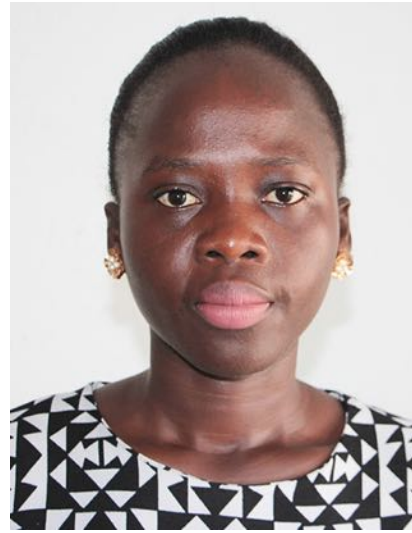


## A REVIEW OF GHANA'S FOOD SYSTEM AND ITS IMPLICATIONS ON SUSTAINABILITY AND THE DEVELOPMENT OF NATIONAL FOOD-BASED DIETARY GUIDELINES

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## ABSTRACT

Food-Based Dietary Guidelines (FBDG) provide culturally-appropriate and actionable recommendations based on which populations can make healthy food choices. Food systems sustainability, from production to consumption, and disposal of food and food-related items, should be a critical consideration for developing such guidelines. This rapid review assesses Ghana's food systems to determine the level of sustainability to inform the FBDG recommendations. Peer-reviewed articles, documents and reports of relevance to Ghana were included in this rapid review. A hundred and eight papers, answering different questions on food system sustainability were reviewed. Bread, cereals, fish and indigenous vegetables are the most frequently consumed food groups. Sugar-Sweetened Beverages are the most consumed imported foods. In rural areas, 53% of dietary protein comes from plant sources. Fish is the main the source of animal protein for most Ghanaian households. There is intensive exploitation of marine and fresh water resources. Most livestock are raised by smallholder farmers using free-range system. Poultry is frequently kept on deep litter system and only a few are large-scale. Crop production for household consumption and small-scale animal rearing are predominant, especially in Northern Ghana. By weight, fruits and vegetables are the least cultivated and consumed crops at the household level. Wood is the commonest source of fuel for cooking, especially in rural areas. Single use plastic is the most used and preferred material for food packaging. Indiscriminate and poor management of waste and pesticide misuse is commonly reported. The findings suggest the need for promoting production diversification, use of clean fuel and reusable food packaging as part of FBDGs to enhance sustainability of Ghana's food systems.

**Key words:** sustainability, food system, Ghana, Food-based Dietary Guidelines, production, diversification



## INTRODUCTION

As the world's population continues to rise steadily [1], there is increased global awareness and efforts to produce adequate quantities and variety of nutritious, affordable foods, while preserving the biosphere. This awareness has resulted in a renewed focus on concepts such as food system sustainability. Food system sustainability is the process of providing food and nutrition security to the entire population while preserving the economic, social and environmental qualities of the bio-system so that future food and nutrition needs can be met [2, 3].

Currently, one-third of global food produce is lost or wasted [4]. This is equivalent to losing the net amount of food produced in sub-Saharan Africa. Meanwhile, future predictions suggest that food production should increase to meet global population demands [4, 5]. The rapid development of the middle class, globalization, and urbanization, continue to shift global consumption patterns away from fresh plant-based foods and plant proteins, towards increasing consumption of animal protein (meat, fish), and ultra-processed foods. The main challenge is that these emerging consumption patterns are environmentally unsustainable [6-9]; they increase greenhouse gases emission and take up more scarce resources (freshwater, arable land, energy from fossil fuels) across the entire food systems. For instance, meat produces about 250 times the greenhouse gases produced by legumes [9].

Food loss/waste is a major challenge to the global fight against hunger, carbon dioxide emissions and loss of human, physical, and natural resources needed to maintain our well-being. This situation is further affected by the declining role of backyard/subsistence farming, and intensification methods requiring the application of inorganic fertilizer to meet food productivity needs [10, 11]. Industrialisation has fuelled agricultural commercialisation which favours mono-cropping, which puts biodiversity at risk [12]. In light of the above, adapting resilient, sustainable practices which conserve the food system while ensuring continuity and resistance of the agricultural system to damage is required [14].

Agricultural productivity in sub-Saharan Africa is low with an annual growth rate of 1.8%, compared to a population growth rate of 2.9%. Thus, many African countries import large quantities of food [15]. Additionally, Africa is rapidly losing its forest cover and productive agricultural lands to deforestation for wood fuel and constructing buildings to meet the accommodation needs of an increasing urban population [16].

