sustainability

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Data-Driven Innovations and Sustainability of Food Security: Can Asymmetric Information Be Blamed for Food Insecurity in Africa?

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Abstract: Africa still struggles to end hunger, partly because not all Africans have access to nutritious food. Although studies have established the connection between digital technologies and food security, the reality in Africa is that, despite the laudable feat in the use of digital technologies, the accessibility and utilization of food still face challenges. Digital agriculture, or technology, is a data-driven innovation that predicts agricultural outcomes and guides food producers throughout the different phases of operations on the farm. The literature documents the efficacy of digital agriculture in food production and availability well, but it has hardly examined how it enhances food accessibility and utilization. And even though studies that have examined food accessibility and utilization have merely assessed income as a tool that guarantees food accessibility and utilization, not much attention has been paid to how digital resources can aid in the access to and utilization of food. Drawing on information asymmetry theory and the systematic qualitative method, this article investigates how digital agriculture, through the internet and mobile phones, enhances efforts towards the accessibility and utilization of food as prerequisites for the attainment of SDG 2 in Africa. The findings provide an understanding of the potential of digital technologies in promoting the accessibility and utilization of food. It advocates strategies through which stakeholders in the agricultural sector can utilize technology in ways that aid Africa's strategic efforts to attain food security and zero hunger.

Keywords: agriculture; digital; food security; hunger; mobile phones

Citation: Agunyai, S.C.; Ojakorotu, V. Data-Driven Innovations and Sustainability of Food Security: Can Asymmetric Information Be Blamed for Food Insecurity in Africa? *Sustainability* **2024**, *16*, 8980. https://doi.org/10.3390/su16208980

Received: 30 August 2024
Revised: 5 October 2024
Accepted: 13 October 2024
Published: 17 October 2024

1. Introduction

The increasing rate of access to the internet and the use of mobile phones in Africa are positive information and communication technology outcomes that have not been reflected in the quest of Africa to end hunger. While Africa is growing tremendously in the numbers of internet subscribers and users of mobile phones, the same cannot be said about how these digital technologies have contributed to enhancing the accessibility and utilization of food. Africa is one of the continents that still largely suffers from limitations in feeding its population and completely ending hunger and malnutrition [1]. Although the pace of digital technologies in the form of huge numbers of subscribers and utilization of the internet and mobile phones has continued to rise, infrastructures that will complement these technologies to enhance the accessibility and effective utilization of food have been on the decline [2], thus exacerbating the problems of hunger and malnutrition on the continent [1,2]. As of 2021, the undernourishment index in Africa is 20.2 [3]. Although this indicates a reduction from the undernourishment index of 22.7 in 2016, the Global Hunger Index reports that of the 10 hungriest countries in the world, 8 are in Africa [2]. This goes to show that the feat in the utilization of digital technologies does not necessarily translate into sustainable food security. In Kenya, despite the prolific access to the internet and mobile phones, reports showed that about 1 million people are still highly food insecure, and acute

malnutrition affects over 760,488 children between the ages of 6 and 59 months, as well as 112,401 pregnant and nursing women and girls (PBWGs) [4]. This can be interpreted to mean that while other continents are positively utilizing and tailoring their digital technologies towards sustainable food security that can consolidate their efforts towards the attainment of SDG 2, their African counterpart suffers from huge infrastructural deficits that limit its efforts at achieving SDG 2, an end to hunger.

The Figure 1 below shows that 9 of the 12 countries with a high food insecurity index are in Africa [2]. This shows the extent of hunger and malnutrition on the continent. It is a situation where Africans suffer from hunger and malnutrition despite their arable lands and progressive development in the ICT sector. Unlike the food security sector, the ICT segment of the continent has been very strong, vibrant, and growing progressively, especially with the growing use of mobile phones and the internet. Internet use or access is also improving because of the huge utilization of applications on mobile phones. The sector, according to the World Bank report, remains Africa's fastest-growing regarding the numbers of mobile phones and internet users [5]. In Nigeria, it was reported that between 2012 and 2016, the number of Facebook users grew from 6 to 16 million people, and that millions of people have subscribed to the use of WhatsApp, Blackberry Messenger, Twitter, and other digital technologies [6,7]. Despite the transformation in the use of the internet, especially among the youth in Africa, it has hardly been effective in the food security sector. Today, farmers from rural Africa still find it very difficult to connect to their customers and determine the exact quantity and quality of harvests or agricultural produce required in the market. This information gap, which is partly caused by a lack of access to mobile phones, is in some ways the cause of food waste and shortages in some African countries. For example, unequal access to information about the supply chain by farmers, especially those that have to do with storage, transportation, and marketing, could lead to food waste. The wastage could be avoided if food producers had adequate access to digital agricultural technologies such as blockchains, artificial intelligence (AI), mobile phones, WhatsApp, and others, which can provide precise information about the produce needed in the market [1]. The point being made is that, apart from income that can aid food accessibility through purchase, digital agricultural technologies can also promote food accessibility [1]. This can be in the form of showcasing the harvests on mobile phones for people to see and make demands for the purchase of food [2]. The utilization of food, on the other hand, can also be made possible through smart phones, AI, and automation. The exact quantity, quality, and nutritional value of food can easily be detected and identified using any of the digital agricultural technologies [8]. Although there is a growing recognition of the fact that access to the use and effective application of digital technologies in agricultural production will enhance food security in Africa, the efforts to date in terms of access to deploy these digital tools have not been evenly widespread and uniform. Access to the use of ICT or digital tools by farmers in Africa has been highly uneven and discriminatory. Women are almost about 50% active in food production, but they hardly have access to digital agricultural technologies compared to their male counterparts [2].

The digital divide between female and male farmers in Africa is partly a limiting factor to food security. Some of the causes of the digital divide between men and women in Africa are poor education, ethno-religious and cultural beliefs and practices, low digital skills or knowledge, women's intra-household inequity limiting their ability to own mobile phones, excessive engagement in childbearing and nurturing, the patriarchal nature of African society, low financial capacity, and gender discrimination, among others. Education is key to the handling of applications on digital tools such as mobile phones, AI, automation, and other technologies. Applications on smartphones cover food issues such as rapid food detection, food traceability systems, and personalized diet guidance [8]. The skills and knowledge with which to handle these applications are critical to food accessibility and utilization, as evidence has shown that female farmers in Africa lack the requisite skills to operate applications on mobile phones [2]. For instance, due to their low level of education, many female farmers have been continually denied the opportunity to get online help to

secure loans and other credit facilities to boost their food production in Africa. A digital tool like the WhatsApp application on smart phones allows food inspection and enables food producers to invest in and achieve prosperity with their farms through access to online and on-the-spot credit or loans [9,10]. The cases of Ghana's agro-centre (https://www.acdivoca.org/av-ventures/agrocenta/ (accessed on 1 October 2024)) and Uganda's Emata Software (https://www.indexinsuranceforum.org/news/ugandan-fintech-startup-emata-has-successfully-secured-24-million-seed-funding (accessed on 1 October 2024)), which allow smallholder farmers to have access to finances and markets to borrow loans to aid agricultural food production, have aptly described the utility-value of digital agricultural technologies. As these mobile apps work in rural areas with network access, they tend to benefit rural farmers and enhance their productivity. However, the majority of women farmers, especially those from rural areas, lack the education to operate and manage loan applications on smartphones. While India has designed KhetScore to promote financial inclusion and facilitate the access of women farmers to online loans and credit, their African counterparts still largely suffer from inadequate access to credit [11]. This invariably accounts for why Africa's quest for food security has largely remained unsustainable. In addition to poor education and digital skills, ethno-religious beliefs and practices (such as the purdah system) that confine women to the house are certainly another limiting factor for the poor access of women farmers to digital agricultural technology. Others include the patriarchal nature of African society, which allows male domination, as there is the likelihood that in every household, men are likely to be the first to possess mobile phones. This is because men tend to be more economically active than women.

