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Beyond COVID-19 pandemic period: Strategies for sustainable livestock feed and food production

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***Target Audience:** Nigerian Government, Policy makers, Feed producers, Farmers, Food suppliers, General public*

Abstract

Since the detection of first case in Nigeria on the 27th February, 2020, the number of confirmed COVID-19 cases has been risen exponentially. The prescribed guidelines to curb its spread including physical distancing, travel restrictions, partial or total closure of food production and market outlets further disrupt timely access to nutritious foods, thereby threatening food security. Achieving sustainable feed-food supply beyond this period calls for prompt implementation of reforms, policies and intervention responses across each sub-unit of feed-food production chain. Stern measures should be put in place to ensure that we produce what we consume while Nigerians should be willing to consume what we produce locally.

***Keywords**: Agriculture, COVID-19, Food security, Livestock feeds, Supports, Welfare*

Description of Problem

Over the past decades, the entire world had been ravaged with several epidemics and pandemics including Spanish flu, Asian flu, Hong Kong flu, HIV/AIDS, West Nile Virus, SARS, African Swine Fever (ASF), Ebola, H1N1 influenza and Lyme diseases (1, 2). The emergence of novel strain of corona virus in late December, 2019 which caused viral pneumonia has thrown the world into serious crises. The coronavirus disease (COVID-19) is a communicable respiratory infection caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The rise in the number of confirmed cases and death rate across the globe compelled the World Health Organization (WHO) to declare COVID-19 as a pandemic (3).

The increasing rate of these outbreaks might be attributed to the climate change, disruption of ecosystem, land use change for industrial agriculture, deforestation, biodiversity loss, and the removal of essential protective barriers (1). More so, the zoonotic nature of these infections, as they could be transmitted through wild and domesticated animals, and higher rate of human-wildlife contact has heightened the rate of spread of these diseases in recent times. As the search for appropriate medication and vaccine for COVID-19 continues, part of the prevention strategies adopted globally to curb the spread include social distancing (about 2 metres apart), strict personal hygiene, travel bans and vehicle movement restrictions with waiver for livestock feeds and human food items (Figure 1).

Achieving a sustainable food production to feed the massive populace has been posing a serious challenge to most developing countries across the globe, particularly in Sub-Saharan Africa (4). Unprecedented population surge in recent times far beyond the earlier infinitesimal rate of growth, high prevalence of poverty, double burden of endemic infectious, non-communicable diseases, and the negative

impacts of global warming and climate change on feed-food production chain are among the critical factors responsible for such food insecurity (5). This problem has been made more critical by the current COVID-19 pandemic which, apart from the tragic human health challenges, had also limited the production and distribution efficiency of feed and food industries, and had crippled the timely accessibility and affordability of foods by the people (Figure 1). Efforts to cushion hunger and malnutrition during this difficult time led to the sharing of palliatives in various measures by the world bodies, government at all levels, ministries and agencies, organizations, and individuals (1). However, this noble action has its shortcomings as it could not solve all the consequential effects of the pandemic and lockdown associated with it. Unlike many European Union countries that are self-sufficient in several agricultural products, most developing countries such as Nigeria have very low self-sufficiency rate, in that the proportion of grains and animal foods consumed is significantly lower when compared with those that comes from raw products produced within the country. Thus, heavy dependence on production inputs and food imports from both regional and international markets remains a viable option to satisfy their nutritional demands.