The Ghana agricultural sector employs close to 50% of the labour force and contributes to about 19% of Gross Domestic Product (GDP) [17]. Food loss contributes significantly to the low productivity of the Ghanaian food system. Annually, about 20-30% of cereals and legumes, 20-50% of fruits and vegetables, roots and tubers produced in the country do not reach the final consumer and this has plunged the country into the importation of food [18]. Ghana imported 70% and 15%, respectively, of rice and maize requirements in 2014 [19]. Thus, the Ministry of Food and Agriculture has outlined several components of the Medium-Term Agriculture Sector Investment Plan to improve agriculture sustainability and food security. These included



modernizing agriculture by improving productivity, mechanization, irrigation and water management among other components [20].

Strategic investment in food systems and agricultural-related activities from production, marketing and consumption will ensure sustainability. Adequate evidence is needed to better understand issues on production, management, consumption and waste disposal practices. Such information can support national food guidance, such as food-based dietary guidelines. This rapid review assessed the sustainability of Ghana's food systems focusing on production, consumption and waste disposal.

## METHODS

### Search strategy

Peer-reviewed articles, documents, and reports of relevance to Ghana, irrespective of their publication date, were included in this rapid review. Google, Google Scholar, Science Direct, PubMed and JSTOR databases were searched from 20<sup>th</sup> July to 4<sup>th</sup> August, 2020. Details of the search terms used and the search period for each database is presented in table 1. Experts and stakeholders working in different governmental and non-governmental institutions provided additional relevant documents for this review.