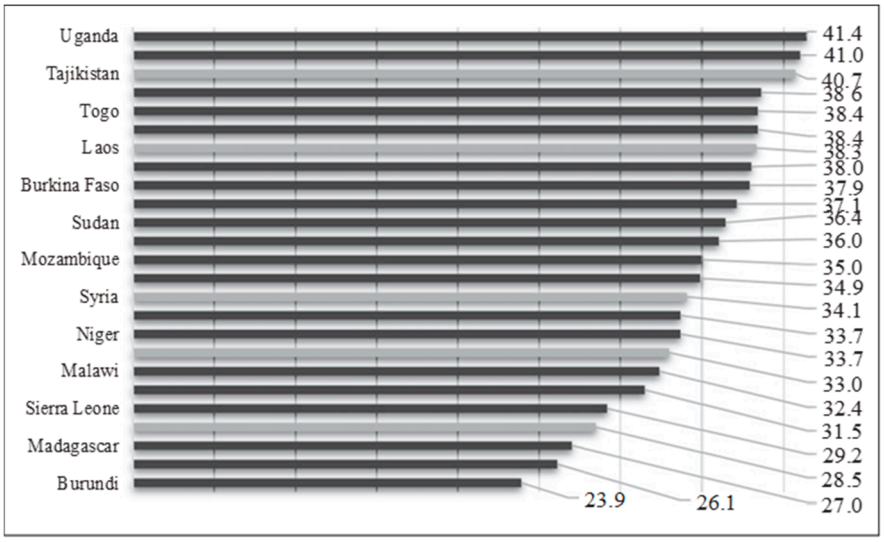

Figure 1. Countries with high hunger and food insecurity index. Source: Drawn by author, partly referring to the literature [2].

Evidence from Table 1 below shows that men have more access to mobile phones than women. Factors such as low education, poor financial capacity, ethno-religious practices, poor handing skills, and the low empowerment of women may likely be responsible for the data in the below table. This has severe implications for their active involvement in the food supply chain, as they may find it very difficult to communicate with potential buyers of their farm produce. It will likely push them to rely on middlemen in the supply chain.

Education, poverty, location, age, access to job opportunities, gender gap, and the level of development are reasons why there is differential digital use and internet access between men and women farmers in Africa as shown in Table 2. Full connectivity necessitates an internet connection, despite the promising trend of more people owning mobile phones in Africa. This is where the disparities become significantly wider, though: Africans seem to be a relatively disconnected people. Comparatively speaking to their wealthier,

metropolitan, and better-educated counterparts, Africans who live in rural areas are poor and lack education and access to the internet [4]. Reducing the digital divide is still a top priority for the majority of African nations as well as the continent. Infrastructure expansion will be necessary to close the gaps [7]. This brings to the fore the need to investigate how food in Africa can be sustainable through digital agricultural technologies. The sustainability of food security in Africa partly depends on technologies that can detect, predict, prevent, or control harsh climatic conditions in order to boost food production on the one hand, and those (smart phones, the internet, and WhatsApp) that can effectively aid food accessibility and utilization in Africa on the other hand [2,9]. Indeed, the connection between digital agricultural technologies and food availability in terms of food productivity in Africa has always pulled attention, considering the continent's population. But how digital agricultural technologies aid the other two components (accessibility and utilization) of food security remains largely unclear. The main objective of this article is to examine how data-driven innovations like smartphones, WhatsApp, Facebook, and other mobile applications enhance food accessibility and utilization in Africa. Beyond the key indicator (that is, income or purchasing power) of food accessibility, this article contends that data-driven innovations could also play an active role in food accessibility and utilization. Food accessibility is the ability of individuals or households to obtain food through purchase or other means of accessing food in terms of quantity and quality (appropriate diet and nutrients). Studies that have investigated this subject have merely focused on purchase (money) as the means of accessing food, whereas other means, like data-driven innovations (smartphones, WhatsApp, the internet, Facebook, and others), have received little attention. This article intends to investigate the impact of data-driven innovations on the sustainability of food security in Africa.

Table 1. Gender digital divide in Africa. **Source:** Prepared by the researchers using the Afro barometer 2022.

Africa	Percentage (%) Use of Smart Phone	Percentage of Internet Access
Male	41%	49%
Female	32%	40%

Table 2. Summary of digital access gaps in Africa (percentage-point differences between highest and lowest categories, as shown). **Source:** Prepared by the researchers using the Afro barometer 2022.

	Education Gap (Post-Secondary%—No Primary %)	Poverty Gap (No Lived Poverty%—High Lived Poverty%)	Location Gap (Urban%—Rural%)	Age Gap (30 and under%—over 60%)	Employment Gap (Employed Full Time%—Not Employed%)	Gender Gap (Men%—Women%)	Development Gap (Non-LDC%—LDC%)
Own mobile phone	31	14	16	5	12	9	14
Own phone with internet access	72	36	35	32	25	9	23
Personal or household ownership of computer	60	43	30	10	21	4	22
Frequent Internet use	72	39	36	33	24	8	23

2. Mapping the Problem between Data-Driven Innovations and Food Security in Africa

Lots of studies on digitalization and food security are quick to examine the utility or efficacy of technology on food availability (productivity) rather than accessibility and utilization. This article is an attempt to depart or deviate from what is commonly known in the literature to determine the extent to which data-driven innovations, such as mobile phones, could enhance food accessibility and utilization in Africa. Research in this area is

critical in order to provide enough information to food producers on how to raise awareness about their crops by using mobile phones to encourage people to access them. Although this initiative could draw attention and commendation, it also raises doubt about effective use and handling due to the lack of education of farmers, especially women farmers in Africa [12]. Today, Africa may not be failing when it comes to internet access and the use of smartphones, but the skills and knowledge to handle these digital innovations, especially among food producers (farmers), are scarce [2,7]. While the surge in the use of digital technologies in Africa has been established, the problem of asymmetric information, where not all farmers, especially women, have equal access to information on issues of food production, accessibility, and utilization, is partly the reason why the agricultural sector, unlike other sectors, has hardly felt the utility of digital technologies. To enhance food security, efforts must be made to enhance equal access to relevant information that can aid the effective production and utilization of food in Africa [13]. Farmers make up the principal market for Africa's agricultural innovation, yet they hardly use these technologies, partly due to a lack of internet and electricity [14]. The disconnect between smallholder farmers and digital innovations is a result of the high level of illiteracy and digital illiteracy in Africa. According to the UNDP, about 33% of the sub-Saharan population cannot read and write [15]. What is more is that despite the fact that 46% of the sub-Saharan population have access to mobile internet, only 22% of them can access 3G and 4G, and rural communities are the least likely to have access to the internet or mobile phones [15,16]. Evidence also shows that people in rural, agricultural-dominated regions hardly possess the digital skills or knowledge to operate or handle the technology. This certainly will have severe implications for food waste in the affected regions and, by extension, Africa.

Despite widespread hunger and chronic malnutrition, Africa throws away almost 40% of the food it produces, partly as a result of a lack of information to navigate the food supply chain [8]. In Africa, food waste is an even worse concern. Compared to other locations, sub-Saharan Africa appears to have the largest percentage of food lost after harvest. With losses of up to 50%, fruits and vegetables bear the brunt of this global suffering [8]. Wrong or lack of access to information, especially by farmers in rural areas, have partly been responsible for food waste on the continent [2]. A study that looked at food losses during handling, shipping, and storage in six sub-Saharan African nations found that poor or limited information on how best to store food accounted for 80.4% of losses. Fruits, vegetables, roots, and tubers saw the biggest losses—up to 55.9%—because of their perishability and inadequate infrastructure for processing and storage [6]. For instance, food producers, with limited access to the digital communication device, are most likely to suffer in the food supply chain as they may likely find it extremely difficult to determine the exact quantity of food to supply to the market. While how to tackle food waste is well documented, the problem lies in the transfer of this knowledge or information to those that need it: food producers, households, government, and businesses

Poor access to food is another problematic issue arising from food waste. This is because the more farmers or food producers experience problems in the food supply chain, the higher the chances of food not getting to the final consumers. Growing inefficiencies in information gathering about storage, transportation, processing, and retail, which are all components of the supply chain, could likely hamper access to food in Africa [2]. The fact that millions of people on the continent suffer from daily hunger in both urban and rural areas stands in stark contrast to this wastefulness [8]. Data-driven approaches such as using lifecycle analysis to understand hotspots in food product value chains are likely to lessen food waste and promote access to food in Africa [14].