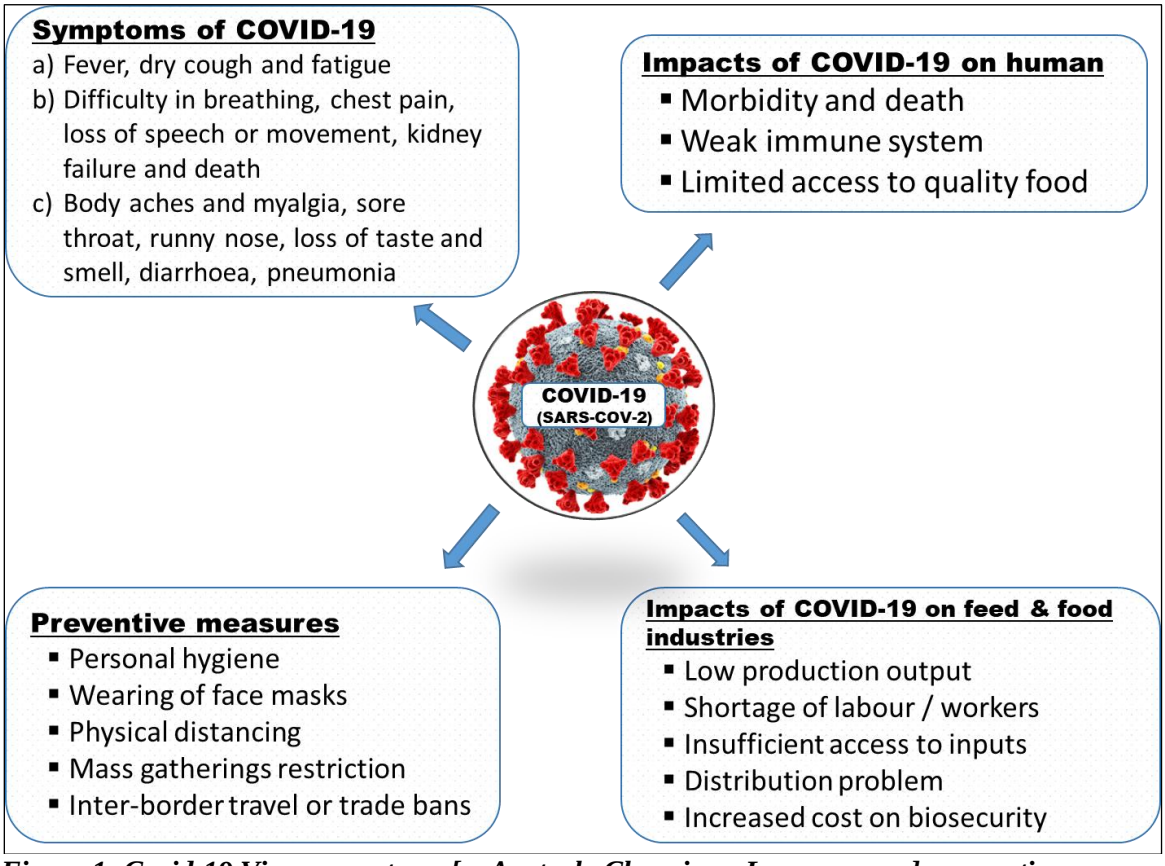

Figure 1: Covid-19 Virus: symptoms [a. Acute, b. Chronic, c. Less common]; preventive measures and impacts on man, feed and food sectors (FAO, 2020; Poudel et al. 2020; Tijjani and Ma, 2020)

Evidently, challenges which ensued from the current pandemic has outspanned the health sectors. Therefore, efforts to accentuate its direct and indirect effects on agricultural production, livestock feed industry (feed additives and finished feeds), agro-allied sectors, marketing and distribution outlets, and economies of food production would assist greatly in adequate planning and implementation of policies and programmes to achieve food and nutrition security during and after the pandemic. In view of this, this paper addresses the implications of COVID-19 pandemic on livestock feed and food production chains, access to nutritious foods vis-à-vis food demand and food prices, possible ways to mitigate post-pandemic food crisis, and sustainable food policies for the future.

COVID-19: impacts on food security and vulnerability of livelihoods in sub-Saharan Africa (SSA)

The second goal of the United Nation's Sustainable Development Goals tagged 'Zero Hunger' which aim to end all forms of hunger and malnutrition, achieve food security and improved nutrition as well as sustainable agriculture necessitates the need to intensify efforts on sustainable livestock production systems. Increase in population growth at tremendous rate has informed the prediction that 3 billion people are expected to join the current world population by 2050. The population upsurge and changes in consumption patterns had revealed that there will be a significant increase in demand for high quality protein such as milk, meat, and eggs (6). Therefore, there is a pressing need to address how to achieve food and nutrition security both locally and globally.