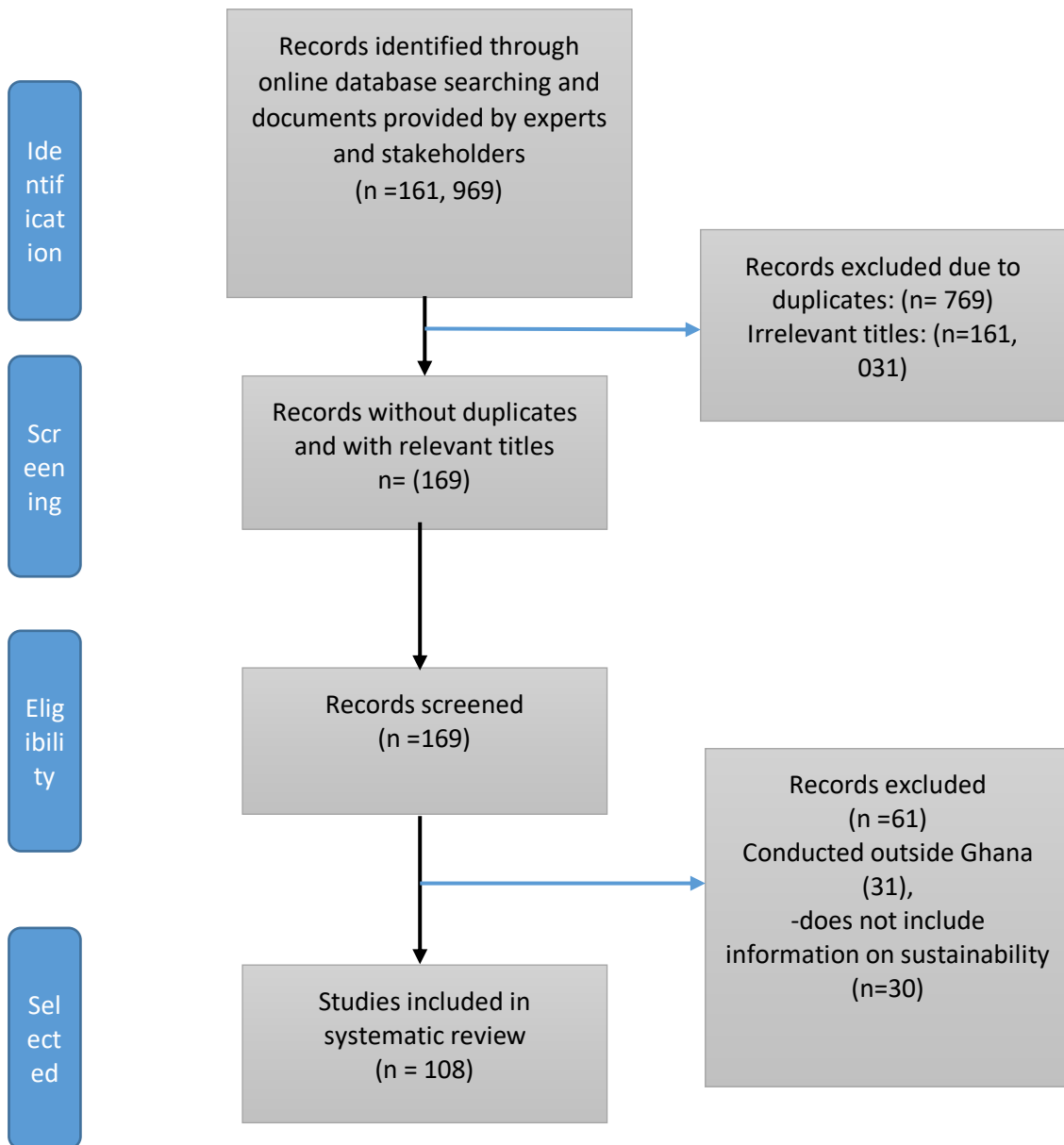
### Inclusion and exclusion criteria

The rapid review included papers conducted in Ghana or and of relevance to Ghana. All papers and documents that collected data on any dimension of food system sustainability such as food waste and or loss, production methods, packaging, energy use, consumption practices, waste disposal, and nutrition education were included in the study.

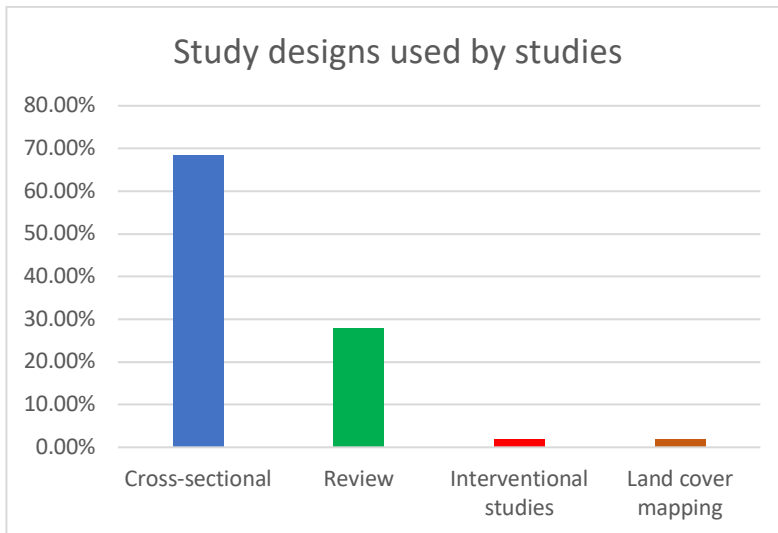
### Evidence synthesis

A total of 161, 959 documents were retrieved from online databases; an additional ten documents were obtained from experts in various institutions, resulting in 161, 969. A total of 161, 800 were rejected based on titles. The abstracts of 169 papers with relevant titles were screened. The full versions of 123 documents that passed abstract screening were read. Sixty-one papers were rejected at these two stages. A total of 108 studies were included in this review. Figure 1 shows the Prisma flow diagram for study selection. Majority of the documents were based on cross-sectional (68.5%) studies. Greater Accra region was the site for almost one-fifth of the documents (16.7%). Study designs of documents and their regional distribution are presented in figure 2 and 3. The papers included in this rapid review were diverse. For those who reported on food production, most assessed the number of crops produced and the total land covered by cash and crop farming. Studies that assessed household-level consumption usually used multiple 24-four-hour recalls, dietary diversity score and food frequency questionnaire.