Food-insecure households are unable to grow their own food and likely do not have the resources to purchase food. Their incapacity to obtain work or produce revenue places restrictions on the income of these households. Poverty-stricken households are more susceptible to economic shocks since they usually have a large number of dependents and few workers. Income level has a major impact on food waste [12]. Higher earners are more likely to buy food than lower earners since food is more affordable for them [12].

Although wealth and other economic factors have an impact on food waste, families found no connection between household income levels and the amount of food wasted [14]. A study conducted by Wamola found a connection between household income and food waste [16]. During their investigation, it was discovered that food waste was higher in those earning a low income per month than in those with greater monthly incomes.

The poor supply chain is another problem confronting food security in Africa. Local food supply chains are increasingly marginalized due to the activities of middlemen dominating the market [17]. The activities of these middlemen thrive on distorted or hijacked information about the true picture of food prices and food production materials like fertilizers and other equipment; hence, the subtleties of different contexts may be missed. It is imperative to note that food producers who have direct access to information about different processes of the supply chain rather than relying on middlemen's advice are likely to understand what exactly to supply in terms of quantity, prices of the food, and the best possible transportation method, among others. However, the reality in most African states, like Nigeria, shows that the poor supply chain is still a big challenge confronting food security. The food supply chain still faces pressure from the middlemen, which has been identified as one of the factors causing distortion to the free flow of the food supply chain [18]. Nonetheless, the implication of activities of middlemen remains under-researched in the supply chain literature, and the few studies that have examined it have ignored the different nuances of food supply chain dynamics in poor African countries [19]. There are six steps in a typical food supply chain: purchasing components and raw materials, production, packaging, storage, wholesale distribution, and retail redistribution to the final consumers. All these stages require access to accurate information; otherwise, the supply chain would be in serious jeopardy. Having no access to authentic information in each and every step of the food supply could erode customers' trust and loyalty as well as weaken brand integrity [18]. It could also lead to low sales and profits on the part of food producers, hence affecting their income for the launch of new food products [17].

The activities of middlemen in the supply chain become necessary because most farmers, especially those from rural unpowered electricity areas and internet-lacking zones, cannot handle everything in the food supply chain [1]. They are engaged in activities like the processing, packing, transporting, and selling of crops, while farmers remain focused on food production. Their tasks also include the collection of milk from several dairy farms, ensuring it is pasteurized and packaged, and then distributing it to supermarkets [20]. They assist in getting the produce of farmers to the bigger markets outside their local areas [21]. They use their connections and distribution channels to help farmers to sell their crops or get the supplies they need for their farms. Evidence shows that while middlemen relieve farmers of the stress of having to market their products, their activities are laden with risks [22]. The case of Desmanda Milk in South Africa adequately explains how risky the middlemen are in the supply chain. The refusal of Desmanda Milk to promptly inform farmers about their dwindling financial status or adequately update farmers about the operation of Desmanda Milk, which led to their financial collapse, left farmers without payment for their produce, highlighting the potential for middlemen to cause significant harm when they fail to meet their obligations [23]. This goes to show that the secrecy of some middlemen in concealing vital information about farming facilities and prevailing food prices in a bid to make more profits is partly the leading cause of the poor supply chain in Africa. Like in South Africa, middlemen in Nigeria have been accused of diverting fertilizers specially provided for rural farmers by the government [24]. This reason for this diversion is partly blamed on the unequal access to timely and accurate information. It would absolutely be very difficult for farmers without access to information to be aware of the number of fertilizers distributed to them by the government. An effective and robust food supply chain largely depends on access to accurate information. The need to eradicate all forms of stumbling blocks in the supply chain and enhance food security is the strategy in conducting this research, which seeks to ascertain if data-driven innovations could

enhance food security, and if not, whether wrong or unequal access to information could be blamed.

In Africa, the extent of asymmetric information is deep and worrisome, as evidence shows that many parts of rural Africa lack access to the authentic information required for a smooth food supply chain [25]. In Africa, the food supply chain may be significantly impacted by incomplete information and poor communication. This is due to the fact that key actors (farmers, middlemen, consumers, retailers, and others) in the chain are somehow not aware of the activities and processes in the supply chain [26]. Evidence has shown that ineffective communication and poor access to information have often resulted in mistakes, inefficiencies, excessive waste, and mistrust between providers and users of food on the continent [27]. Africa's food and agricultural output has grown slowly, and this is partly due to a lack of adoption of technology and limited access to accurate information [28]. In terms of adopting agricultural technology, Africa has fallen behind Latin America and Asia. Even if in 1965, African agriculture was just as capital-intensive as Asian agriculture, during the next thirty-five years this advantage was lost [29]. Due to the growing activities of middlemen caused partly by the inability of farmers in rural Africa to gain access to the internet and useful information, the growth in fertilizer use in Africa over the 1965–2000 period has been very slow in relation to the other two regions: fertilizer use per worker increased only 3-fold in Africa, compared with 7-fold in Latin America and 12-fold in Asia [30]. Also, as a result of distorted access to information on how to manage climate change, millions of cattle, sheep, goats, camels, and poultry are lost annually from parasitic and infectious diseases, droughts, floods, and other natural disasters [31].

Farmers need accurate information to navigate or limit the consequences of climate change and to provide feedback on how well government intervention is working. Consumers of food, on the other hand, need accurate information to decide what to eat and not to eat and remain healthy. Without access to accurate information, it would be difficult for African countries to achieve the sustainable development goals [32]. This is because all 17 SDGs largely depend on the availability of accurate information. There is a need to ensure that men and women in African societies have fair and equitable access to information, which might enable them to produce and disseminate knowledge for the good of society [33]. Nonetheless, the lack of information availability in rural areas makes it more difficult for them to take advantage of new prospects, government assistance, and innovation in the agriculture industry [34]. Rural communities are confronting new challenges that have a big influence on their ability to feed themselves, particularly in light of climate change. These communities could be better prepared for natural disasters if scientific programs and technologies were developed, but first they would require access to the available data [35].

While studies have identified that digital agricultural technologies like the internet, social media, mobile phones, Facebook, and other mobile applications play a critical role in food security, there is scant research on the digital skills and capacity of African farmers. It is imperative to note that how the digital skills and capacity of farmers enhance massive agricultural food production, accessibility, and utilization is hardly interrogated in Africa. Research in this direction can furnish understanding and facilitate appropriate policy guides towards digital education and acquisition skills by farmers in rural Africa. The main objective of this article is to assess the impact of digital agricultural technologies on food security in Africa. Specifically, it focuses on the possibilities of digital technologies in enhancing farmers' efforts at food accessibility and utilization in Africa. The findings are significant for theory and policy. Theoretically, it expands the discussion on the dimensions of farmers–consumers relations and how technologies help to enhance positive food utilization outcomes. It also suggests strategies through which African countries can optimize digital technologies to enhance strategic efforts at improving food security in Africa. After the introductory section, the information asymmetry analysis forms the theoretical construct in explaining the impacts of digital technologies on food security. The

article also appraises the digital capacity or skills of farmers in Africa. It concludes with discussions on the sustainability of digital agricultural technologies in Africa.

3. Tracing the Link between Data-Driven Innovations and Food Accessibility and Utilization in Africa Using Information Asymmetry Analysis

Scholarly evidence and reports from international food organizations have clearly shown that Africa needs valid and reliable information from digital technological innovations such as AI, WhatsApp, Facebook, and mobile phones, among others, to enhance food security. All three components (availability, accessibility, and utilization) of food security require adequate access to true and genuine information to thrive. This is because all the data-driven innovations are potential sources of information that have direct and indirect influences on food accessibility and utilization. This influence can be in the form of the welfare of food producers (farmers) and consumers (households, individuals), efficiency of the market, job creation, food distribution chains or supply, and food nutrients, among others [2,36,37]. From among these core influences or functions, the efficiency of the market and producer and consumer welfare highlight the connection between digital innovations and the accessibility and utilization of food [2]. This is the same with the assumption and postulation of information asymmetry analysis, which opines that having access to true information from any of the data-driven innovations would not only smooth contract execution but also reduce transaction costs [38]. This theory aptly explains this subject, in that inadequate or difficult access of farmers to true information in the agricultural sector could negatively affect the decision of food producers (farmers) in terms of not having adequate knowledge of how to store food and transport food, as well as processing, financing, and marketing. Indeed, inadequate access to the right information by farmers has led to the wastage of food due to poor preservation skills or knowledge, which in turn affect the accessibility and utilization of food. For instance, it is almost impossible for consumers to purchase or access food that is very low in nutrients as a result of poor storage, except those consumers who also lack access to the right or correct information.