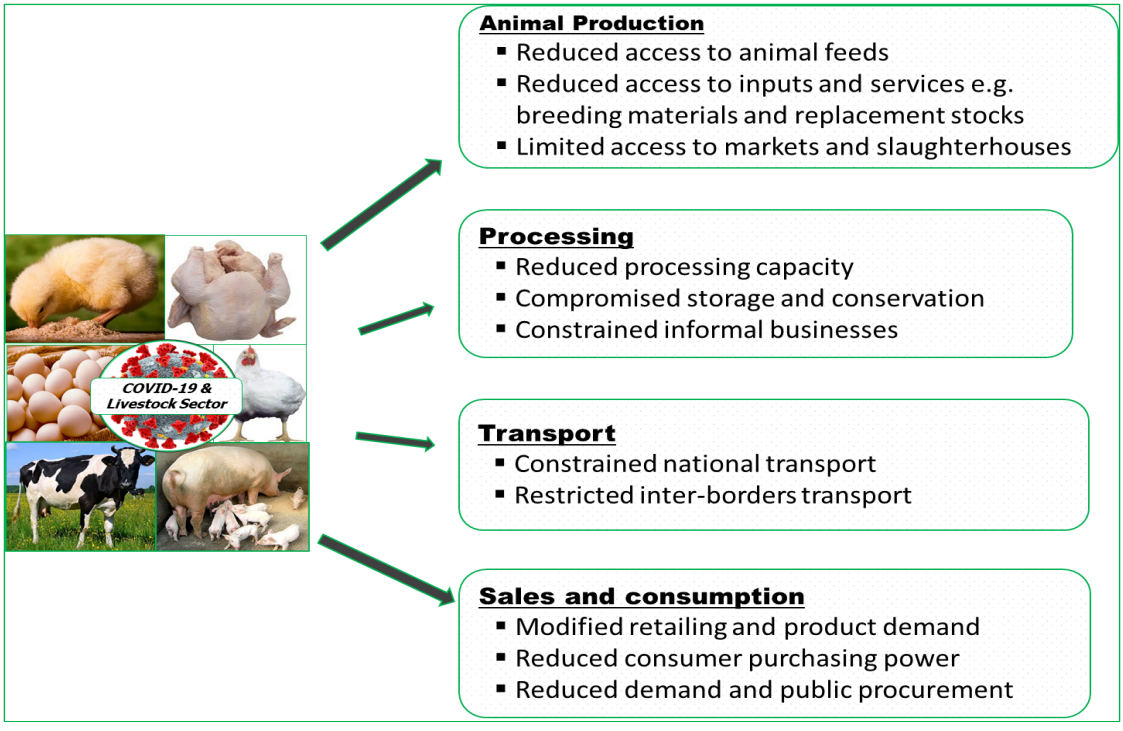

Figure 2: Impacts of COVID-19 on Livestock sector (FAO, 2020)

Previously, sub-Saharan Africa (SSA) was rated as the second region of the world with higher people suffering from chronic hunger, under- and malnutrition after Asia Pacific region due to the 2011 global food crisis (4). This is evident by the insufficient food production, inadequate dietary intake below the recommended levels, as well as poor nutritional value of food consumed. Heavy dependence on importation of food items whose prices are increasingly high and volatile due to significant currency depreciation (high exchange rate) has contributed to this menace. A report from the World Bank Group dated May 28, 2020 noted that food insecurity will become worse, and that the poorest and most vulnerable people will be the worst affected even though more than 820 million people were already chronically food insecure before Covid-19 crisis (7). Nigeria is rated the poverty capital of the world with an estimated 87 million people living on less than $2 a day threshold. Unfortunately, about 75% are in rural areas who cannot afford high-valued foods. In Nigeria, millions of children rely on school nutrition programs as one of their primary food sources, making them highly vulnerable to hunger due to school closures (2,5). Meanwhile, eggs and other livestock products (chicken, meat, milk and fish) seem not to be adequately included in the relief package provided during the pandemic to support livelihoods (5). Thus, the lockdown occasioned by the pandemic would impact major repercussions on food and nutrition security of children living in poverty or below poverty line.

Implications of COVID-19 pandemic on livestock feed and food production and supply chains

Proper livestock feeding is the supply of a diet balanced in all nutrients and free from deleterious components, at a level that meets the production objective, considering the animal's physiological state, and generates animal products that are safe for human consumption. As at 2011, the Food and Agriculture Organization of the United Nations (FAO) had projected the need for about 70% increase in the existing animal feed production in order to meet the global demand for food security. Finished feed comprises of various ingredients which provide energy, other essential nutrients and non-nutritive additives required for optimal livestock performance. In developing countries, maize is an excellent and most popular source of energy while soybean meal and fish meal are the major sources of protein and amino acids in practical poultry diets. Meanwhile, almost all the raw materials needed to produce vitamins and trace minerals premixes in livestock feeding are manufactured and imported from Europe, Americas and Asian continents.

