

# Food from the Campus: Understanding Africa's Transition to Sustainable Urban FoodSecurity during the Covid-19 Pandemic

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## Research Article

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# Abstract

This paper takes a critical look at the 20-hectares research/demonstration farm at Bayero University Kano's Centre for Dryland Agriculture (CDA) in Kano, Nigeria. The paper examines how knowledge-based mode farm driven by scientific, ethical, and technological innovations contributes to ensuring some level of food security during the COVID-19 pandemic. The main research question driving the current study is: in what ways can universities demonstration farms support urban food security during pandemics? The study circumvented lockdown restriction challenges by deploying elevator pitch approach, walk-in interviews, document analysis, and covert observation to elicit the needed data for the study. The CDA farm produced several tons of variety of vegetables using its clean energy and locally recyclable water sources to secure food needs of some urban households during the lockdown. The ability of the farm to effectively embrace sustainable farming system suggests that transitioning to bioeconomy based food security is achievable and affordable in developing countries. Essentially, the paper recommends the need for universities to take a leading role and responsibility in promoting the principles of bioeconomy in agriculture through engagement and collaborations with municipalities and planned and unplanned urban communities in Africa's fast urbanising cities.

## 1. Introduction

The coronavirus (COVID-19) outbreak has caused the confinement of over one-third of the global population through lockdown and food supplies were affected widely concern (Galanakis, 2020). As far as food production and consumption are concerned this situation has brought to the fore the imperative of promoting sustainability in food chain. The impact of the pandemic is largely felt by the most vulnerable population groups such as the chronically hungry, small farmers, and malnourished children (Siche, 2020). Women are also in many ways negatively affected by the through increased stress from their increased but largely unrecognized care economy services to their households and other pandemic-related income plummeting (Power, 2020). Thus, in response to this challenge many governments and groups among other measures had to recourse to sharing food handouts to vulnerable groups such as the poor and homeless persons.

The coronavirus outbreak has once again confirms the extent of presumptions and phobias around food security challenges in developing countries. Indeed, long before the COVID-19 outbreak, the serious crisis of malnutrition and hunger Sub-Saharan Africa are well-known (Webb et al., 2018). Nevertheless, the coronavirus pandemic has overarching impacts on the global food supplies and this crisis is likely to extend to the post-pandemic times (Shahidi, 2020). For instance, UN FAO (2020) observed that food production is being affected by the new sanitary measures, changing consumer demands, border and transport restrictions, logistics and market access. Food safety culture has also changed as shopping for foods and other groceries is now considered to be one of the ventures through which people risk catching the virus (Desai & Aronoff, 2020).

In spite of the grave challenges that COVID–19 has raised for the global food demand and supply chains, it is important to understand that food is one particular commodity that is continuously needed during emergencies and it reaches people either delayed or on time. This is particularly seen in food hands out given to displaced persons as in the cases of conflicts, droughts, floods, etc. Whilst humanitarian agencies have experiences on food delivery systems, the situation during pandemics such as the Coronavirus appears to be more complex and complicated. In the case of urban areas where more than half of the human population lives, Mukiibi (2020) observed that COVID–19 has exacerbated urban food insecurity for the urban poor through skyrocketing food price amidst lockdown related job losses. As COVID–19 is likely to have affected more cities and towns in more complex ways, it is apparent that new food access architecture is urgently needed.

Recently, Barau (2020) observed that urbanization is rapidly depleting spaces for urban agriculture and hence the need to embrace innovative strategies such as zero-acreage farming (ZFarming) to foster urban food security. Beyond that, more attention is needed on securing safe and nutritious foods for urban citizens that are exposed to unhygienic and processed foods.

Hence, it is crucial to explore how cities and towns can plan to adapt and respond to food insecurity challenges associated with pandemics. It is important to stress that transformation to sustainable food systems requires a paradigm shift from agriculture-cantered to food-cantered policy and research framework (El Bilali et al., 2019). This kind of shift will enable countries and communities to attain long-term food and nutrition security as it relates to their availability and access by all, utilization, stability, resilience and efficiency. However, one of the best ways to achieve this in developing countries is through improvement of agricultural infrastructure and provisioning of new farm technologies (Boratyńska & Huseynov, 2017). Therefore, African countries need investments in new technologies and innovations to scale up food and nutritional security. It is suggested that African countries can improve their population wellbeing and food security by integrating urban food system into urban planning and implementation of the Sustainable Development Goals (SDGs) and in particular SDG 11—sustainable cities and SDG 2 – zero hunger (Barau et al., 2020). The vulnerable groups in African urban areas need particular attention as they may have nutritional and food needs that are different from rest of the population such as children, aged, pregnant and lactating mothers, severally malnourished displaced persons etc. In some instances, it was found that state humanitarian agencies supporting the displaced persons fleeing conflicts in North-eastern Nigeria were blind to their beneficiaries' dietary needs and preferences of these people when they move into other cities (Barau, 2018). In such situations and also during pandemics vulnerable people need to be supported with healthier foods by their host cities in developing countries.

At the moment, the challenges of food insecurity in developing economies is enormous. Agricultural economists are of the view that food security and economic development in most developing economies depend on structural, agricultural and dietary transformations (Timmer, 2017). In the first case, the situation involves the decline of agriculture's contribution to the GDP and employment and which ultimately creates scenarios for falling food prices, rising urban economic and industrial activities and financial instability which can be worsened by climatic uncertainties. The second case involves how

domestic food consumption changes, innovation, international trade, and policy changes reshape agricultural production system of a country. On the other hand, the third transformation typology has to do with how a country's households' patterns of dietary changes influence its patterns of food production and consumption.

Nevertheless, these transformation theories are for normal times and not for periods such as Coronavirus pandemic when food and nutrition systems are exposed to shortages, shocks and uncertainties.

The above theories have underscored the importance of innovation, instability, urban food and economy, dietary changes as well as the role of policy. All these key elements are critical to addressing and understanding challenges of uncertain periods. However, a major challenge that remains unresolved in sub-Saharan Africa is the inability of agricultural transformation to enable smallholder farmers to attain food and nutritional security (Ecker, 2018). Nevertheless, an example of an encouraging situation of dietary transformation in Ethiopia suggests that sub-Saharan African is witnessing remarkable improvement in the consumption of high-value foods such as animal products, fruits, vegetables and processed foods (Worku et al., 2017). Increase in the consumption of foods and quality of diet in Africa is a welcome development. However, aligning food consumption and production to sustainability pathways is also crucial in this region. Knowledge based food security enhancement is needed in developing countries and particularly sub-Saharan Africa. In this regard, universities and research centres have critical roles to play in enhancing food security during pandemics and epidemics.