From the analysis above, it is obvious that information coming from the different internet-driven technologies and applications (mobile phones, WhatsApp) is critical to food security in Africa. This is because such information to a very large extent determines the choices made by both the producer and consumer in terms of food production, marketing, accessibility, and utilization. On the path of food producers, access to the right information would enhance knowledge on the most appropriate food preservation model and transportation and marketing models to ease accessibility. Getting access to the right information gives farmers the opportunity to fix or charge acceptable prices for their farm products. It is a fact that mobile smart phones enable farmers, through different intra-trade platforms, to see or access trade opportunities, such as access to good transportation services to convey agricultural products to different markets. According to Aker, the ability of farmers to obtain the right information from the use of mobile smart phones could reduce the dispersion of prices of agricultural products in within-border and cross-border markets, search costs, improve market information, and lower the inefficiency rate in moving agricultural goods across markets [39,40].

It is imperative to note that while studies have been able to establish that food accessibility and utilization largely depend on the availability of the right information from digital agricultural technologies [2,14,37,41–43], other studies have also identified how incorrect information has influenced market failure, thus affecting food accessibility and utilization [44,45]. For studies that have examined the implications of the right information for food security, their findings have been positive. Lio and Liu, in their study, established that the use of highly sophisticated agricultural technologies largely depends on the availability of the right and efficient information, which in turn enhances food transaction processes (food accessibility) as well as labor specialization and efficiency and intermediate goods deployment [41]. Aker and Mbiti, who examined the prowess of agricultural technologies in the African region, found that mobile phones have been transformed from mere

communication tools to a service delivery platform, where people can access food and obtain information on how to utilize the same food [37]. Today, most consumers of food really do not need to visit the physical market to buy and effectively utilize food; they can do so through mobile phones, as information readily available on mobile phones can direct consumers on the nutrient components and usage of the food. Through the right, accurate, and timely information on mobile phones, consumers can be informed on how to obtain and utilize food with ease. It is the same with the finding that revealed that the right information from digital agricultural technologies promotes how farmers and traders coordinate food transactions [43]. It was also found that farmers–traders coordination arises from the right information in mobile phones and other digital technologies, which, in turn, helps to lessen post-harvest losses, improve farmers' knowledge of the optimal planting and harvesting dates, and enhance market linkages.

The reverse is the case or result from the perspective of wrong or asymmetric information. Asymmetric information typified a situation where parties to a transaction (in this context, food supply chain or accessibility) are not equally informed. It represents a situation whereby either the food producer or consumer, or both, do not have access to the right information to make food decisions. There has been growing research on how asymmetric information impacts food quality, utilization, and accessibility. And evidence from these studies has identified the agriculture-food sector as one of the fields mostly affected by asymmetric information [44]. The problem has always revolved around lack of information on food quality, prices, nutrients, utilization, and safety that normally occur along the supply chain until the ultimate consumer [44]. A critical review of the findings in the above empirical studies reveals that food accessibility and utilization, which are critical components of food security, are threatened by wrong or inefficient information. For instance, a food producer (farmer) that has no accurate information about the market dynamics (demand, transportation, policies, prices) is likely to face market failure. The producer is likely not to be aware of how to supply food to the market, the price to charge, and the inability to interact with the consumers on the adequacy, utilization, and safety of the food.

In Africa, incorrect information and the peculiarities of mobile phones, internet access, and availability, as well as rural electrification and their impact on food accessibility and utilization, have constantly generated concerns for public policy. While access to the right information through the use of digital agricultural technologies such as mobile phones has aided intra-country food accessibility and utilization, in some others, the sub-national distribution of food and effective utilization remain problematic [2]. In Tanzania, Sife et al. identified poor rural electricity to power mobile phones and a lack of internet as major reasons why food producers or farmers rely on inaccurate information from middlemen, which in turn affects food accessibility and utilization [46]. This is the same as what was found in Uganda: inadequate or unequal access to the right and accurate information on mobile phones by farmers has created more ravaging devastating challenges in the agricultural food supply chain [47]. This problem may have been caused by the inability of the national and regional governments to leverage the benefits offered by digital agricultural technologies to address the inherent problems affecting food accessibility and utilization [2]. Indeed, the food supply chain and utilization have greatly been affected by asymmetric information in Africa. For instance, food producers need to have the right information about the quality, standard, access, and use of food. This information, which is usually through ICT, could provide them the opportunities to be aware of the food standards expected of them and what they can expect in return in the delivery process [47]. For instance, food processors need to be aware of the food inputs to be processed into quality finished products for consumers. Food traders require accurate information to forecast or predict the best food storage period, capacity, and conditions. Providers of food inputs also require accurate information about the best inputs that can adequately meet the needs and concerns of farmers, traders, and processors. All of these go to show that the right or accurate information flows from the use of digital agricultural technologies

are highly instrumental in the effective utilization and accessibility to food in Africa. Unlike asymmetric information, adequate access to accurate and appropriate information has a significant impact on the sustainability of food security. However, reports and studies' findings showed that most of the countries in Africa suffer from limitations such as low internet access, irregular rural electricity, the overbearing influence of agricultural middlemen, and low digital skills, among others, which tend to limit farmers' capacity and access to accurate information [2,36,48]. This state of affairs in some African countries, no doubt, is partly the reason why food security has not been sustainable. For instance, farmers without adequate access to the right and accurate information or that rely on information from middlemen may find it very difficult to cope in the food supply chain. This is because with the wrong information about the safety of the roads and transportation with which to convey agricultural food to the market, especially in conflicting African states like Nigeria, the food may not eventually get to the market; they may likely be hijacked by insurgents and bandits, thus amounting to food loss, scarcity, and insecurity [48,49].

Similarly, incorrect or lopsided information could affect food utilization, which connotes sufficient energy and nutrient intake from food by individuals [9]. Effective food utilization thrives on practices of good care and feeding, adequate food preparation, diet diversity, and intra-household food distribution [50]. These practices of food utilization depend on the availability of the right information, either to food producers or consumers [2]. In Africa, poor communities have bad access to good food and good access to bad food, as a lack of nutritious food is borne out in health and productive capacity. Information plays a key role in food utilization, and the absence or lack of it could lead to food insecurity [51]. Consumers need the right information about the intake of food, so food producers or farmers also require adequate and accurate information to supply the nutritious food needed by consumers in the market [50]. However, asymmetric information, depicting wrong or lack of accurate information, has remained a potential source of food insecurity in Africa [52]. This is so because the majority of food consumers in Africa hardly have information about how food is prepared in terms of the conditions under which food is produced and distributed, the nutrient component of the food, and cultural practices binding food intake [53]. In Africa, food guidelines are hardly followed, partly due to a lack of information and limited access to food. It is one of the reasons why about 20% of its population is undernourished and 30% of children in Africa suffer from stunted growth due to malnutrition [53]. Insufficient data or information to comprehensively assess progress towards global nutrition targets (such as stunting, obesity, diabetics, exclusive breastfeeding, anemia, weight at birth, and childhood weight, among others) have been blamed for the prevalence of the poor or wrong utilization of food in Africa [51].