In the previous years, shortage in feed resources to meet the animals' need has been attributed to the lingering competition between animal and man for conventional feed resources (8). Increasing demand for agricultural land-use for crop production and global warming caused significant decrease in crop yield. The coronavirus pandemic had also made matters worse (9). Local crop farmers in Nigeria noted that chunks of grains are decaying in stores, and as such incurred losses to the tune of millions of naira (Ajeigbe, Pers. Comm.). While some farmers are willing to sell at ridiculously low price, yet no patronage from off-takers because there is no enough money in circulation. Although feed additives manufacturing companies were recognized to be on essential duty, majority of those companies were forced to halt operations in that they had to reduce the employee's presence by half in the production area in order to curb the spread of COVID-19. Thus, the production output reduced to nearly half its full capacity. In addition, they were forced to operate upon strict compliance with the

preventive measures for the protection and safety of its employees, thereby causing them to incur more expenses on personal protective equipment and biosecurity of the staff and workplace (9). Travel restrictions across country's borders had affected supply of raw materials needed for livestock production (2). Importation charges have increased while exchange rate becomes more unstable. Hoarding of available ones by the local distributors and the transportation logistics due to lockdown have led to hike in prices. All these might contribute to increase in cost of feed production, and reduced profit margin for feed producers.

COVID-19 pandemic has crippled livestock sector, especially the poultry industry, across the world (Figure 2). Unlike other sectors where production can be adjusted to suit market demand, poultry farming is so peculiar in that production level could not be stopped or reduced significantly overnight. Hatching or table eggs are being laid continuously by laying hens. The eggs could not be stored indefinitely, thus they have to be sold or set in the hatcheries to minimize storage loss and prevent wastage. However, the pandemic made it near to impossible to sell eggs and day-old chicks both within and outside the countries. There has been a slump in demand for raised birds (broiler chickens, turkey and cockerel) which resulted into oversupply crisis and concomitant reduction in the unit price of poultry meat by between 8.4 and 37%.Most farmers in SSA often raise livestock in preparation for high sales and premium prices at festive periods such as Christmas, Easter, Eid al-Fitr, and Eid-ul-Maolud. Cattle, ram and chickens usually fill the spaces along the highways and the markets bustle with people preparing to celebrate the festivals with delicacies made from animal products. Due to coronavirus pandemic, livestock production and trade had declined because of markets closure and fear of low patronage envisaged by farmers (Figure 2). Majority of rural smallholders would not be able to sell their farm products as and when due, thereby depriving them of a source of income. Meanwhile, they will be forced to feed their animals on maintenance ration which will increase their cost of production, or increase the pressure on feed resources. Health management of the flock in case of incidence of disease outbreaks would also require extra costs which could further deplete the financial resources of farmers' households.

Unlike in western countries, feed and food production systems in African countries is more labour-intensive. Thousands of casual labourers are usually involved in such activities including supply of feed ingredients, feed manufacturing, livestock rearing, slaughtering and delivery in order to produce animal protein foods (meat, eggs, and milk) for the populace, and this is applicable to many other food commodities. Shortage of manpower due to health threats posed by COVID-19, sickness and absence among these workers would had adverse effect on production, as well as the welfare of the food animals made available to consumers (5, 9).Another indirect impact of this current pandemic is the retrenchment of workers and/or pay cuts in the wages or salary of workers. Poudel *et al.* (2) quoted International Labour Organization (ILO) which estimated that about 2.7 billion workers across the globe lost their jobs due to partial or full closure of their work places. In Nigeria, the job loss would have increased the unemployment and under-employment rate far above the 23.1% earlier reported by the National Bureau of Statistics (which year) while downward review of salary would have heightened the financial stress of poor families. Inter-state travel bans might also curtail transport of livestock products from farms to the potential buyers in the urban centres.

Access to quality food: Effects of COVID-19 pandemic on food demand and supply

Having unrestricted access to nutritious foods is the hallmark of food security. Beyond the need to attain satiety, nutrients in foods give vigour and vitality. More so, nutritional components such as amino acids, energy, vitamins and minerals are required to activate and boost the intense immune response against infectious diseases (10). Hence, food availability and affordability have been disrupted by the lingering COVID-19 pandemic is of global concern. Obviously, global food supply chains has been impeded by COVID-19 pandemic. Generally, some of the factors influencing food demand include population growth, income level, urbanization, educational status, and marketing strategy (Figure 3). Meanwhile, continuous access to quality food was impaired by reduction in food production both locally and globally, food price, hike, post-harvest loss, changes in purchasing practices as well as inter-border trade and vehicle restrictions (Figure 4).