Universities and research centres have great potentials to improve food security and nutrition particularly through their research and demonstration farms. For instance, studies have shown that 158 experiments from over 30 universities and academies of agricultural sciences in China proved that scientific farming reduces Nitrogen fertilizer use by 24% and increase yields by 12% (Zhang et al., 2012). Such significant changes were possible due to improved use of soils and water, application of good crop management techniques and use of elite varieties with high yield potentials. Therefore, universities and research centres in Africa need to do more in order to diffuse innovative and sustainable farming skills that would enhance the experiences of farming communities in sub Saharan Africa. This is necessary because in countries such as Nigeria where the extension services are too inadequate as the ratio of extension agent to farming families stands at 1: 2000–22,000 with some states having less than 40 extension agents (Ifejika Speranza et al., 2018). In other words, farmers in many Nigerian states would hardly see any extension agent during pandemics and epidemics. On the other hand, universities can have alternatives of reaching out to farmers and consumers through different methods of diffusing and dissemination of knowledge and innovation aspects of sustainable food production. Such abnormal times need knowledge based interventions that will help societies to fast track and circumvent traditional delays and red tapes. Indeed, social scientists have for long since recognized that calamities induce the processes of social change (Cohen, 2020). Therefore, it is assumed that COVID–19 is likely to catalyse transition to sustainability pathways such as bioeconomy in developing countries such as Nigeria.

This paper takes a critical look at the 22-hectares research/demonstration farm at Bayero University Kano's Centre for Dryland Agriculture (CDA). The aim of the paper is to examine how campus model farm driven by scientific and technological innovations contributes to ensure some level of food security during the COVID-19 pandemic. The main research question driving the current study is: in what ways can universities demonstration farms transform urban food security during pandemics? This paper may provide some insights into how scientific and sustainable farming system open windows of transitioning to safe food production and consumption by people within and around urban areas that were locked down during pandemics. The paper is divided into seven sections which comprise the introduction that explains the context of the paper and this is followed by a section on bioeconomy and food security. The third section describes the CDA farm and its components, while the fourth section explains its methodology. Section five and six explain the results and discuss their implications respectively while the concluding parts highlight the implications of the paper.

## **2. Bioeconomy And Its Potentials In Fostering Food And Nutrition Security In Africa**

The concept of bioeconomy revolves around addressing scarcity, wastage and pressure on natural resources and consequently it aims at adding value to sustainability pathways (Zwier et al., 2015). Thus, the concept encapsulates the need to develop alternative strategies to smoothen transition towards building resilient and sustainable societies. It is also defined as a complete societal transition that involves a wide range of sectors, actors, and interests (Priefer et al., 2017). In general, the idea behind the concept of bioeconomy promotes building solutions to grand challenges (climate change, food security, health, industrial restructuring, and energy security) which characterize current and future risks to human survival (Bugge et al., 2016). These challenges are neither limited nor restricted to a particular cluster of economies or geographical locations. Instead, they permeate boundaries and scales and their heats are shared by all humans and non-human residents of the planet. It has been pointed out that investment in bioeconomy is a solution for grand challenges and disruptions as it ensures sustainability in the food industry (Kristinsson & Jörundsdóttir, 2019). One of the lessons that coronavirus pandemic has brought up is the imperative for preparing for the alternative futures—which social scientists consider to be either in the fashion of business as usual; managed transition; chaotic transition; and managed degrowth (Wells et al., 2020). The authors have also conceptualized the Coronavirus pandemics as a kind of unprecedented meta-transition event that cuts across socio-technical regimes simultaneously and at different scale, pace, and pervasiveness. Given this situation, it is up to scientists, policymakers, and communities to seek for appropriate socio-technical responses that suits the nature of their vulnerabilities.

As enshrined in the concept of bioeconomy, any feasible responsible for securing food security for urban areas and others must conform to best practice that are socially and ecologically sound. Scholars have emphasized that the ethics of sustainable food production centre around four elements namely animals, nature, producers and consumers (Höglund, 2020). Thus, it is imperative to reduce harm for animals and

improve their welfare; for the environment consideration is on lowering impact on the climate and ecosystems; for producers: safe working conditions and good pay are crucial; and for consumers on the other hand, issues relating to health and access to food are of paramount importance. Recently, attention is shifting towards Responsible Research and Innovation (RRI) as a strategy to ensure that technological innovation consequences on environmental and social systems are addressed holistically (Gremmen et al., 2019). These issues are important in designing all forms of research, innovation, and development products in agricultural systems. In this regard, a number of researchers have argued that bioeconomy thrives best in an atmosphere of committed research and innovation policy (Schütte, 2018). Universities have critical roles to play in driving sustainability in many ways. For instance, Nejati & Nejati (2013) identified the four dimensions of the role of universities in mainstreaming sustainability through: community outreach, sustainability commitment and monitoring, waste and energy, and land use and planning. Community outreach is fundamental to ethics of sustainability since universities as repositories of knowledge have duty to support communities to live sustainably through their guidance, capacity and skills development and knowledge dissemination.

While such atmosphere is more established in developed economies, the situation may not be favourable in most developing countries due to poor investment in the bioeconomy from both public and private sector. Encouragingly, some African countries have experimented with some agricultural interventions schemes for communities ravaged by diseases such as the HIV/AIDS and such experimentations were found to be successful in improving livelihoods of vulnerable groups (Cohen et al., 2015). While the situation of the HIV/AIDS cannot be compared to the coronavirus pandemic, the example implies the need for African countries to design strategies for improving food security during pandemics. In particular, when it comes to strategising for securitization of food during pandemics, it is critical for governments to involve universities, innovators, and communities. It is also crucial to build such strategies on the fact that urbanisation is increasing food demand and at the same time dwindling the size of agricultural lands at urban fringes of developing countries.