Using South Africa and Nigeria as case studies of how asymmetric information affects food security, evidence has shown that even though the lack of access to accurate information largely remains as a critical issue in the supply chain that hampers food security in both countries, South Africa, unlike Nigeria and Kenya, has fared better in coping with and managing incorrect information. In South Africa, it has been reported that agricultural food production has been boosted and enhanced with massive access to digital technology as mobile phones enhance social connectivity among key actors in the food supply chain, but that the economic impact has been rather limited by issues of accessibility, internet connectivity, and ease of use, especially in rural areas of Limpopo and the North West provinces [54]. Despite the penetration of data innovations, farmers in some rural communities still have problems connecting to the internet and poor access to the use of mobile phones. This may have partly accounted for South Africa's food insecurity at the household level, as not all households have access to adequate food [55]. Almost 20% of South African households still suffer from inadequate or severe inadequate access to food [56]. This varied by province, population group of the household head, and household size. While South Africa seems to have been able to cope and effectively control the flow of correct information as it concerns food security, the activities of middlemen in the supply chain, which often distort information or consist of information shrouded in secrecy, are still

largely going on [57]. The case of the failure of Desmanda Milk to pay to over 20 dairy farmers in KwaZulu-Natal, the Eastern Cape, and the North West an estimated value of between ZAR 80 and 90 million aptly explained how a lack of accurate information in the supply chain affects food security [58].

The extent of the effect of asymmetric information on food security is huge and devastating in Nigeria. Despite the rapid penetration of internet and mobile use in Nigeria, poor electricity and internet access in some rural areas have prevented farmers and consumers' access to authentic information that can aid food accessibility and utilization [59]. The FAO reported that the lack of access to information of farmers in Nigeria increases information and coordination costs, which prevent greater farmer participation in commercial agriculture in the country [60]. This has implications for reliance on middlemen by Nigerian farmers, who could not have access to authentic information. Evidence showed that the farmers–middlemen relationship has been stained with extortions, diversion, misinformation, and secrecy [61]. The case of the diversion of free fertilizers to rural farmers by the Nigerian government in Nasarawa State aptly describes the depth of misinformation and asymmetric information in Nigeria [62]. Although efforts have been taken to eradicate the middlemen in the supply chain through the distribution of mobile phones to farmers, internet access and poor electricity have messed up this effort in Nigeria [63].

4. Methodology

A systematic qualitative review of empirical studies on the subject was utilized to gather data for this article. Given the ambivalence of data innovations and food security as concepts, a systematic review was deemed appropriate as it assisted in assessing evidence from a diverse body of research or literature. This method was utilized to uncover new knowledge and understandings, often helping to provide an answer to the question 'why' and helping to build theory [64]. With this method, an answer to the question 'Why is access to accurate information from digital agricultural technologies necessary for food accessibility and utilization?' was provided through rigorous reviews of empirical studies on the subject. This article presents the different stages of meta-ethnography, which is the most common methodology used for qualitative systematic reviews [35]. This method was implemented through the following steps: formulation of the research question and key search terms and methods; design of a multistage review process; critical appraisal of qualitative literature; development of data extraction tools; and data analysis. Search key words pertinent to the research question were therefore first determined, and the results are shown in Table 3. Candel noted that earlier systematic evaluations on digital technology and food security provided more insight into the identification of these concepts [65]. The article addresses significant factors during the protocol-building process and uses a previously generated review question as a working example.

The criteria for the choice of empirical studies utilized in this research include those whose objectives and findings cover issues relating to the impact of data innovations, electricity, and internet use on food security. Another criterion includes empirical studies that covered the period of 1970–2024 and that specifically examined the connection between digital agricultural innovations and food security. The reason for this period includes the need to capture the level of technology and food security in Africa after the independence of some African countries. It was also considered due to the robustness of the role agriculture played in the periods covered. These studies were also included based on their sources, which either focus on Africa or at least allude to issues relating to the continent's digital agricultural innovations and food security. Key phrases for the year of release, language, and type of document were also part of the search technique. The 'AND' term was used to make sure that studies relating to Africa, published between 1970 and 2024, written in English, with a limitation on articles, books, book chapters, and institutional reports, were taken into consideration. The 'WITH/NEAR' in the table was purposefully taken into consideration in the search in order to include documents that used any of the terms

from the first two domains. Therefore, the search query generated on the databases was informed by the preceding.

Table 3. Search strategy. NB: * was utilized to denote a 'search string' to add prefixes and suffixes to the keyword in the search. Source: Researchers' self-compilation.

	Domain 1: Data Innovations/Asymmetric Information		Domain 2: Food Security		Domain 3 Location		Others
Keywords	Agric-mobile phone use, ICT, agri-tech		Food accessibility, food utilization/nutrition		Africa		Year of publication (1970–2024: document type (must be articles, books, book chapters or online reports and government/official documents)
Search terms	Digital Innovations *Mobile phones, ICT*, technology* information	(WITH/ NEAR)	*food security*, effective utilization of food*, *adequate access to food*	AND	Africa	AND	1970–2024: articles, books, book chapters or online institutional reports

Following the preceding order, different hits from Scopus and Web of Science articles were shown in Table 4. In order to retrieve the empirical articles used in this research, keywords relevant to the core variables in the research were utilized. Variables such as data innovations, food security, ICT, and food security in Africa were among the targeted hits that led to the retrieval of 70 Scopus indexed articles and 30 Web of Science articles respectively. Other variables like mobile phones and food security, asymmetric information and food security as well as the role of government in curbing asymmetric information in Africa were keywords that produced different numbers of documents as shown in Table 4 from Scopus and Web of Science. In all, selected documents (books, articles, online publications, were 1007 from Scopus Indexed sources and 870 from Web of Science.

Table 4. Keywords and results returned in databases. Source: Prepared by the researchers using Mendeley.

Keywords	Hits from Scopus	Hits from Web of Science
'Data Innovations' with 'food security' or 'ICT' or 'food security ' and 'Africa'	70	30
'Mobile phones' and 'food security in Africa'	700	530
'Food security' and 'Africa'	25	20
'Asymmetric information' and 'food security'	56	17
'Government's role in curbing asymmetric information' or 'food security promotion through data innovations in Africa'	12	3
Merged results	1035	980
Selected articles, books, reports, online publications, especially those written in English	1007	870
Merging the databases	1100	

a. Specific Screening and eligibility

The second stage involves successive screening of documents through the application of the inclusion and exclusion criteria. The criteria are as follows:

The inclusion indicators are as follows.

1. Articles that are theoretical or empirically based;
2. Articles that expand knowledge on data innovations and food security in Africa;
3. Articles that provide information on the effects of asymmetric information on food security in Africa;
4. Articles that provide insights on how to address asymmetric information in Africa, organizations/actors, government, and policies.

The exclusion indicators are as follows.

1. Articles that do not examined data innovations and food security in Africa;
2. Articles that do not provide information on Africa's asymmetric information implications;
3. Articles that do not provide information on how digital technologies promote food security in Africa.

Data that do not examine issues relating to Criteria 1, 2, and 3 are not eligible. All titles and abstracts were loaded in Mendeley software v2.118.0 for screening using the above criteria. The number of documents was further reduced as follows:

- After reading the titles of research works, 620 were excluded, and the number of relevant articles was reduced to 300;
- The abstracts of the remaining 300 articles were read. Also, based on the aforementioned criteria, 162 of them were excluded and they were further reduced to 138;
- The full texts of these 138 articles were exported to Mendeley and read, and 30 documents were excluded thereafter. A total of 108 articles were therefore used for the systematic review.

For the multistage systematic review process, the first stage consisted of the reading of interpretive studies that discussed in detail how data-driven innovations like mobile phones enhance food security in Africa. In this phase, more recent empirical studies from no earlier than 2010 were selected. The second stage consisted of searching and the selection of studies that cover topical issues of rural electricity, internet facilities, food supply chain, and transportation of food to the market. In the third phase of the meta-ethnography, a thorough reading and re-reading of studies beginning from the introduction to the conclusion to uncover the metaphors needed to extract data relevant to the core goal of this article was performed. The reason for this was to ensure that the findings in previous studies supported or validated the arguments in this article. In the fourth stage, we determined the extent of the relationships among the selected studies in terms of methodology, findings, metaphors, concepts, ideas, and phrases. In the fifth stage, the translation of studies into one another was performed. While the sixth phase was the synthesis stage, where selected studies are synthesized, the last stage of the meta-ethnography approach was the expression and writing of an evidence-based analysis of the impact of data-driven innovation on food accessibility and utilization. The keywords that were employed for data searches included digital information technology, agri-tech, food security technology, and the digitalization of food to examine how unequal access to information undermines food accessibility and utilization. Data were descriptively content-analyzed.