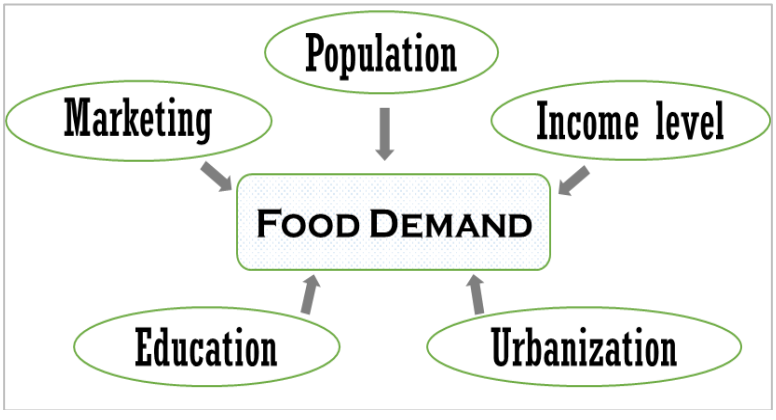

Figure 3: Factors affecting food demand

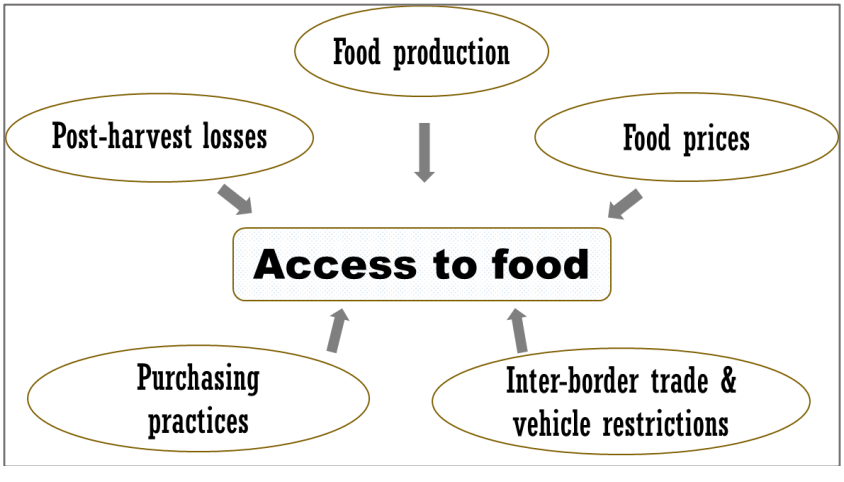

Figure 4: Factors that influence access to quality food during COVID-19 pandemic

While more than half of the nation's population live in urban centres (7), higher proportion of domestic food production comes from the rural settlements.Inadequate processing and storage facilities has worsened the post-harvest losses. During this pandemic, production and processing factories are either shutting down or cutting down production output whereas consumers strove to stockpile some staple foods for the fear of lockdown and 'stay at home' order (9). Partial or complete closure of markets hinder small-scale livestock producers to sell their live animals while the activities of intermediaries, who collect farm produce for further processing or retailing were severely disrupted. Thus, hoarding and limited food supply had crippled availability of foodstuffs to the urban dwellers (2,3). Marketing has taken a new shape. E-commerce platform is increasingly employed as the direct distribution channels for goods and food items to the consumers. Consumers shifted toward online platforms and supermarkets to secure the groceries and other essential needs, especially in areas where informal markets are being closed or constrained (9). However, in areas with limited e-marketing channels for local products, farmers might not be able to sell their produce at the right time and profitably. In addition, increase in food price has further inhibited equitable access to quality nutritious foods especially among highly vulnerable groups with limited resources and resilience (1,7).

Post-pandemic era: combating the future pandemic on feed and food supply

How soon the COVID-19 pandemic and its attendant effects will go away could not be accurately predicted. However, it is evident that food and nutrition crises, economic setback, and corruptions ravaging our commonwealth in this nation will still linger for months or years ahead. Hence, proactive steps aimed at protecting the livelihoods and food access of the most vulnerable people need to be reinforced. Therefore, it becomes imperative to explore available opportunities and strategies to re-orient the feed and food systems in a sustainable and eco-friendly manner. Concerted efforts should be geared towards the following measures:

a. Crop and pasture production: Producing food crops such as cereals, pulses, root tubers, fruits and vegetables above our consumption level is not impossible in Nigeria. Truly, we have large expanse of fertile agricultural land and some agricultural machinery are available at the custody of Ministry of Agriculture. Yet, we practice more of subsistence farming. More than ever before, the reality has dawned on us to support farmers and farmer organizations with access to farm machinery, inputs and fertilizer to boost their production capacity. To curtail problem of feed scarcity for ruminant animals during dry season, establishment of grazing reserves could be properly re-introduced as part of livestock production transformation policy in Nigeria. Pastures and grazing reserves would supply forage needed to support ruminants all year round, ensure efficient and sustainable resources use, and also reduce conflicts between farmers and pastoralists. Meanwhile, all relevant stakeholders need to be adequately informed of the pros and cons of grazing reserves without any political and ethnoreligious sentiments.