There has been agitation among researchers for nature based sustainable urban agricultural systems for supporting sustainable city and food security in Africa (Barau et al., 2020). It is understandable that food insecurity challenges are invariably related to climate, water, energy, and land constraints which are more pronounced in dryland areas of the developing economies. Since the livelihoods of 70% of the sub-Saharan African population depend on rain-fed agriculture, it is apposite to recognise that climate change will invariably affect subsistent farmers and this will in turn result in dwindling of food production (Connolly-Boutin & Smit, 2016). While it is argued that increasing food productivity requires rapid increase in land productivity (Conceição et al., 2016), it is pertinent to add that the increasing land pressure and degradation of arable land undermines the future of global sustainable food production (Gomiero, 2016).

Some researchers have concluded that urban agriculture can only make limited contributions to food security in Africa given the low access to land by the urban poor (Badami & Ramankutty, 2015). It is pertinent to note that African cities are fast losing their critical role as sources of demand for rural produce (Andersson Djurfeldt, 2015). Urban food insecurity is increasingly becoming complex and

complicated as many challenges are affected by urbanisation and globalisation. For example, the proliferation of supermarkets that sell agricultural products is undermining informal urban food production systems in African cities (Crush & Frayne, 2011). This implies that any form of bioeconomy related food system must be inclusive and supportive of the livelihoods of the poor. At the moment, urban and peri-urban food security challenges need more interventions and innovations as there is a disconnect between this system and urban governance in African countries (Smit, 2016). In other words, cities and towns must strive to attain some level of sufficiency of essential food commodities.

It is well known that during the Second World War cities like London were able to maintain some level of food sufficiency through the efforts of households to cultivate some vegetables and crops through the so-called Victorian gardens (Brown, 2013; Han & Go, 2019). However, the COVID-19 pandemic has shown that urban citizens in developing countries are vulnerable to food insecurity in a way higher than their traditional food deficits. Africans in particular can only consume less than 50% of the recommended 73 kg per person per year (Yang & Keding, 2009). As many governments shutdown cities and towns, the public access to clean, safe, and nutritional food supplies became more difficult and costly. Some researchers have warned that it is imperative to plan for the necessary specifications for delivering complementary food for people in need during crisis (Theurich & Grote, 2017). Consequently, the COVID-19 pandemic has opened windows for researchers in universities and research centres to investigate the strategic importance of bioeconomy-driven farming system in African urban areas. Such knowledge interventions should digress from traditional research practices that exclude the people. As a matter of necessity research and innovation initiatives for all purposes must ensure that ethical and societal values are well integrated and must avoid erosion of public confidence in them (Novitzky et al., 2020). Therefore, any research based intervention for addressing pandemics should put the people first and at its core.

### 3. Study Site

- ◦ Description of Centre for Dryland Agriculture (CDA) Demonstration Farm

This description is based on analysis of documents from the Office of the Director of the CDA. The farm was conceived in 2018 as a component of a knowledge and innovation value chain that comprises of laboratories (microbiology, soil and water analysis, food analysis), tissue culture facility, the farm (greenhouses, tunnels, shade net houses, open field, water and nutrient management, automated weather station), and a marketing component. The other components of the value chain provide pre- and post-production support services to the farm. The services include selection and multiplication of disease-free planting materials from tissue cultures, production of biopesticides from the microbiology laboratory for biological control of pests, analysis of soils and fertilizers to determine types and rates of nutrients to apply.

- ◦ Components of the Farm

The farm comprises of two green houses, three raised tunnels, three insect net houses and an open field of 20 ha. It is the largest scientific farm not only in urban Kano but in the entire Kano State. The farm is located within Bayero University Kano's New Campus.

- ◦ ■ Greenhouses

The first greenhouse with a dimension of 160m<sup>2</sup> (20m x 8 m) is provided for primary hardening of tender seedlings from tissue culture, while the second green house of 1,152m<sup>2</sup> (36m x 32m) serves as a vegetable nursery. The structures are covered with polyethylene (PE) and insect-proof net at the side openings. The side walls are equipped with rolling curtains made of PE. The green houses are fitted with mini sprinklers for irrigation and fertigation, and foggers for regulating humidity and temperature. The climate control system within the structures is based on water- circulation cooling pad (wet curtain) and 48" air suction fans and inner blowers which create air turbulence. The foggers, which are installed close to the inner top of the structure, are operated when temperatures are high such that micro drops will evaporate while falling down from the foggers and this will cool down the air temperature at crop level. The seedling production in the nursery is in polyurethane trays with conic holes filled with peat. The trays are placed on nursery tables and delicately irrigated with foggers at the beginning, and later with micro sprinklers with a small doze of water and nutrients and at a high frequency.

- ◦ ■ Raised Tunnels

The farm has three raised tunnels naturally ventilated polyethylene houses (poly houses) of 640m<sup>2</sup> area each. The structures have two segments arc as roof with an air vent to allow the chimney effect to drain out the hot air. They are covered with PE and with an insect proof net at the roof and side openings. The side walls are equipped with rolling curtains made of PE. The irrigation system in the poly houses is based on two drip lines for every 1.6m bed. Foggers are installed close to the inner top for controlling humidity and regulating high temperature days.

The poly houses are used to produce vegetables crops such as tomato, cabbage, sweet pepper cucumber and lettuce.

- ◦ ■ Insect Net Houses

Insect proof net houses minimize the penetration of insects, which are the vectors of viral diseases. The CDA Farm has two types of insect net houses, the first type with a dimension of 2080 m<sup>2</sup> is linked to the tissue culture facility for secondary hardening of seedlings before transplanting them into bags or pots for final transfer and transplanting on the field. The nets are green and provide 50% shading of light to protect the tender plantlets. The plants at this stage are irrigated with micro sprinklers until they reach full maturity for transplanting in the field. The bags or pots are placed on suspended plastic trays to avoid penetration of the roots into the soil.

The second type of insect net house is made of white nets which provide less than 25% shading of light. The CDA farm has two of such structure each 0.4 ha in area. The irrigation system in this type of insect

net house is based on 2 drip lines per row, with rows spaced 1.6 m apart. The net houses are also used for production of vegetable crops such as tomato, cabbage, sweet pepper cucumber and lettuce.

- ◦ ■ Open Field

The open field comprises of five hectares equipped with drip irrigation lines for fruit trees production, another five hectares of drip-irrigated fields for vegetable production, and five hectares of mini sprinkler irrigation also for vegetables production. The range of fruits planted include different varieties of citrus, mango, guava, grape, banana, and pawpaw. Each type of fruit tree has a separate valve from one irrigation control head. The five hectares vegetable plots equipped with mini sprinkler irrigation system are split into sub plots of one hectare each with inner roads for easy access (see Figure 1). Each sub plot has a control head for irrigation and fertilization. Each control head controls 4 electronic valves, this means that the smallest size of plot (sub-sub plot) is 2500 m<sup>2</sup>. Flexible distribution pipes run all along the field in the middle of the 5 ha plots, which give the possibility of closing down irrigation to part of the sub plots or to all of it.

