting the food industry in the UK and EU about food safety laws in order to assure customers' confidence in the produce quality, food safety and produce integrity in the UK and EU markets. BRC has been able to achieve this by insisting on BRC certification as part of the approval process for allowing produces sales and purchases in the UK and EU markets generally thereby reducing the incidences of customer complaints, products rejection and product recalls. BRC, being the first food safety standard to meet the Global Food Safety Initiative (GFSI) benchmark, has gained customers' confidence and acceptability over time.

Hazard Analysis and Critical Control Point (HACCP): HACCP is a procedure for handling food preparation such as to eliminate, prevent and or reduce hazards that are likely to occur as a result of consumption of some agricultural produce by killing the microorganisms or preventing the growth of microorganism that are responsible for the hazards in food. The HACCP procedures allow the growers to identify and safely manage any physical, chemical and biological hazards that could make the agricultural produce unsafe for consumption so as to reduce and prevent foodborne diseases thereby assuring food safety for the citizens. By the HACCP principles, the processors of agricultural produce (seafood, meat and poultry products) have been mandated to acquire HACCP certification before offering their produce for sale in the markets. HACCP achieve this by spelling out and monitoring compliance to the standards (Standard Operating Procedures (SOP's)) of basic

personal hygiene, sanitation and food storage standards that must adhere to by the food producers and processors such as to control biological, chemical and physical hazards that may emanate from consumption of agricultural produce.

Food And Drug Administration (FDA): Food Safety Modernization Act of 2011 (FSMA) is established to protect the citizens' of the United States of America from the risk of microbial contamination by suggesting and implementation of safety standards for growing and handling of produce meant for human consumption. The Food and Drug Administration (FDA) as the U.S. food regulatory agency established with the mandate to protect the citizens of the United States of America has been able to achieve her core mandate through the implementation of the produce safety rule which compels food producers / farmers to adopt modern, and preventive approaches in growing, harvesting, packing, and holding food crops such that the produce will be free from any form of physical, chemical and or biological impurities. The rule generally established minimum safety standards for growing and handling of fruits and vegetables meant for human consumption in such a way to minimize the risk of microbiological contamination that may occur during the growing and handling of agricultural produce particularly fresh fruits and vegetables.

Halal Certification has evolved over time from being a mere religious certification to a level of determination of wholesomeness of product in the international produce markets (Research and Markets, 2021). In Nigeria, Halal certification of produce has not attracted much attention because of lack of functional Halal certification body with international recognition (Annabi and Wada, 2016; Oyelakin and Yusuf, 2018; Mughal, 2017; Ramlan, 2021). Therefore, efforts must be made by relevant stakeholders in promotion of halal certification, training of relevant bodies in halal certification of produce and in recognition of National Halal Certification bodies / agencies in Nigeria for the promotion of halal products and certification (Annabi and Wada, 2016; Oyelakin and Yusuf, 2018) after the endorsement of Halal regulatory framework (Ramlan, 2021).

Agencies Responsible For Monitoring Compliance of Produce To The International Market Standards In Nigeria: Nigerian Agricultural Quarantine Service (NAQS) Nigerian Agricultural Quarantine Service (NAQS) and the National Planned Protection Organization (NPPO) are the agencies charged with the responsibility of phytosanitary (agrochemicals - pesticides, herbicides, fungicides) certification of Nigerian commodities. The Nigerian Agricultural Quarantine Service (NAQS) is statutorily, empowered to facilitates, inspects and certifies any agricultural produce leaving Nigeria to the international market for compliance with phytosanitary measures as regards the use of agrochemicals (CBI, 2019).

National Food and Drug Administration Comission (NAFDAC) NAFDAC is responsible for inspection and there is provision in the Drugs and Related Products (Registration etc.) Act 1996 (As amended) Pesticide Registration Regulations 2005 that inspectors should be trained and fully qualified. NAFDAC also defines those actions that will be considered as offences, and the consequences of the infringement, such as the revocation of a licence used in connection with the commission of the offence.

How Good Agricultural Practices (GAPS) *Could Help To Attain Environmental Sustainability:* Good agricultural practices help to achieve environmental sustainability and produce quality through the adoption of sustainable practices such as effective soil - water management; degraded land restoration; integrated pest management and selection of drought tolerant cultivars. GAP practices in agricultural production include reducing, capturing and or storing emissions. To reduce emissions, farmers could apply organic manure, alter manure management, reduce fuel consumption, switch to alternative sources of energy, produce biofuels feedstock. While agricultural management practices that could lead to sequestration of greenhouse gases (GHG) include: change in tillage practices, crop rotation, use of organic manure; improvement of water management practices, reduction in tillage / improvement in residue management practices, agroforestry, cover cropping adoption of new agricultural land management practices, cessation or adjustment of pre-existing agricultural practices (stop tillage or irrigation) that is expected to reduce GHG emissions and or increase GHG removal (Source Shoch and Swails, 2021) rotational commercial crop, continuous commercial crop with cover crop, rotational commercial crop with cover crop, double cropping, relay cropping, intercropping of cover crop with commercial crop during the same growing season, increase of row spacing, application of organic manure, non-removal of mother rhizomes, cutting rhizome with clean knives, intercropping with other crops for shade and application of EM-5 solution for disease prevention, complete organic production (no chemical pesticides, herbicides or fertilizer), mulching with organic matter (VM0042, Version 1.0 Sectoral Scope 14).

Conclusion: Good Agricultural Practices (GAPs) are collection of practices aimed at producing and handling agricultural produce with adequate consciousness of environment, workers and users' health. Adoption of GAPs are recommended in ginger value chain in order to ensure that the produce is safe and sustainable thus meeting the requirements of the importing countries. Challenges in adoption of GAPs in Nigerian ginger value chain include inadequacy of organic farming inputs, diverse country specific ginger standard requirements, lack of awareness of GAPs practices in ginger farming. These challenges notwithstanding, organization of Nigerian ginger farmers into cooperative societies is an important way of overcoming the challenges as farmers in cooperative societies have access to innovations, subsidized inputs and markets.

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