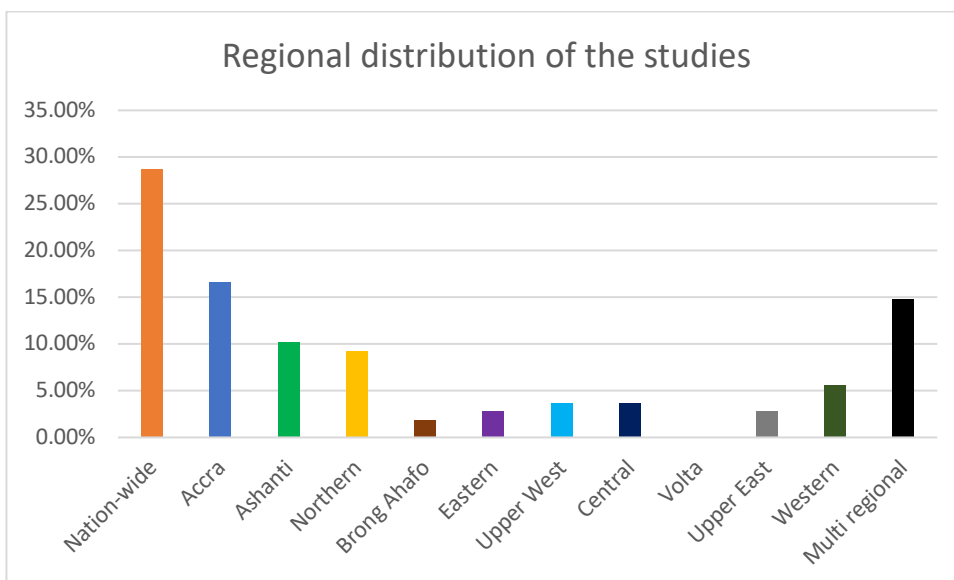




**Figure 1: Data extraction table**



**Figure 2: Study design of studies included in the review**



**Figure 3: Regional distribution of studies**

### Evidence extraction

Data extracted from the included studies were author, year of publication, region or district in which studies were conducted, sample size, mean, median or age range of study participants, methods and findings on agriculture sustainability.

### Quality Assessment

The Effective Public Health Practice Project (EPHPP) quality assessment tool was used to rate papers on their quality level. Studies were rated as strong, moderate or weak based on a priori criteria. The criteria comprised of representativeness of sample size, percentage of sample size, appropriateness of study design, description of cofounders, blinding for interventional studies, validity and reliability of data collection tools and procedures, drop-outs and appropriateness of analytical methods. Each criterion is rated



as strong, moderate or weak. Each paper's overall rating was either strong, moderate or weak based on each criterion's rating. Papers were rated as strong if they had no weak rating in all the criteria, moderate if they had one weak rating and weak if they had two or more weak ratings.

### Limitation of the review

The majority of the documents included in the review were cross-sectional. Although a large number of the included documents indicate research on food system sustainability in Ghana, the studies were predominantly localized in some regions of Ghana while in some regions, there was only one study conducted. Additionally, only one paper was found on nutrition education of school children in Ghana.

### Findings

The framework presented in figure 4 shows a summary of the findings of the review.

### Food Consumption

Fifteen studies reported on food consumption [21-31]. Carbohydrate foods are the main source of energy and consist mainly of cereals, roots, tubers and plantain [25]. Cassava is the most consumed staple crop [32]. Of the cereal group, the most frequently consumed are maize and rice. Among urban dwellers, most of whom depend on food purchases to meet dietary needs, there has been a reduction in tubers and other indigenous staple foods and an increase in refined foods such as imported rice. For instance, rice consumption, most of which is imported, is greater than three times per week among 60% of households in Accra [23]. Cereals, roots, tubers and plantain are usually consumed with vegetable-based soups and sauces, but the quantities of the former are usually far lesser than the latter.

In the Northern part of the country such as in the Upper West region, guinea corn, millet and legumes are important staple crops [33] while rural dwellers in the Eastern region of the country frequently consumed plantain, yam and cocoyam. Nation-wide analysis of available dietary data from urban areas indicates that, among the general Ghanaian population, the least consumed food group is milk and dairy [31]. Its consumption ranges between 0-0.7 servings per week. Fruit consumption is also low and is occasionally consumed as a result of their seasonality and or because they are not part of traditional eating behaviour [30, 33, 34].

Among urban Ghanaians, the most frequently consumed snacks were sugar-sweetened beverages, pastries, sweets, roasted corn, roasted plantain and groundnut [31]. The young and wealthy group of the urban population frequently consumed milo, sugar-sweetened beverages, rice, red meat, eggs, margarine and exotic vegetables. On the other hand, deprived and the elderly frequently consumed fruits, plantain, smoked fish, palm oil, beans, 'banku' (corn and cassava dough meal) and indigenous vegetables [31]. Among urban dwellers in the Ashanti Region, the dietary pattern consisted of dairy products, red meat, processed meat, eggs, pasta, legumes, rice, snacks and condiments while that of rural dwellers consisted of refined cereals, fruits, nuts, seeds, roots, tubers, plantain and fermented maize [25]. Within 1991/1992-2011/2012, the consumption of eggs increased from 0.56 kg per capita to 1.2 kg per capita while meat



consumption increased from 1.27 kg per capita to 7.98 kg per capita. Poultry meat consumption has also increased over the years, and its share of total food expenditure rose from 3% in 1991/1992 to 8% in 2012/2013. The observed increase is more profound among urban and peri-urban households.