- ◦ Water and Nutrient Management

The water requirement of the farm varies based on different stages of crops cycle; a budgetary peak water requirement was computed (Table 1) with 2 days storage for the smooth running of the farm to achieve target productivity. A sump with a capacity of two million litres was constructed for storing the water. The walls and bottom surface of the pond were lined with plastic film to avoid seepage, percolation, and lateral movement. Based on ground water prospecting, potentiality and well yield, about 10 bore wells were sunk to lift water and convey to the sump. The sump was positioned in such a way that all pumping units for drip, sprinkler, seedling green house, poly houses and net houses were installed and operated from one pumping station. Fertilizer tanks, nutrient injection and irrigation control systems are located in the pumping station. Thus, the farms operates independent of the municipal water as it draws its water locally with high potentials for recycling and renewal through rainwater.

**Table 1.** Summary of peak water requirement for the farm\*

S/N	Description	Peak water requirement per day (litres)
1	5 ha drip system for vegetables	250,000
2	5 ha Sprinkler System for Vegetables	250,000
3	5 ha drip system for fruit crops	250,000
4	1152m2 GH seedling + Cooling pad + fogging	15,000
5	3 Nr Raised Tunnels 640m2 each	15,000
6	Shade Net House TC Lab 2080m2	15,000
7	1 ha Shade Net house	50,000
	<b>Per day requirement</b>	<b>845,000</b>
	<b>For two days storage</b>	<b>1,690,000</b>

\* Peak water requirement was estimated at 5mm/day/ha.

- ◦ Energy Source

The energy requirements of greenhouses, poly houses and insect net houses are generated by a set of photovoltaic solar panels fitted on the roof of the pumping station and storage batteries placed in the pump house. All other irrigation system components including the bore well pumps, the pressure generating pumps at the outlet of the reservoirs, and the fertilizers injection system are powered by the Bayero University grid which takes electricity from a 3-megawatt solar station.

- ◦ Relationship of the farm with surrounding communities

In a bid to enhance the cordial relationship with the neighbouring communities, CDA identified 22 communities as its “adopted” villages. In the previous pre-COVID seasons, CDA has provided extension advice and improved seeds and processing equipment to the communities. The equipment introduced to the communities include multipurpose thresher, groundnut oil extracting machine, and crusher for producing livestock feed from crop wastes. In order to alleviate some of the disruptions in agricultural input supply chain due to the COVID–19 lockdown, CDA distributed improved varieties of cowpea, groundnuts and sorghum to farmers in the adopted villages. In this regard, one tonne of cowpea where 500 people each received 2 kg bags of seeds. The farm has also shared 11 bags of 70 kg of groundnut seed another 8 kg x 40 of sorghum seeds. The improved seeds are adaptive to the farmers’ climate and water stressed environment.

- ◦ Future Plans

The farm has planned to put in place an integrated system that incorporates aquaculture, poultry, and processing components into the current set-up. Deliberate effort will be made to ensure optimal recycling of wastes and by-products from the various components. Grains produced on the farm will be used in formulating poultry feed, while the poultry manure and wastewater drained from aquaculture will be used in fertilizing and irrigating crops. Part of the waste management strategy will also involve recycling through composting of plant and animal wastes. Vacuum freeze dryers and juice processing machinery will be acquired installed for minimizing waste and adding value to the farm produce.

## 4. Research And Date Methods

The current study coupled different sorts of data ranging from document analysis, observations and interviews. In particular, the study circumvented the challenges occasioned by the COVID 19 incidents where states imposed total lockdowns and other forms of restrictions that discouraged mobility and direct interactions of the public. The restriction in Kano, our study area which is an urban agglomeration proved more difficult as the lockdown was enforced more strictly as compared to rural and peri-urban areas. Thus, the study data covered period between March to June 2020. The researchers exploited the windows of the weekly one-day free lockdown given to families to restock their provisions to access study population who patronize the CDA demonstration farm. Thus, by cocktailing some established methodologies the researchers were able to solicit data relevant to meeting the study goal and research question.

Since study population many of whom are university staff have little time in the farm within which to make purchases and considering the lockdown and safety measures it was imperative for the team to use Walk-Along Interviews, and Elevator Pitch Approach as they tremendously simplify data elicitation from the respondents (Begley, 2018; Liu et al., 2017; Van Hecke et al., 2016). The authors had visited the farm weekly to make such observations and interviews with at least twenty six (26) willing respondents: 16 for the elevator pitch and ten for the walk-along interviews. Out of this number seven are females and the rest are males and this variation can be explained by the fact that men got more chances to move around than their female counterparts during the lockdown. The question asked cover quality of the products, pricing, accessibility, adequacy, diversity, information availability, ethical issues, and customer relations.

Similarly, covert observational method was used because it helps in observing respondents' behaviours under enclosed environment (Gajendragadkar et al., 2013). In this situation, we used the methods to observe respondents preferences for different farm products and also to observe some gender dimensions of farm patronage. We complemented these qualitative methods with content analysis of conversations between the CDA farm and customers who placed orders using WhatsApp and Telegram social media outlets. This was with a view to further appraise customer needs. The paper has also investigated the bioeconomy attributes of this science farm which ranged from its adoption of solar energy to power its greenhouse rooms, products diversity, science integration, waste recycling, water resource use, sanitation facilities, host community engagement etc. for ethical considerations the

consent of the participants was sought with exception of the individuals who placed orders since no individuals identity were exposed but their orders which they placed in the social networks that are open to all and sundry. Regardless of that, we posted a notice to all users that we had a look at their preferences for farm produce. Through its comprehensive and interdisciplinary approach, this paper is set to improve our understanding of the critical importance of bioeconomy related agricultural system within and around urban areas.

Another critical data used for the study was on the farm production and transaction extracted from the farm sales record. The data also enabled us to analyse variety of the farm produce and the waste produced. However, in order to understand the extent of the impact of COVID 19 on vegetable consumption using the CDA Farm as an example, we singled out two vegetables namely green pepper and tomato to exemplify the extent of the situation. Furthermore, this is also because the two products had an uninterrupted supplies for the time the data was collected. This analysis was made using descriptive statistics with support of Microsoft Excel.