5. Research Results: Connecting the Usefulness of Data-Driven Innovations to Food Accessibility and Utilization in Africa

Food accessibility is a component of food security that describes the ability of everyone or household in a country to have the means through income or other means to obtain quality food in the right quantity [66]. Having access to accurate and appropriate information represents another means through which people can obtain or access food. In addition to income or purchasing power, which looks more like economic access to food, information from digital or data-driven innovations like mobile phones can also aid in access to food. The latter, which looks more like physical access to food, largely depends on the availability of reliable information. For instance, physical access to food, which

entails ensuring food reaches the market, household, or consumers, requires accurate information about how the food is going to reach these destinations (market, households, and consumers) [31]. In doing this, farmers or food producers need the right information about the best transport system to convey food to those destinations; information is also needed to identify the exact quantity and quality of food to be supplied. Importantly, accurate information is needed about pricing, storage, the distribution process, and food supply regulations and policies guiding the standardization of food [33]. It had been affirmed that through accurate information from data-driven innovations like mobile phones, farmers can make inquiries about the latest prices of agricultural products without visiting the market [36]. Outside Africa, accurate information from data innovations has been highly instrumental in access to food. In India, fishermen, while on the sea, can use their mobile phones to inquire about prices in various markets within their reach and move their products to the most lucrative and promising market [47]. This accurately confirms the utility or impact of accurate information on food accessibility. Economic and physical access, which are components of food accessibility, are both dependent on accurate information from data-driven innovations like mobile phones. Even in Africa, the impact of accurate information on food accessibility has been well documented. Aker and Mbiti revealed that having access to the right information reduces households' food risk exposures and enhances efficient service delivery in the agricultural sector [37]. It was also opined that Africa can eradicate hunger that is partly caused by inadequate access to food by leveraging accurate channels of information provided by data-driven innovations to reduce business and transaction costs [67]. This is because high business and transaction costs, as well as incorrect information, are identified as traditional inhibitors of agricultural growth in most developing nations [68]. Access to the right information, which reduces the marketing costs of agricultural commodities, is highly instrumental to increasing access to food [69]. With the right information, agricultural extension services will be improved, and farmers will be more engaged in food production [43,70]. All these attributes of data-driven innovations, if sustained, could lessen hunger as more and more people would then have access to food in Africa.

Food utilization is another critical component of food security that has been impacted by accurate information from data-driven innovations. This component represents the way the human body absorbs the most of various nutrients in food. The basic concern of this component is the ability of individuals to consume nutritious food in the form of sufficient energy and nutrient intake. Nutritious food intake is largely dependent on access to the right information on how food is prepared, the feeding practices, diet diversity, and the spread of food within households. The information potential of data-driven innovation promotes producer and consumer welfare [2]. For food producers, having adequate and accurate information could avail them of the opportunity to produce and supply nutritious food. It will improve interests in embarking on the production of food with adequate nutrients because farmers will be aware of food standards and the quality they should fulfill for traders or consumers to utilize their food. Studies abound to show the impact of accurate information on the consumption of nutritious food [71–73]. Evidence from these studies has shown that having access to accurate information can effectively reduce hunger and malnutrition [9]. It could enhance various other benefits, such as accessing relevant nutrition and agricultural information, financial services, insurance, tools for better risk management, and new business opportunities in rural areas [71]. In addition, studies have also confirmed that weight management programs on data-driven devices like mobile phones can reduce body mass index (BMI), boost physical activity, promote adherence to changes, and sustain weight loss [74,75]. Access to accurate information on food nutrition can increase consumers' awareness of how to reduce malnutrition, engage in nutrition monitoring through adequate food accessibility, and coordinate interventions [71].

It is evidently clear from the above revelations that access to the right and accurate information from the use of data-driven devices like mobile phones has played a significant role in effective food utilization. Consumers or users of food through ICT are aware of

the nutritional value and components of food they are buying from traders and farmers [41]. They also have access to information on the usage of food, as many nursing mothers, through information on their mobile phones, can easily identify the baby food with appropriate nutrients that they can purchase for their babies. Instructively, data-driven innovations have significantly contributed to consumers' welfare, especially in the areas of adequate access to information to avoid foods that can trigger ailments such as obesity, high blood pressure, diabetes, and liver and kidney problems [70]. Furthermore, relevant information on how to maintain and sustain diet diversity at both the individual and household level is available on mobile phones and other data-driven innovations [2]. Today, a lot of people do not need to go through long queues to see a doctor or other clinical barriers to reduce their weight and obesity because of the availability of weight management programs on their mobile phones. More importantly, information on how to utilize food in the right quantity and quality can be found on mobile phones; this saves consumers the stress of having to see food producers face-to-face for directives on how to utilize food [71]. All these attributes significantly contribute to food security [76]. Data-driven innovations and their utility for food security have stimulated numerous food e-commerce platforms, attending to various sources of demand, from fresh produce to ready-to-eat meals. And these platforms have emerged to connect farmers, food retailers, and processors with households or restaurants [77].

Although these revelations about the efficacy of data-driven innovations, especially the way information has remained a strong determinant of food accessibility and utilization, have been commended across continents, including Africa, there has also been suspicion on the utility and sustenance of accurate information on these innovations in Africa. This suspicion is not farfetched because Africa still suffers greatly from hunger and malnutrition. The next section of the article looks at why Africa is still largely ravaged by hunger and malnutrition despite the potential of information from mobile phones.

6. Asymmetric Information, Hunger and Mal-Nutrition in Africa

The evidence from theoretical analysis and empirical studies reviewed has shown that while Africa is constantly breaking new grounds in the area of access to the internet and the massive use of data-driven innovations such as massive mobile phone use, this feat has had a minimal positive impact in the way Africans access and utilize food [1,2,7]. Otherwise, the lingering cases of hunger, food loss, poor storage of food, inability to access quality food, low weight at birth, malnutrition, stunted children's growth, obesity, and other nutrition targets would be a thing of the past on the continent [76,77]. The cause of this problem is not the massive use of data-driven innovations and an increase in the numbers of mobile phone subscribers, but the inability to obtain accurate and appropriate information [44]. In Africa, food producers or farmers suffer limitations hampering their capacity to supply food that can meet the standards and expectations of consumers due to incorrect information or a lack of access to the right information [44]. A lack of information affects both food producers and consumers [2]. For farmers who produce food, the inability to obtain the right information about farming inputs, planting periods, storage processes, and the transportation of foods could limit their capacity to farm or plant in the best planting periods, maintain the best standard of food production, and store food, as well as make informed decisions on how to convey their agricultural products to the market [41]. This invariably leads to a shortage or oversupply of food, thus causing hunger and food wastage. It could also lead to the supply of substandard and expired food to the market, thus impairing food quality and energy intake. Incorrect information or a lack of access to information by food producers can also lead to bottlenecks in the food supply chain, especially when farmers have no access to information on how best to distribute or convey their agricultural products to the market [77]. There is a need to identify the right channel or means of transport that can be used to convey food to the market; otherwise, it could amount to food loss and damage.