One of the perennial problems of agriculture in Nigeria is inadequate processing and storage facilities. This is grossly responsible for high post-production loss in agri-food systems. Hence, government should provide modern processing plants and storage facilities for forage conservation and produce from crop and livestock farms to ensure food availability all-year round while minimizing wastage. More so, bail-out supports and subsidies could be made available to key

players and stakeholders in feed and food industry, including toll feed millers and local farmers, so that they could survive and maintain, their pre-pandemic production level.

b. Alternative feed resources and utilization: As larger proportion of livestock feed resources are imported, sustainable livestock feed production requires the need to further intensify efforts on efficient utilization of energy, protein and micro-ingredients from sustainable or renewable sources for inclusion in animal feed (6, 8). Previously, suitable alternatives which have been used to replace maize as energy feedstuffs in livestock feeding include sorghum (11), wheat (12, 13), cassava root meal (14, 15), and malted sorghum sprout (16, 17). Soybean meal, as the major plant protein source, has been replaced to a considerable degree extent with copra meal, rapeseed meal (8), castor oil seed meal (18, 19), shrimp waste meal (20), palm-kernel extraction by-products (21) and undecorticated sunflower seed meal (22).

Currently, insect meal produced from larvae of Black Soldier Fly (*Hermeti aillucens*) and house fly (*Musca domestica*) is receiving more attention as a viable replacement for fish meal and soybean meal in livestock feeding because it offers a means of producing protein that doesn't compete with human food production, in an eco-friendly and sustainable manner. Previous findings with PROteINSECT reported that feeding 2% crude insect meal and 1.25% extracted insect proteins produced similar performance in chickens (23). Makkar *et al*. (24), in a review, also opined that insect meal could replace between 25% and 100% of soymeal or fishmeal in the animals' diets with no adverse effects. Meanwhile, some of the major constraints to their maximal utilization in monogastric nutrition include high fibrous contents, presence of anti-nutritional factors like tannin, hydrocyanide (HCN), dhurrin and non-starch polysaccharides, poor protein quality as well as reduced concentration of essential amino acids. Various interventions to optimize nutritive value and efficient utilization of alternatives feed resources involves the use of appropriate processing techniques, fortification with single or multiple enzymes, and supplementation with free limiting amino acids (13, 15-17, 19).

Vitamins and minerals play crucial roles in efficient utilisation of bulk nutrients such as protein, carbohydrates and fats in livestock diets. Vitamins shortage was one of the major challenges faced by feed mill industry in Nigeria during COVID-19 pandemic due to port closures and shipping delays because they are mostly produced in Europe and Asian continent. Unfortunately, it is somewhat difficult to find feed-grade alternative to some of these vitamins in a concentrated form. Previously, in our laboratory, the efficacy of *Spirulina platensis*, a green micro-filamentous algae, as organic source of vitamin-mineral premix was investigated in the diets of broiler chickens. We found that 50g/kg of *Spirulina platensis* improved nutrient utilisation and health status of broiler chickens (25). Thus, *Spirulina platensis* could be used to replace conventional vitamins and trace mineral premixes formulated from inorganic salts and vitamin analogues in broiler nutrition. More research into organic and natural sources of vitamins and minerals in livestock feeding is hereby advocated.

c. Use of phytogenics – Phytogenics have a long history in human nutrition where they have been used as spices, flavours, food preservatives and medicines since ancient times. The use of phytogenics as feed additives is receiving more attention as alternative to antibiotics to improve animal's productivity due to their nutritional and health benefits (26). Phytogenics contain appreciable amounts of essential oils and oleoresins which exert antioxidant, antimicrobials, anti-proliferate,

hypolipidemic, detoxifying, taste modifier, digestion stimulating, and immunomodulatory properties. They also stimulate growth performance, improve immune status and enhanced liver functions (27). Positive effects of dietary feeding of phytobiotics (including ginger, garlic, nutmeg, Crina, cloves, Chaya leaf, and black pepper) on feed intake, body gain better feed utilization, and immune response in broiler chickens have been reported (28, 29). Phytobiotics enable production of safer and functional foods (meat and eggs) which offer better health benefits to consumers. More so, reduction of pathogenic gut microbes also minimizes the risk of food contamination during processing.