Simple descriptive statistics was employed to describe the distribution of the farm produced. In order to assess the pattern of farm production over the study period. Similarly, we employed hierarchical cluster analysis technique as a similarity coefficient using the Euclidean distance. Prior to that the data were standardized such that the variance = 1, and the mean = 0. The clustering strategy used was the paired group method. In addition, the data was evaluated using the analysis of variance (ANOVA) and the results were compared by Tukey's and Student's t- tests at  $\alpha = 5\%$  using the JMP Statistical software version 15.0 (JMP, 2018).

## 5. Results

- ◦ Lockdown and Vegetable Purchase Patterns

During the coronavirus lockdown there was a general decline in the supply of fresh fruits and vegetables in urban Kano. The CDA farm was able to produce up several tonnes of 11 varieties of fruits and vegetation for their customers during the lockdown in Kano which essentially extended between March and June 2020. The items produced by them during the lockdown are given in Figure 2.

Some of the respondents confirmed this adding that the farm "satisfied our essential vegetable needs". Almost all respondents rated the quality of the products high and the price goods. When asked to shed light on this a respondent added that: "prices are cheaper than what obtains in the conventional markets in the town where lockdown caused high inflation and here you are more certain of the source and hygiene of the products."

For the purpose of isolating the impact of COVID 19 in this study, the period between March 2, 2020 - 26 June, 2020 was partitioned into 6 (Table 2) and evaluated. The rationale is to be able to clearly identify if the variations observed in the data collected are associated with COVID 19. It is important to recognize that Kano State underwent different patterns of lockdown and restrictions between March and June 2020

as shown in Table 2. This implies that restrictions have implications on people’s access to food items and also affected the nature of their purchases.

**Table 2:** Categorisation of timeframe within the COVID 19 pandemic in Kano (March 2, 2020 - 26 June, 2020)

Scenario	Attributes	Time frame
Pre-COVID (P1)	Normal condition	Week 10 -12
COVID-19 Partial (P2)	Interstate restriction; associated panic buying	Week 13 - early Week 16
COVID-19 Intense (P3)	Total lockdown	Week 16 – 18
COVID-19 2day-Relaxed (P4)	2 open days a week	Week 19 - early week 21
COVID-19 3day-Relaxed (P5)	3 open days a week	Week 21 – 25
COVID-19 4day-Relaxed (P6)	4 open days a week	Week 26

- ◦ Impact of COVID–19 on the vegetables supply in the CDA Farm

The seemingly two most available vegetables were analysed to examine the impact of COVID 19 on the food supply system. In the summary (Table 3), there seems to be a marked distinction between mean vegetable supply from pre and post week 16. This was synonymous to pre-COVID and COVI 19 periods. Thus, it appears there was variation between the production of vegetables sold in the different timeframes (weeks) and observed vegetables. In all the vegetables studied there was similarity in the pattern variation in supplies between weeks 10–19. For the basis of comparison and to further understand the behaviour of the variation in the observation, a cluster analysis was used. Cluster Analysis (CA) was carried out to identify in which period did more significant similarity/dissimilarity based on the variation in vegetable supply, and if this variation can be related to COVID 19 pandemic in Kano.

**Table 3:** Mean Distribution of vegetables supplied in the model farm

Green Pepper	Tomatoes
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Weeks	Mean Quantity (kg)	Min-Max	Mean Quantity (kg)	Min-Max
Week 10	3.40	2-6	40.80	7-85
Week 11	3.83	2-7	18.30	2-30
Week 12	5.20	1-9	45.42	5-120
Week 13	3.83	2-7	38.00	10-66
Week 14	1.90	0.5-4	-	-
Week 15	5.07	2-9	8.43	3-17
Week 16	12.70	1-31	28.75	10-49
Week 17	15.64	5-52	70.36	16-336.5
Week 18	5.83	4-8.5	59.43	18-170
Week 19	16.00	5-27	17.57	0-35
Week 20	-	-	22.71	0-80
Week 21	-	-	47.03	7-130
Week 22	92.25	3-348	14.67	5.5-45
Week 23	-	-	7.69	0-22.5
Week 24	13.00	13-13	14.60	9-21
Week 25	2.90	2-4	20.83	12-32.5
Week 26	1.67	1-3	9.17	4-12

Table 4 shows the variation in the mean supply of vegetable across the temporal scale for different COVID–19 scenarios. Although there was panic buying during week 15 and 16, it is important to point out some attractions. First, there was an increase in the take-up of the commodity owing to shrinkage in the supply system in the city. Secondly, the quality of product and the safety attached to cleaner production in the model farm attracted the campus community to patronise the farm products. One of the respondents suggested that she “trust the hygiene and quality of the products plus the good price.” Thirdly, the easy product booking via WhatsApp and Telegram, and home delivery services during the P3 period were some of the reasons for the pattern.

**Table 4:** Variation in vegetable supply across the different time frame in the CDA model Farm

Scenario/Time frame	Tomato (kg)	Green Pepper(kg)
COVID-19 2day-Relaxed	26.59±10.87ab	187.5±21.61a
COVID-19 3day-Relaxed	12.91±9.06b	5.75±10.8b
COVID-19 4day-Relaxed	15±21.74ab	1.87±15.28b
COVID-19 Intense	59.5±10.54a	14.5±8.47b
COVID-19 Partial	14.7±13.75ab	3.55±6.83b
Pre-COVID	35.5±10.87ab	4.11±7.41b
F-Value	0.0271*	0.0001*

Equal letters in the rows or columns do not differ statistically from each other by the Tukey test ( $p \leq 0.05$ ).

- Impact of COVID 19 on Farm Vegetable Production and Waste

There is an assumption that food loss and waste can be reduced at the household level if there is an effective resource utilization. To such a degree, we explored the extent to which this assumption may fit in at the farm level. Figure 3 shows the interaction of the quantity of vegetable supplied and the quantity of vegetable produced and wasted. Significant increase in vegetable loss and waste was observed during the P3 and slight extension into P4 for Tomatoes. However, this trend was only observed in P4 for green pepper. The result demonstrated an increasing trend in vegetable loss and waste as a function of increased production (Table 5).