### **Agricultural land use; animal and crop farming**

Thirty-five papers reported on agricultural land use, crop production, livestock rearing and fishing [24, 33-66]. Smallholder farmers dominate the agricultural sector in Ghana, and altogether, they produce 80% of the total agricultural output [62]. In a nationwide study, Ecker & Fang [48] observed an increase in the size of cultivated land and the number of food crops. Land size increased significantly from  $6.68 \pm 7.56$  acres in 2006 to  $7.19 \pm 7.04$  acres in 2013 whereas the number of food crops cultivated increased from  $2.11 \pm 0.98$  to  $2.13 \pm 0.9$  but this increase was not significant. Asante & Amuakwa-Mensah [62] in congruence also reported an expansion of land under cultivation but no increase in the number of crops. Cropland in the Northern region decreased from 57% to 51% within eight years and the remaining face a significant risk of being converted to residential land; the average landholding in the Northern and Brong Ahafo was 2.9 hectares [39, 43]. Poor households in Western and Eastern regions could not access land for agricultural production due to land acquisition changes and the sale of potential farmlands by kinsmen for economic gain rather than releasing it to family members for farming [59]. In rural areas of the Northern and Ashanti regions where a similar situation occurs, it has reduced the number of cash and non-cash crops produced, mono-cropping, and intensification of grain production. These practices have negative impacts on nutrition security and food systems sustainability in the country [52].

Farming remains a predominant rural activity, particularly among rural households in the Northern regions [26]. The commonly cultivated crops were maize, cowpea, groundnut, millet, plantain, green leafy vegetables, garden eggs, okro, pepper, tomatoes oranges, pineapples, bananas, [24, 57]. Of these, maize was the most grown, but tubers, roots and plantain were the most consumed home-grown foods followed by maize and other cereals [38, 39, 41, 52, 57]. About 650,000 hectares of land in the country is dedicated to maize production [53]. The average household land holdings are larger in the south compared to the northern regions. Average household land holdings were 3.6 ha in the Brong Ahafo region, 3.3 ha in the Northern region, 3.0 ha in the Upper West region and 1.8 ha in the Upper East region. In rural areas of the Ashanti Region, the average household land holding was 5.7 ha (42). Households in the Northern part of the country use 30 kg of maize, 20 kg of rice and 12 kg of soyabeans produced over 2.7 ha of land as seeds, while a majority of food consumption needs are met by own cultivated crops [39, 46]. The least cultivated crops were fruits and vegetables, and they were also the least consumed own grown foods [26]. Cash crops cultivated were predominantly cocoa, oil-palm, rice, soya beans, maize and tomatoes [37, 39, 40, 44]. Across the country, cocoa is the most cultivated cash crop [63]. Cash cropping was associated with food insecurity as households were unable to meet their food needs with income generated from the sale of cash crops [40, 60]. Poultry, most of which consisted of chicken were reared on a small scale wherein family labour is used, and locally available raw materials are used for feeds. The number of poultry birds kept per farm or



household range between 10 and 5000 [36, 41, 50]. Among farmers engaged in poultry farming in the Greater Accra municipality, 80% kept more than 500 birds [50], [41]. However, nationwide trend analysis reveals a significant reduction in poultry quantities produced in the country [58]. Between the period of 1970 to 1980, Ghana produced enough poultry mainly chicken and eggs to meet its local consumption needs, however, there was a consistent decline in domestic poultry production due to infiltration of frozen chicken imports which tend to be cheaper [58]. About 39 million chickens were reared by Ghanaian households in 2012/2013 [26]. Five other papers reported on ruminants and non-ruminants aside poultry [33, 34, 26, 41, 49]. Generally, animals including cattle, sheep and goats are reared mostly in the Northern part of the country, on a small scale, purposively for sale or as security during times of urgent need for cash; on the average households consumed less than 10% of their own produced livestock [26, 33]. National data from the 2012 survey indicates that goats were the most raised ruminants, and about 1 million goats are raised altogether by Ghanaian households [26]. Within ten years spanning 2001 to 2010, the production of goat, sheep and cattle increased by 52%, 36% and 11%.

Three studies reported on fish farming [26, 64, 66]. The studies documented that a total of 331, 500 metric tons of fish are produced in Ghana. Fishing is a major source of livelihood for urban households in coastal areas [26, 66]. Aquaculture production increased by about 15% per year between 2009 and 2014, but it constitutes 11.6% of overall fish production in the country. Marine fisheries production constitutes 61% of fish produced in the country, but there has been a decline from 420,000 metric tons in 1997 to 203,000 metric tons in 2014 [66]. Freshwater fish make up 27% of the total fish produced in the country. The small-scale fishing industry produces 70% of marine fish supply. There has, however, been a decline in fish production in recent years [66, 67].