Improved environmental impact as a results of phytobiotics emanated from non-release of antibiotics residues into the environment (soil and water bodies) and utilization of waste products. Fafiolu *et al.* (27) explored the use of citrus peels, which constitutes the major waste products of the food and juice extraction industry, and found that Sweet Orange (*Citrus sinensis*) and Lemon (*Citrus limon*) peels enhanced growth performance, health status, and better gut health in chickens. Since part of the prescribed treatments for COVID-19 include the use of herbs and other natural products such as ginger, garlic, turmeric, neem leaf, pawpaw leaf, guava leaf, lemon, lime, orange, and honey. It is, therefore, expedient to include these phytobiotics in human and animal nutrition for prophylactic measure now and in future.

d. Change in dietary lifestyle –The perceived quality and convenience associated with the available snacks and fast foods as a ready-to-eat foods increased its patronage. However, owing to the health benefits, World Health Organization (WHO) recommends that there should be reduction in overall consumption of sugars and foods that promote high glucose response (30). This has led to the consumption of low-carbohydrate diets, slowly digested food products, and increased intake of functional foods (31). Dietary fibre (DF) is the edible parts or analogous carbohydrates that are resistant to digestion and absorption in the small intestine with complete or partial fermentation in the large intestine (30, 32).They are found mainly in cereals, fruits and vegetables. Dietary fiber and whole grains contain a unique blend of bioactive components including resistant starches, vitamins, minerals, phytochemicals and antioxidants (32). Nutritionally, DF has low energy value but its inclusion in foods enhances large intestinal function. It has important physiological effects on glucose, lipid metabolism and mineral bioavailability (32). Dietary fiber in human diets lowers serum cholesterol, reduce the risk of heart attack, colon cancer, obesity, blood pressure, appendicitis and many other diseases (31). On the other hand, resistant starch is part of some ingredients that assist in preventing and managing pre-diabetes and type 2- diabetes.

Wheat flour which is the major ingredient in snacks (cookies, cakes, biscuits) and bread production is largely imported to Nigeria with huge loss due to foreign exchange (31). Thus, foods scientist had been working on veritable substitutes with better nutritional quality and desirable functional properties for wheat flour. Composite flours are a mixture of flours from tubers rich in starch, protein-rich flours, cereals and/or vitamins and minerals-rich foods with or without wheat flour which are used for confectionery (30, 33). Potentials of composite flours produced from various crops such as unripe plantain and defatted sesame flour (34), instant plantain-breadfruit flour (35), orange-fleshed sweet potato and wheat flours (36), unripe cooking banana, pigeon pea, and sweet potato flour blends (33), unripe plantain and orange vesicle (30), and wheat flour, pigeon pea flour and sweet potato flour

(31) have been investigated. Benefits of such composite flours include supply of adequate dietary nutrients as various recipe complement each other to provide deficient essential nutrients and combat malnutrition problems. They also enhance utilization of crops that are adaptable to each regions, reduce importation of wheat which are relatively expensive, increase profit margins of farmers and bakers, prevents wastage due to post-harvest losses, increase farming and economic activities, thus ensuring food security in Nigeria. Composite flours are noted to contribute substantial amounts of dietary minerals, essential lipids and fat-soluble vitamins to consumers. They are known to be rich in macro-minerals which are essential for growth and repair, maintaining body fluid balance, cell function, and act as cofactors in various enzyme systems (33). Moreover, it could also be formulated into instant flours for convalescence and in the formulation of baby foods as these categories of humans require high levels of minerals for growth and repair (30). Therefore, bakers should embrace the use of composite flours in biscuits, bread, and snacks production. Citizens need to re-orientate their taste to embrace consumption of locally produced food products. This will enhance the productivity of domestic companies, create more employment opportunities and boost the nation's economy.

e. Present nourishing foods as gifts - As part of efforts to secure social protection for all Nigerians, community food and nutrition-support interventions should be intensified to protect the health and welfare of children, pregnant and lactating mothers, as well as other vulnerable groups (5). Considering protein foods, the importance of eggs and chicken in human diet cannot be under-looked. While the government order to close down schools has reduced egg consumption by school pupils on school feeding programmes, majority of the low-income families, especially the artisans and rural dwellers, now see eggs and chicken as a luxury and not a necessity as they strive to eat to survive. Also, food vendors which offer fast-cooked noodles and eggs have little or no patronage. Eggs are among the most available, affordable and wholesome protein foods. It supplies an appreciable amount of high-quality protein, essential amino acids, unsaturated fatty acids, vitamins and trace minerals needed for proper growth and body functions. Egg is highly nutritious and equally delicious. Noteworthy is the fact that eggs can be eaten by every segment of the population, from the infants to the adults. It can be consumed as whole food, part of a balanced diet, or as snack. Apart from being a rich source of quality protein, vitamins and trace minerals, chicken meat is rated and appreciated for their low cholesterol level, higher ratio of unsaturated to saturated fatty acids as a healthful alternative to red meat. Because of its low calories, it is recommended as a foodstuff for weight-control diets, convalescents and old people who are not physically active. The meat is tender, easily chewable, more digestible, and have a mild flavour that can be used along in recipes with other foods.