Although there was price volatility in vegetable products during the P2 through P4 periods within the city, the demonstration farm had maintained fixed prices for commodities throughout the period as part of COVID response to the campus community and beyond. This situation has implications on the observed trends of waste increase if monetary value is factored into the system.

**Table 5:** Monitoring the influence of vegetable waste production at different time frame

Scenario/Time frame	Tomato (kg)	Green Pepper(kg)
COVID-19 2day-Relaxed	5.35±2.33abc	18.6±2.13a
COVID-19 3day-Relaxed	2.49±1.94c	0.45±1.06b
COVID-19 4day-Relaxed	2.25±4.67abc	0.03±1.51b
COVID-19 Intense	11.13±2.26a	1.41±0.83b
COVID-19 Partial	2.58±2.95bc	0.35±0.67b
Pre-COVID	8.71±2.33ab	0.53±0.73b
F-Value	0.0481*	0.0001*

Equal letters in the rows or columns do not differ statistically from each other by the Student's t test ( $p \leq 0.05$ ).

- ◦ Gender Dimensions of Farm Products Booking during the Lockdown

Looking at the CDA WhatsApp/Telegram social media platforms reveals some similarities with the above given statistical analysis. Two important gender patterns emerged from these sources which further highlighted the critical importance of gendered food security during the observed period of the pandemic. For instance, female customers placed more orders in both quantity and diversity of the products. Our covert observations, walk-along-interviews and elevator pitch also arrived at the same result. For instance, a typical and averaged order by a female on WhatsApp appears like: 5 crates of egg, 3 kilograms of cucumber, green beans, tomatoes, onions, and carrots respectively. On the other hand, men's order on average look like: 2 crates of egg, 2 kilograms of okra, and tomatoes respectively. Thus, women more than men stocked more vegetables during the intense lockdown period. Another important gender perspective revealed by this study is in relation to the decline of orders by female customers as lockdown was gradually eased in urban Kano. Again, compared to men, women made more online booking than men many of whom visited the farm to purchase products directly from the farm. We also observed instances where married couples visited the farm to make purchases and we considered such as joint decisions of the families. Three of our female respondents observed that the farm operators showed no discrimination on gender and rank of its customers.

## 6. Discussion

In discussing the results of the current study we pay attention on contexts of transition and transformative pathways followed by the CDA farm during the COVID-19 lockdown. We also shed light on the public consumption of the farm products while linking that to bioeconomy and urban food security during the peak period of the pandemic. In the first place, it is important to understand that the success of every transformation lies on the investments made to lubricate the transition processes. Thus, in the case of urban Kano, the presence of CDA demonstration farm has sowed the seed of transformation to

bioeconomy in agriculture. In this way, the farm has adapted and translated the concept and practice of bioeconomy in Africa especially during the pandemic. Essentially, the farm supports and operates on many principles of sustainability especially in relation to energy and water use and its focus on clean and safe production of vegetables. During the lockdown in Kano, the farm has been able to produce thousands of tons of vegetables which supports many families to secure their safe and nutritional food needs. The implication of this is that the farm can potentially help the consumers to meet their basic needs of vegetables which is estimated at 73 kg per annum per person and which is hardly met by many Africans (Yang & Keding, 2009). Given the success of the farm to support families with affordable and clean vegetables during pandemics, it must be stressed that the said success is never planned as no one foresees the pandemic coming. In other words, this implies that planning for bioeconomy can help urban areas to tap multiple benefits during normal and abnormal times (Kristinsson & Jörundsdóttir, 2019).

It is apparent that universities and research centres can effectively lead bioeconomy and sustainable food security development in developing countries and elsewhere. This study has proved that the CDA farm has successfully embraced the paradigm shift that enabled it to put into practice what El Bilali et al. (2019) considered as the imperative of transitioning from agriculture to food centred farming. Nevertheless, this model needs to be supported through what other researchers have emphasized on the need for increased investment in infrastructure, innovation and policy (Boratyńska & Huseynov, 2017; Schütte, 2018). Such investments are much needed in developing countries and especially in areas vulnerable to climate change and other social crisis. Thus, universities should initiate and improve their networks and collaborations with all stakeholders to foster food based bioeconomy. In other words, universities and research centres have duty and responsibility to disseminate the good lessons and practices from their experiments to local communities. While the CDA farm has been able to do that through its improved seed variety distribution this kind of intervention needs to go beyond that to include micro pilot schemes for sustainable farming in rural and peri-urban farming communities. On the other hand, the public and private sector have duty to make more investments in sustainable food infrastructure in developing countries. Thus, it is not surprising that some scholars have embedded provisioning of infrastructure in the strategies for achieving postnormal food security which is explained in the context of sociotechnical transition pathways (Wells et al., 2020).

This study has highlighted the role played by the CDA farm to supporting 22 neighbouring peri-urban farming communities with improved seeds during the lockdown. It is pertinent to revisit the role of universities in community development and particularly in the context of environmental ethics, values, and social responsibility. The role of universities in community outreach has been recognised in previous studies (Nejati & Nejati, 2013); nevertheless, it is important that organisations responsible for ranking universities to factor in community development and environmental ethics in their metrics and variables of such assessments.

Governments and local and foreign funding agencies should also condition award of grants to the willingness of universities and research centres to uphold ethical and community development initiatives.

Another critical issue that has emerged from this study is the importance of understanding the temporal patterns of imposing and lifting lockdowns which has significant implications on food supply and demand. This study has revealed households' vegetables purchasing behaviours during lockdowns which vary across the days. In particular, the waste generated by farms which is minimal is still of great concern despite the plans of the farm for circulating the waste into the farm system. Thus, achieving zero waste should be targeted by all food producers, consumers and sellers during epidemics and pandemics. Indeed, more studies are needed to improve our knowledge on food demand and supply crisis critical points. This is important for supporting decisions by governments, businesses and humanitarian agencies who are in many ways involved with food sharing, supply and distribution.

Urban researchers in Africa have stressed the need for embracing innovative farming system such as zero acreage farming and exploitation of native plants nutrition to enhance safe urban food security (Barau, 2020; Barau et al., 2020). Nevertheless, scientific and sustainable farming system as exemplified by this study are important for stimulating wider transitions to bioeconomy within and beyond urban areas. Model farms as shown in this study can help a diverse range of consumer communities to meet their nutritional needs during uncertainties.

More than ever before, urban citizens need to consume cleaner foods as cities have become dumping grounds of processed foods that are easily available in shopping malls and supermarkets (Crush & Frayne, 2011).