### **The current level of mixed-crop and livestock farms**

Three studies reported on mixed-crop and livestock farms [33, 26, 41]. More than half (51.5%) of households in Ghana are engaged in farming. A greater proportion of households (4.9 million) are engaged in crop farming than livestock raising (4.5 million) [26]. Livestock rearing is dominant among households in the rural North and is usually an adjunct to crop farming. Faeces from livestock production could be used in the crop farm for fertilizing soil while farm products such as unwholesome maize could be used for feeding livestock. In the Greater Accra region, about 10% of households are engaged in mixed farming [41]. In the northern part of the country, the land is purposely provided for crop farming but not for livestock raising. Livestock farmers, therefore, rely on the free-range system for animal feeding [33].

### **Production of ruminants and non-ruminants**

Three studies reported on the production of ruminants and non-ruminants [26, 33, 34]. Non-ruminants comprising mainly chicken are the most raised livestock. As of 2012, two million households in the country raised chickens, a million raise goats and a small number of households raise other types of livestock. A total of 39 million chickens are raised in the country, and 4 million guinea fowls are reared. A total of 7 million goats, 6 million sheep, 2 million cattle are reared altogether by Ghanaian households [26].



### **Extensive and intensive livestock and poultry farming**

Eight studies reported on extensive and intensive livestock and poultry farming [23, 26, 33, 34, 36, 58, 68, 69]. Majority of livestock and poultry farmers are small scale holders—the majority of farmers who keep livestock such as cattle practice free-range system and open grazing [33]. In the northern part of the country, household members' usually adult children are responsible for herding, tethering, feeding and caring for sick animals [33]. For those who raise poultry, most practice deep-litre system [68]. About 1508 broiler chicken-producing poultry farms and 2889 egg-producing farms exist in the country. The distribution of the 1508 farms are as follows; Greater Accra, 21.1%, Eastern, 18.4%, Central 14.7%, Ashanti region, 14.2%, Brong Ahafo 13.7%, Western 9.9%, Volta 5.4%, Northern 0.9%, Upper West 0.9%, Upper East 0.7%. Majority of the poultry farms 98.7% operate on a commercial scale and are found in the southern part [68]. Of this number, only about thirty are large scale farms, and the rest are small scale [69].

### **Animal and Plant source Food Consumption**

Twenty-one papers reported on food consumption [21, 24, 28, 29, 30, 31, 33, 37, 40, 49, 64, 66, 70-78]. Protein makes up 8% of total energy intake and is composed mainly of fish; which accounts for 60% of total animal protein consumed. Per capita, fish consumption was 28kg in 2014 [78]. Dried fish consisting of mostly herrings was the most frequently consumed fish type [21, 29, 74]. The most commonly consumed meat is beef (50%) and chicken (31.3%). Pulses and nuts, including soya beans and groundnuts, are an important source of protein for households in the Northern part of the country. Among children under five years in the Northern region of the country, 96.4% consumed grains, roots and tubers, 45-60% consumed legumes, 15% consume dairy, while less than 1.5% consume eggs [64]. The children's diet completely lacked fruits, while the consumption of fresh vegetables was high in the post-harvest period. Non-timber forest products such as mushrooms, snails, honey and fruits were frequently consumed by households in the Western region, especially by poor households (5-6 times per week) [37].

In rural areas of Ghana, plant source contributed 53% of total protein intake while animal sources contributed 47% [74]. In the Western Region, the consumption of plant source protein was greater than animal source, especially among poor households. Bushmeat consumption is common among rural households in the Western and Ashanti regions [21, 71]. Bushmeat consumption is more prominent during lean seasons and contributes significantly to protein consumption of rural farmer households in the Western region [74]. In the same region, 21,410 kg of bushmeat was consumed monthly, which is equivalent to 0.001kg/person/day [71].

### **Fuel for Cooking**

Three studies reported on fuel used for cooking [26, 81, 82]. A high proportion of Ghanaian households (41.3%) use wood as a main source of cooking. Charcoal is used by about 30%, while 22.3% use gas. The use of firewood is more prevalent among rural households, where more than 70% of households rely on wood for cooking [26]. This is especially so for rural households (87.4%) in the Northern region. Among rural



dwellers in the Ashanti, Eastern, Western, Northern, Upper West and Volta region, 80% use wood as the main source of cooking [81]. In rural areas of the Upper East region, 100% of residents use wood as a main source of cooking; among urban households, fuel usage is 10% for wood, 60% for charcoal and 29.9% for gas [82]. Nationwide, households in urban areas use predominantly charcoal (43.6%) or gas (35.8%) for cooking [26].