Asymmetric information, which includes lopsided or unequal access to information, has partly remained the cause of hunger and malnutrition persisting in Africa. In Africa, in spite of the feat in the use of mobile phones, some rural areas still continue to suffer from a lack of internet access to service data-driven innovations like mobile phones and a lack of rural electrification, which has almost made it impossible to use mobile phones [37]. Regular electricity is critical to the functionality of mobile phones; without a regular supply of power, the development profile of ICT and mobile phones can be hardly seen [2,6,7]. For Aker and Mbiti, an irregular or total lack of regular power is among the major factors constraining the development impact of ICT protocols in Africa [37]. The full utilization of data-driven innovations for productive outcomes is distorted by the inefficient supply of electricity [78]. Bertolini, in an attempt to explain the cause of asymmetric information and its effects on food security in Africa, opined that the use of mobile phones and access to the internet in rural Africa is still affected by poor investment and a lack of electricity [79]. The twin problems of lack of internet and regular electricity in rural and remote areas of Africa could, according to the findings of studies, be partly responsible for asymmetric information, which in turn creates a tendency of unequal access to information about food availability, accessibility, and utilization [12]. For instance, how well could farmers and consumers from rural areas where access to the internet and regular electricity are almost nonexistent obtain information about food and its usage compared to those in the city with internet and regular power supply [2]? This has remained one of the reasons why hunger and malnutrition are common in rural areas of Africa. The peculiarities of Africa's rural areas in terms of mobile phone use and access to the internet as regarding their impact on food security have constituted a major source of public policy concern [2]. It is clear that electricity and internet availability play a central role in information gathering about food availability, accessibility, and utilization. All things being equal, a lack of information about the availability of food may exacerbate the tendency for hunger, whereas those with adequate information about where to find or obtain food may not necessarily feel hungry. The ability to know or identify where to obtain food in the right quantity and quality largely depends on information. Indeed, Africa is still ravaged with hunger and largely unable to feed its population, partly because critical stakeholders (farmers) in agricultural production lack information on the adequate farming inputs, food storage, farming mechanisms, food distribution, and marketing models. This has severe implications for hunger and undernourishment in Africa [1,50].

Having established that hunger is partly a product of the lopsided or unequal access to information, it is imperative to explain further how unequal access to information has created tendencies of hunger in Africa. Lack of or unequal access to information affects all the critical stakeholders in the rungs of food security: farmers, traders, processors, and consumers [2]. For farmers, having access to information on climate change, soil nutrients, prices of food, farming inputs, the best period to plant, and how to store food, transport, and market food would go a long way in food production and availability [80,81]. Without the right information on what food to produce, how to produce it, and its distribution, hunger and malnutrition will persist. This is even worse for farmers in rural areas characterized by a lack of internet and electricity. Evidence has shown that most rural communities in Africa are cut off from national grid extension strategies [82].

The rationale for the cut-off of rural communities from the national power grid may have been as a result of the high cost of energy [83]. With this experience, farmers in rural Africa likely do not have access to information that could aid their productivity in food production. For instance, they may likely lack information about how to navigate or adapt to climate change during the planting period, viable farming inputs, and others. The direct effect of the lack of electricity and internet is felt on the inability of farmers and consumers to have equal access to free flow information on their mobile phones [2]. This is because the functionality of mobile phones largely depends on a regular power supply and access to the internet. Consumers, on the other hand, are affected by asymmetric information, as they could be misled on the effective utilization of food [4]. For instance, the direct effect of

farmers' lack of information could manifest in the form of consumers' inability to access and utilize food. Ignorance is partly one of the reasons why hunger and malnutrition still persist in Africa. Evidence has shown that a lack of information is partly responsible for farmers, especially those from rural areas, having hardly had access to the internet and electricity, and this has somewhat limited customers' access to information on nutritional quality and quantity of food in Kenya [84]. Despite the sustainable development goal's target to lessen hunger by 2030, lots of disappointments and negative outcomes have been recorded, mainly in Africa. The major failures have partly been attributed to asymmetric information, which has hampered farmers' production choices, hindered farmer–trader coordination, exacerbated post-harvest losses, challenged farmers' knowledge of the optimal planting and harvesting dates, and severely affected market linkages [85].

From the foregoing reviews, it is obvious that asymmetric information, which presents a situation of unequal access or lopsided information, affects both the food producers and consumers, and this accounts for one of the reasons why Africa is still largely ravaged by hunger and malnutrition. Hunger results from the majority of people in rural areas of Africa suffering from lack of access to the internet and electricity, which in turn negatively affects food security as farmers lack adequate information on how to navigate challenges in the food supply chain. Farmers with a lack of accurate information thus do not have an idea of how to supply food to the market, and even if they do, they often fall victim to inaccurate information from the middlemen, which in turn impacts food prices. Higher food prices, which are sometimes induced by the misguided actions of middlemen in the supply chain, may increase hunger and the number of undernourished people [86]. Farmers in remote areas, who often rely on middlemen due to a lack of access to the internet and electricity, are likely not to be aware of the market prices and may not earn much from their production. The larger implication of this is food insecurity, and it is one of the reasons why hunger and malnutrition persist, hence the unsustainability of Africa's quest for food security [87].

7. Asymmetric Information and Sustainability of Food Security in Africa: The Role of Organizations and Government

The ability to maintain and support the process of food production or availability, accessibility, and utilization over time depicts sustenance. Food security, where every person, household, or community would be food secure in terms of the total eradication of hunger and malnutrition, as proposed by SDG 2, is a goal that many African states are working to achieve by the year 2030 [1]. However, the extent to which this goal has been achieved in Africa is unclear, as the continent still suffers from hunger and malnutrition. For instance, among the nine countries that were projected to have the highest level of hunger and malnutrition concern in 2023, six (Nigeria, Somalia, South Sudan, Sudan, Burkina Faso, and Mali) were from Africa [88]. This goes to show how unsustainable food security is in Africa, as Africa, like other continents, pledged to achieve zero hunger by 2030, but with the current trajectory (conflicts, bad governance, military interventions, inflation, climate change issues, among others) on the continent, Africa will likely not be able to achieve zero hunger [1]. Africa's score in all four indicators of the hunger index is poor and very low compared to other continents [88]. Undernourishment, child wasting, stunting, and mortality are still ravaging Africa [85]. Although the reasons why hunger and malnutrition have persisted in Africa have been well documented in the literature, evidence shows that asymmetric information has hardly been mentioned as one of the factors responsible for hunger and malnutrition in Africa [1,2].

All the components of food security (availability, accessibility, and utilization) largely depend on accurate information; otherwise, hunger and malnutrition are inevitable [2,43,46]. Lopsided or unequal access to information by farmers, especially those in rural and remote areas, has remained a potential source of discouragement, which in turn affects the productivity of farmers, especially women in Africa [12]. Comparatively, studies have proven that rural areas, unlike urban centers, lack access to the internet and electricity to power their mobile phones, which in turn has limited their capacity to obtain accurate information to

make agricultural choices, such as conducive planting and harvesting times, current prices to fix on their agricultural products, transporting of their agricultural products to markets, storage, and the distribution of food choices [14,18,24]. This has severe implications for food insecurity or the unsustainability of food security in Africa. Similarly, unequal access to information also has a negative impact on the consumers' decisions and choices, as the majority of them tend to fall victim to food fraud and the inadequate utilization of food [89,90]. For instance, as a result of the prevalence of asymmetric information, where consumers have no equal access to information about the best foods to purchase, consume, and utilize, they are likely to be caught in the web of consuming food that is low in nutrients, thus compromising their energy intake and diet diversity [50]. In Africa, as a result of poor access to accurate information, many poor people have consumed unhealthy food that is harmful to their health [50]. In the same vein, due to inadequate information on diet diversity, many consumers and households have continually eaten a particular food without any diet diversity, which has in turn resulted in diseases such as obesity, diabetes, high blood pressure, and stunted growth, among others. Many health issues and diseases stem from an uneven diet and a disordered lifestyle [91]. Poor information about how food is prepared, the nutrient components, and lack of knowledge on the usage of food has caused much mortality in Africa. This, to a larger extent, explains the extent to which food security is far from being sustainable in Africa, as there is a total breakdown in the maintenance and support of the process of creating massive awareness through information dissemination on the importance of diet diversity and a balanced diet.

Similarly, a lack of information is also capable of causing hunger among rural people, as they may not be able to physically access food. Although economic access to food is indicated by money or purchasing power, evidence has shown that some rural people in some African states still could not physically access food due to inadequate information caused by inaccessible internet and electricity. This may have made Ezeoha et al. conclude that the lack of internet and electricity is among the reasons why Africa still faces hunger [2]. The food supply chain has experienced turbulent tensions, as food delivery hardly reaches destinations because farmers and traders have limited or unequal access to information regarding how safe the intra-country roads and transportation channels are in some African countries [92]. In some severe cases, farmers in some rural areas in Africa rely on incorrect and heavily manipulated information from agricultural intermediaries, which frequently benefits these middlemen at the expense of farmers and undermines the sustainability of food security in Africa. This inaccurate middleman information is part of the problem with high food prices, which are often unaffordable for the majority of rural people in agrarian communities. It is clear from this review that asymmetric information is one of the reasons why Africa is still facing the problem of hunger and malnutrition. Farmers and consumers have been worst hit by asymmetric information, as the welfare of both has been threatened in terms of the inability to produce food (availability), the inability to access food, and the poor utilization of food. This has implications for the unsustainability of food security in Africa. Indeed, based on evidence from empirical studies, it is obvious that asymmetric information constitutes a major public policy concern for food security in Africa.