The benefits of including eggs and chicken in daily diets and palliatives are multi-dimensional. Daily intake of eggs and frequent consumption of chicken would guide against malnourishment and help to boost immune system. Eggs and chicken supply appreciable amount of vitamin A, folate, choline, phosphorus, selenium, vitamin D, riboflavin, vitamin B_{12}, biotin and iodine which all play contributory role in structural formation, development and optimum immune system function. These nutrients also slow cell ageing, autoimmune diseases, and DNA damage. Egg yolk contains antioxidants (lutein and zeaxanthin) that support eye function and minimize the risk of age-related macular degeneration. Therefore, providing eggs and

chicken for the citizens would lessen susceptibility to COVID-19 virus and other ailments. Offering freshly produced or processed chickens from poultry farms domiciled in our country gives a veritable platform of providing safe meat to the populace during this COVID-19 pandemic period. Previously, safety of frozen chickens imported to Nigeria had been a bone of contention. The issue is hinged on whether or not imported chicken is preserved with formaldehyde (also known as formalin). Consumption of formalin-preserved chickens may predispose people to terminal diseases including cancer, hypertension, liver and kidney diseases. Importation of frozen chicken had contributed to the set-backs in Nigerian poultry industry as poultry farmers have to contend with the low, unstable market demand. Thus, this current lockdown should be seen as an opportunity to ensure access to safe and affordable foods to Nigerians, and strengthen broiler production.

In addition, this simple act will not only prevent glut, minimize post-production wastage with resultant economic loss but will also keep the current farmers in business as they get better return on investment. Obviously, there had been drastic reduction in egg sales during this pandemic, and consequently, market price of eggs has dropped by about 20%. For instance, a tray of eggs earlier sold for ₦950 now goes for ₦750. Buying eggs to be included in the relief package would definitely increase the farmer's income level and purchasing power. Furthermore, prospective farmers and youths would be motivated to embrace livestock production and agribusiness as a promising and secured enterprises. Delivery would not be difficult since eggs and chicken are essential food commodities that could be transported across the country. Live and/or processed chickens can be purchased directly from the farm outlets or shopping malls, and distributed to the citizens either in fresh or frozen form. Eggs can be presented in durable packs to prevent breakage, and in various packs of 4, 6, 12, and 15 eggs per pack. Hard-boiled eggs in ready-to-eat form can be shared to encourage timely consumption by all, especially the children. Furthermore, company like Animal Care Services Konsult (ACSK) can be consulted to produce and supply coated hard-boiled eggs with longer shelf life. In view of this, I therefore appeal to governments at various levels, NGOs, religious bodies, philanthropists, and individuals to consider eggs and chicken as important contents of the food package or gifts to the citizens during and beyond COVID-19 pandemic period.

Conclusions and Applications

1. The plight of COVID-19 pandemic on livestock feed and food systems is glaring. Solutions to these problems are not simple but achievable, provided each segment of the feed-food supply chain receives the appropriate reform, strategy, approach and intervention responses.
2. Beyond mouth-saying, Nigerian government and relevant stakeholders should demonstrate strong political will to set up infrastructures for transforming agricultural production by supplying improved seeds, fertilizers, pesticides and tools to farmers. In addition, financial services in terms of subsidies, grants and credit facilities should be provided directly to rural farmers through mobile cash transfers to resume or boost farm operations.
3. Pastures and grazing reserves should be established and properly managed. The use of alternative feed resources should be adopted by livestock farmers. Dietary inclusion of phytobiotics in animal and human nutrition should be promoted. Agro-products should be transformed through value additions so as to elongate

their availability and enhance the overall acceptability by consumers. Rural-Urban road networks should be rehabilitated to ease transport of agrifood products to the local markets.

4. Nigerians need paradigm shift in dietary lifestyle by embracing consumption of domestic goods and food products. Beyond COVID-19 pandemic period, Federal Government of Nigeria and other supporting bodies should provide social protection for all Nigerians. In addition, public health nutrition programme should be intensified by maintaining and upscaling humanitarian food security and health services interventions to protect the health and welfare of infant and young child, pregnant and lactating mothers and other vulnerable groups.

Conflicts of interests

The authors have no known competing financial or personal interests. The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the authors in preference to others of a similar nature that are not mentioned.

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