### **Food Packaging**

Two studies reported on food packaging in Ghana [83, 84]. Among urban residents in the Eastern region of Ghana, about 90% use plastic bags for food packaging, while close to 50% preferred plastics for food packaging. Of those same residents, 7% used glass, 3.5% used paper and less than 2% used leaves. Meanwhile, about a quarter of respondents preferred leaves packaging because they opined that leaves are more environmentally friendly [83]. In urban areas of the Ashanti region, leaves are used in packaging wide varieties of local foods such as kenkey [84].

### **Nutrition Education**

Only one study reported on nutrition education, and this was an interventional study [85]. A six-week nutrition education intervention was carried out among primary school children in the Eastern and Greater Accra regions. The education encompassed topics on food groups, serving and portion sizes, food safety and personal hygiene. The nutrition education significantly improved nutrition knowledge in both lower and upper primary pupils who belonged to the intervention group.

### **Waste and waste management**

Thirty-one studies reported on waste and waste management [51, 66 86-99, 100-110]. The average amount of waste generated daily by households in urban areas ranged from 0.25 kg to 2 kg [87, 93, 100]. Across the country, about 14, 000 tonnes of plastic waste are generated annually from sachet water consumption [109]. Approximately half of the households in Ghana dispose of waste at public disposal sites, about 20% burn or bury the waste while 19% dump waste in water bodies and gutters. Open dumping is more common in the three Northern regions as opposed to Accra, where a majority of households have communal dustbins that are collected periodically from the household [89, 103, 110]. In the Greater Accra and Kumasi metropolises, low-income households usually separate plastic waste consisting mainly of water sachet from other waste generated because of monetary incentive for collecting empty water sachets [91, 96, 108]. With the exception of waste separated for monetary reward, majority of Accra households do not practice waste separation, and medical waste is also disposed of together with household waste [107, 111]. In the Ashanti and Greater Accra regions, indiscriminate waste disposal was more common in rural areas compared to urban areas [98]. Households in the Greater Accra and Central regions store household waste in polythene bags or uncovered containers prior to disposal. In the Accra, Kumasi, Takoradi and Tamale metropolises, households were willing to pay for improved garbage collection and waste management services [94, 112]. Waste management services could significantly reduce the amount of waste generated, but a majority of the households in Accra who use waste management services are not satisfied with their services [86, 100, 110, 111]. Five studies reported on food loss [51, 66, 92, 105, 110].



Among households in the Greater Accra region, about 93% disposed of food debris as waste [110]. An assessment of post-harvest fish losses in the Western region of Ghana reveals that within six years, 92 metric tons of fish were lost. The leading causes of fishing loss were inadequate storage facilities and lack of ice for preservation [51, 66]. For rice produced in an urban area in the Ashanti region, about 8% was lost at the harvesting stage while about 9% was lost to drying and storage [92].

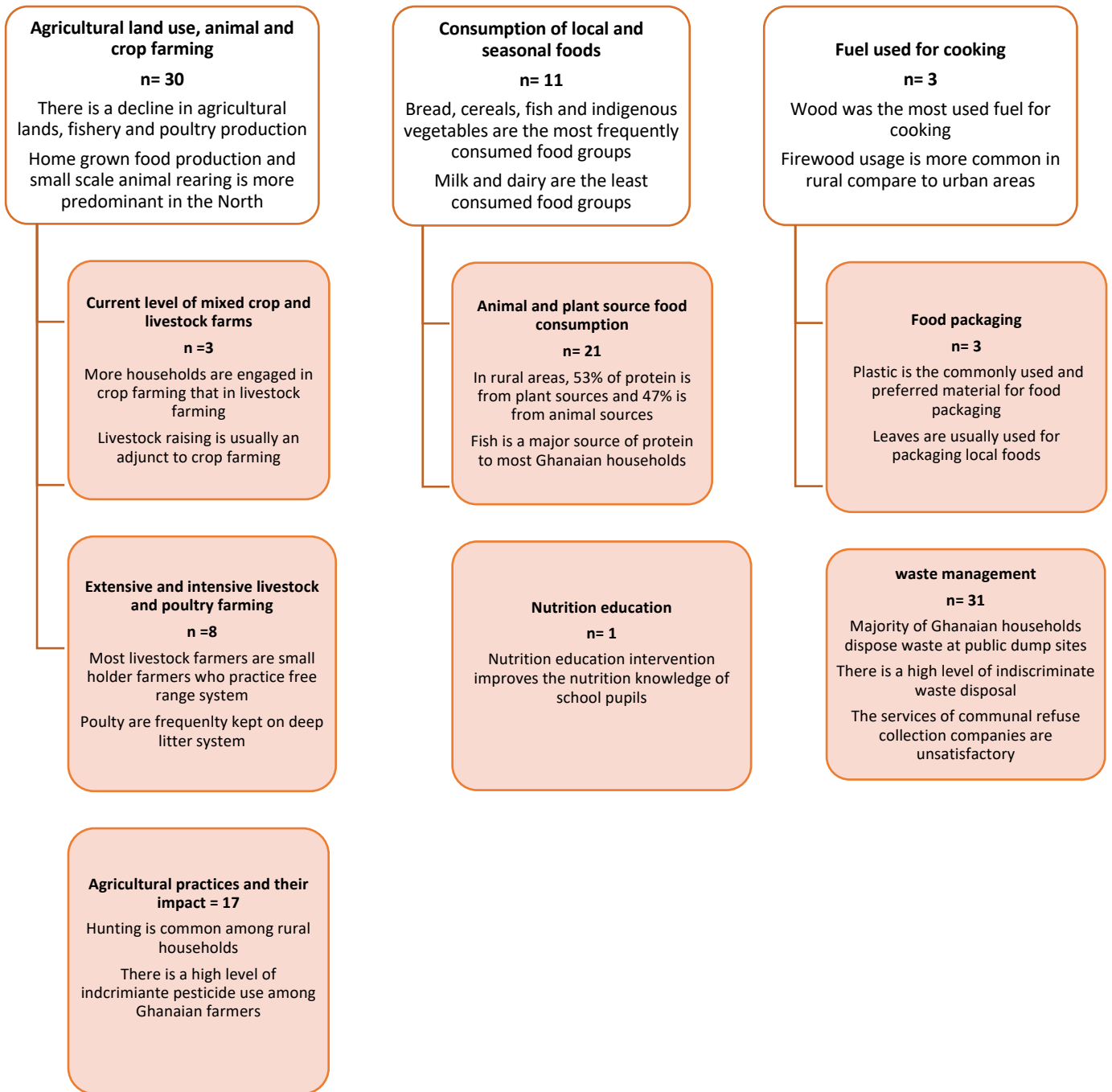
### **Agricultural practices and their impact**