8. The Role of Organizations and Government in Curbing Asymmetric Information and Enhancing Access to Technology in Africa

To address asymmetric information and enhance food security in Africa, organizations with interests in food security, as well as the government, have played a significant role. Organizations in the agro-allied industry or food security sector in Africa have created industry standards with the same implication on all actors in the supply chain [93]. They have also been engaged in the supply of mobile phones to farmers in rural areas for prompt communication and on-the-spot clarification [94]. To address asymmetric information, some of these organizations have deployed the means of certification or revoking the license of operators in the food supply chain. For instance, in South Africa, the Milk Producers Organization (MPO) is an association of milk producer companies that act as middlemen

in transporting milk from dairy farmers to the market [95]. MPO as an organization has instituted standards that must be followed by member companies to curb the effect of asymmetric information on milk delivery to the market [96]. Other roles of the MPO include the distribution of mobile phones to assist rural farmers with communication and the reporting of any fraudulent moves by actors in the supply chain [97]. It is also engaged in curbing asymmetric information and enhancing sustainable dairy farming for all in South Africa, including providing adequate information that can aid animal health and biosecurity and monthly monitoring of members' activities with the aim of identifying fraudulent transactions by members and conducting further investigation with the hope of sanctioning defaulters [98]. This, no doubt, will go a long way in reducing the problem of incorrect and inaccurate information that affects food security in Africa. In an attempt to address the lack of access to accurate information, MPO and other agro-allied organizations (South African Milk Organisation—SAMO; National Milk Distributors' Association—NMDA) have continually assisted in providing updates on the latest technological innovations for farmers to boost food security [99]. Other organizations, such as the Animal Feed Manufacturers Association (AFMA) and the Grain Handling Organization of Southern Africa (GOSA), have all played an active role in curbing asymmetric information, providing digital training workshops for farmers, and enhancing food security in their respective African states. For example, the GOSA has consistently played the role of providing a conducive enabling environment through an adequate update of accurate information to all actors directly involved in the food supply chain [100]. It has also been highly helpful in revealing to farmers and other key players how to curb incorrect information through digital training workshops and seminars. In these training workshops, farmers, especially female farmers, are trained on how to use mobile phones to detect the best planting and harvesting periods [101]. Additionally, the GOSA teaches farmers in the grain supply chain how to navigate and detect wrong information through their phones. It establishes credible communication platforms for information sharing and knowledge to the furtherance of the industry [102]. It also assists in compiling, interpreting, and distributing accurate information to the industry. Similarly, in Nigeria, the Agricultural Society of Nigeria (ASN) is an organization tasked with the role of disseminating accurate agricultural knowledge and information through research publications, including a journal of agriculture, and the organization of agricultural shows, symposia, seminars, lectures, and conferences [103]. It also regulates and checks against the effect of asymmetric information through sanctions, oversight functions, periodic reviews, and accreditation of agricultural institutions in order to promote best practices for agricultural advancement that lead to increased productivity, a favorable return on investment, easier export of agricultural products, job creation along the value chains of such commodities, and stronger national economies [104].

For the control of asymmetric information, the role of the government has been more that of regulations, laws, sanctions, and de-accreditation of fraudulent agricultural institutions and bodies in Africa. To address more access to technology, governments across African countries like South Africa, Kenya, Egypt, Rwanda, and a few others have been engaged in rural electrification to ensure that all the rural areas are powered with regular electricity [105]. This is because the use of mobile phones can only thrive in a community with a regular power supply. The South African government, in recent times, has been able to solve the problem of load shedding that has almost crippled the economy [106]. The government is constantly engaging with local rural farmers through the distribution of mobile phones. In addition, digital training workshops have been conducted where farmers, especially women, can be trained on how to use mobile phones for farming and the distribution of produce to the market. Furthermore, across African countries, the government, through food-specialized agencies, regulates and controls the spread of information about food. The Nigerian government, through the Ministry of Agriculture and National Agency for Food and Drug Administration and Control (NAFDAC), has been able to curb the negative influence of asymmetric information on food security. For instance, on several occasions, NAFDAC has come to the public media and national television to create

awareness and warn the general public against incorrect information peddled by fraudulent food producers [107]. For example, recently, the government agency has shut down and prosecuted unregistered and fraudulent food vendors, including a known religious organization selling spiritual water and other consumable items that are not registered with the agency. The agency has also revoked the licenses of food-producing organizations and rebutted the spread of incorrect information in a bid to discourage consumers from patronizing such fraudulent firms [108]. Although the South African government through AgricSA protects and promotes the interests of farmers in the country, this government agency explores agricultural policies, regulates various departments of water and sanitation across provinces, blocks and detects asymmetric information, and subsequently prosecutes fraudulent bodies caught in the web of asymmetric information [109]. All things being equal, it is hoped that if organizations and governments in Africa continue with the role they play in terms of the provision of mobile phones to farmers in rural areas, a regular supply of electricity, regulation of agricultural bodies, digital education, and extension services for farmers, the lingering challenges encountered in the supply chain will be reduced. To achieve this, government and organizations should be steadfast in the provision of a regular supply of power, ensuring the even distribution of internet services, digital education, and recruitment officers with integrity and a commitment to shun corruption and bribery while doing their statutory job.

9. Conclusions

Across the studies reviewed, it is clear that information emanating from data-driven innovations, such as mobile phones, is critical to Africa's quest to achieve food security. In fact, the sustainability of food availability, accessibility, and utilization also largely depends on the kind of information available to people on the continent. While access to the right, accurate information has aided all of the components of food security, the same cannot be said of asymmetric information that is laden with defects. In the current 21st century Africa, farmers, especially those in rural and remote areas, still suffer from inadequate knowledge about how to manage or adapt to climate change; others still bear the brunt of having low or no clue about safe planting and harvesting periods, storage facilities, marketing of their agricultural products, distribution channels, and the inability to produce in line with approved standards. All these agricultural gaps impugn on food security sustainability in Africa. They are partly some of the reasons why hunger and malnutrition still linger on the continent. On food nutrition and nourishment, Africa's score is still very low and poor compared to other continents. Lopsided and unequal access to information among food users, according to findings in this article, has been partly responsible for persistent malnutrition in Africa.

Instructively, data-driven innovations like mobile phones and access to accurate information are mere tools, which, while being able to solve food insecurity problems, can also aid in heightening them. The genuine implementation of rural electrification and provision of internet accessibility that can sustainably power mobile phones in rural areas, and public openness to the idea of creating awareness through regular dissemination of accurate information committed to enhancing food availability, accessibility, and utilization, especially those that promote diet diversity and food nourishment intake, will combine to lessen the weight of hunger and malnutrition and can galvanize the potentials of information inherent in data-driven innovations for sustainable food security in Africa.

10. Prospect of This Research

The findings are significant for theory and policy. Theoretically, it has expanded discussion on the dimensions of asymmetric information and how digital data innovations can help to enhance positive outcomes of food security. Policy-wise, the findings have provided information on how African states and governments can formulate nationwide policies or reforms on rural electrification and internet accessibility to enhance farmers' access to electricity and internet in rural areas. Importantly, this research has

provided information on how African states, through programs or policies, can utilize specialized agencies in tackling the negative stress of asymmetric information on food security in Africa.

Author Contributions: Conceptualization, V.O.; Methodology, S.C.A.; Software, S.C.A.; Validation, S.C.A.; Formal analysis, S.C.A.; Investigation, V.O.; Data curation, V.O.; Writing—original draft, S.C.A. The published version of the manuscript would be agreed to by all the authors. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest pertaining to this article and its publication.

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