Another important issue worth discussing is the role of gender and nutrition security during the COVID-19 pandemic. It is obvious from this study that women, single or married are very conscious of their nutritional needs and that of their dependents as observed from their established patterns of vegetables purchases. Nevertheless, it is important to recognize that studies have established that in general, women are more pressurised and worn out by the COVID-19 pandemic in many ways as their services to the family multiplied (Power, 2020).

Probably, the patterns seen in this study confirm such increases in women's responsibility to take care of their family members. At this point, it is important for the readers to recognise that the females involved in this study are employed and hence do have some level of economic power and security. As such, one of the limitations of the current study is that majority of its respondents are employed. Hence, more studies are needed on the potentials of bioeconomy in supporting the lives of urban poor and those employed by the informal sector during pandemics. Understanding the food-water-energy nexus is another aspect that needs further studies.

## **7. Conclusion**

It is widely understood that the COVID-19 and its related lockdowns have affected populations especially those living in urban areas. By spotlighting activities of a university based research farm, this study has found links between safe food production and public food and nutritional security during pandemics. In other words, knowledge-based sustainable farming system can be reliable in securing healthy living for

urban population. However, an important point being made here is the critical role of sustainability infrastructure such as energy and water use which reduce the ecological footprints of the farm. The ability of the CDA to effectively inject ethical and sustainability principles in its farm is indicative of the potentials of transitioning to bioeconomy to be achievable and affordable in short term period. Thus, engaging in food based bioeconomy also ensures continuity of low carbon development during pandemics, epidemics and other unforeseen crisis. Apparently, bioeconomy supports and promotes ethical green growth and development in developing countries. Essentially, the paper recommends the need for universities to take a leading role in promoting the principles of bioeconomy in agriculture through engagements with municipalities and planned and unplanned urban communities in Africa's fast urbanising cities.

## Declarations

Competing interests: The authors declare no competing interests.

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## Figures

PROPOSED CROPPING PLAN FOR RAINY SEASON 2020 (CDA FARM)

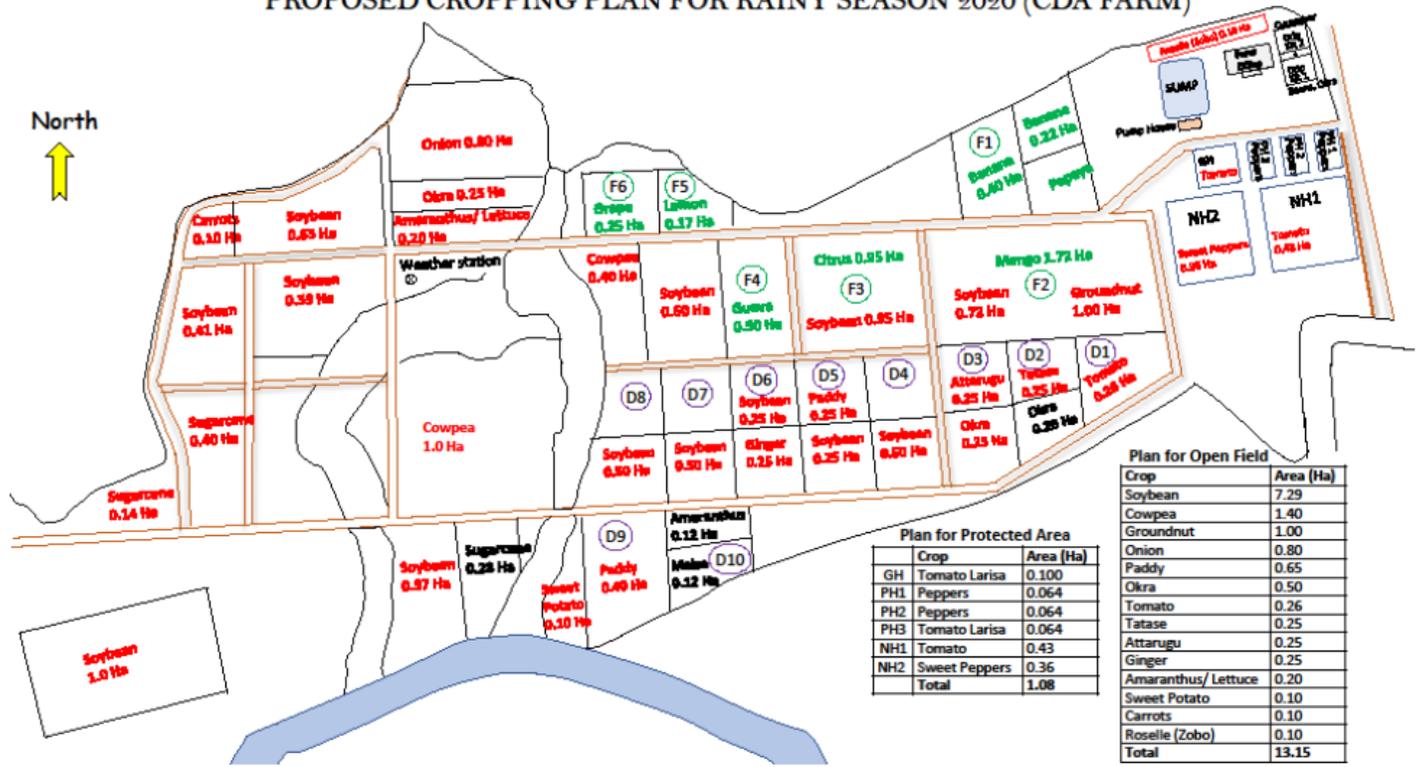
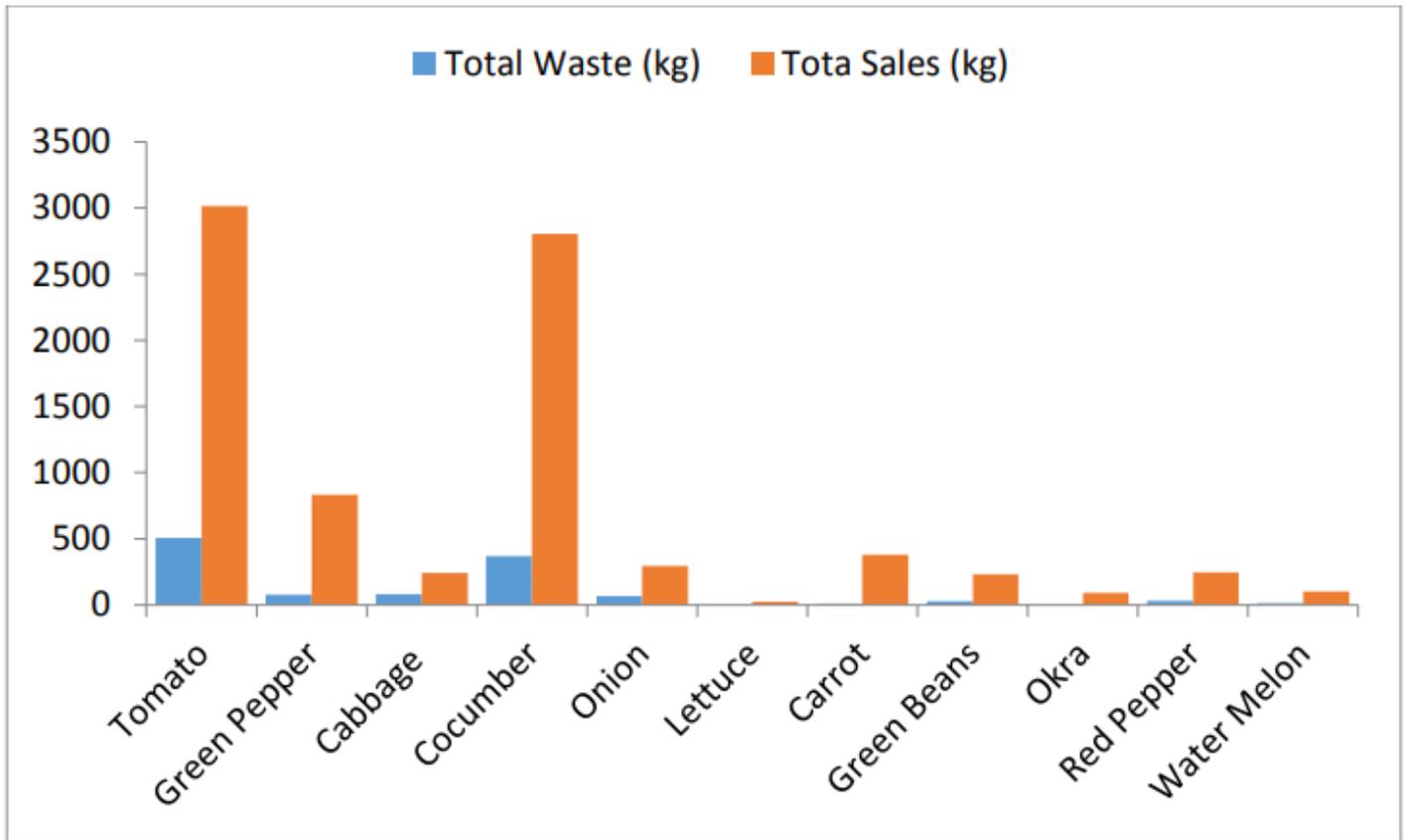


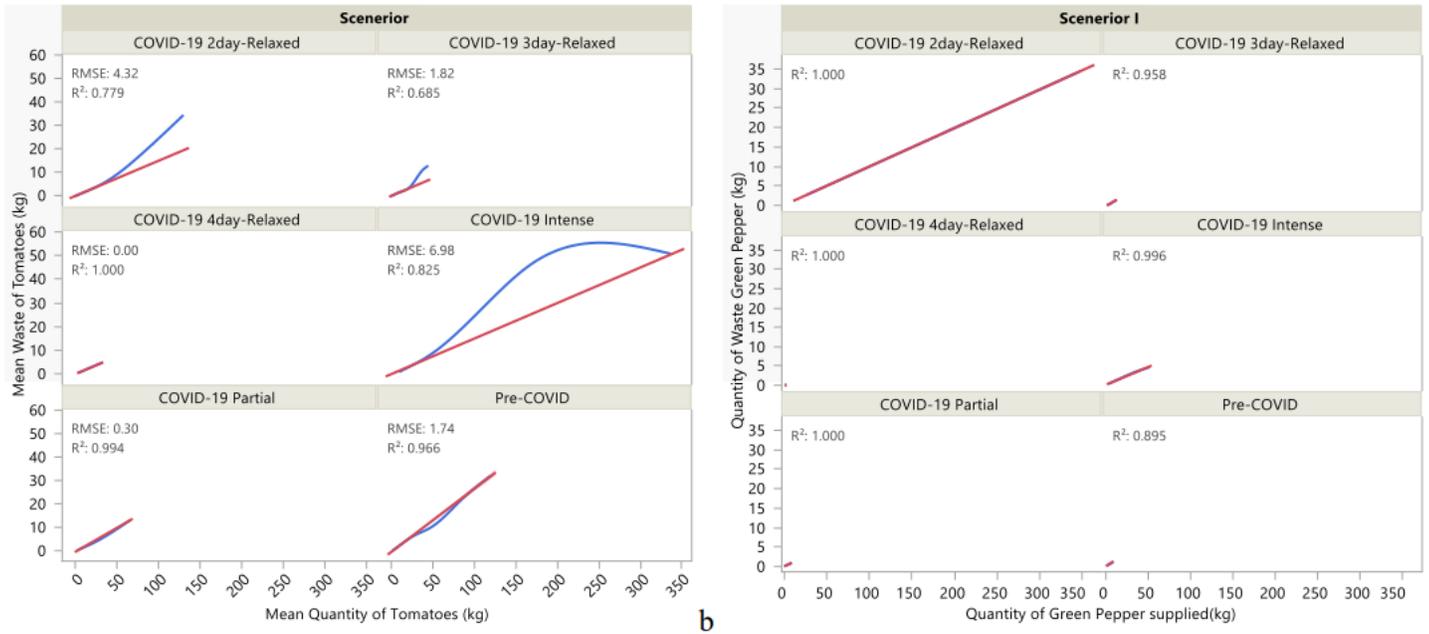
Figure 1

CDA farm plan showing its components for different farming activities



**Figure 2**

The CDA farm produces variety of vegetables and fruits during the COVID 19 lockdown with some losses or leftovers



**Figure 3**

Visualizing the Influence of COVID-19 lock down on vegetable loss and waste. (a) Tomato, (b) Green pepper