Seventeen studies reported on agricultural activities and their impact on the environment [62, 73, 113-115, 117-127]. Agriculture is the second largest contributor to greenhouse gases in Ghana and contributes 15% to total greenhouse gas emissions, of which clearing land through bush burning contribute 45% [127]. Livestock rearing, chemical application, rice farming and burning contributes most to greenhouse emissions [118, 123]. The gas emissions consist of carbon dioxide, methane and nitrogen dioxide [118, 123].

Five studies specifically reported on hunting [71, 73, 115, 116, 117]. Hunting was a common practice among rural households and is sometimes used as a pest control strategy rather than as a source of bushmeat for food [21]. In the Ashanti region, 28% of households actively engage in hunting and 25% hunt throughout the year [21]. In the Western region, the total volume of bushmeat hunted and sold per month was 15, 859 kg, a situation that has led to the extinction of some mammal species within some parts of the area [71, 74].

Six studies reported on pesticide use [119, 120, 121, 124, 125, 128]. There is a high level of indiscriminate pesticide use among Ghanaian farmers. In the Eastern and Greater Accra regions, pesticide use is about 13 times higher than the level recommended and posed a significant risk to aquatic systems [119, 124]. Farmers in the two regions were not knowledgeable on pesticide use and applications and mixed different types of pesticides into one spray for application [119]. The use of unregistered pesticides was rampant in the Ashanti region [113]. Pesticides are mostly applied to cocoa, vegetables and fruits [120].

Two studies reported on bad fishing practices [114, 123]. During unfavourable climatic conditions where there is a significant reduction in big fish catch, fisher folks (72.7%) in the Brong-Ahafo region catch smaller fish and fingerlings to compensate for the low catch. In the Greater Accra region, the practice of light fishing is common among fishermen and contributes to the depletion of fingerlings and high levels of fish spoilage [114].



**Figure 4: The conceptual framework used for the summary of findings**



## DISCUSSION

This review provides essential information on the different aspects of Ghana's food system, including food production, consumption and waste disposal practices and its implications on sustainability and the development of national food-based dietary guidelines. It also reveals the opportunities that exist for strengthening sustainable practices and for dis-incentivizing unsustainable ones.

The consumption data available indicate that staple foods such as roots, tubers, grains and indigenous vegetables still form a major part of the Ghanaian diet despite the country undergoing nutrition transition as evidenced by frequent consumption of sugar-sweetened beverages especially among the urban wealthiest and youngest population. This trend is typical for African countries undergoing the nutrition transition; the initial adoption to dietary changes occurs among the aforementioned groups before it penetrates other population members and becomes ubiquitous [129]. Studies on the broad-based consumption practices remain limited in Ghana, and the possibility of underestimating current consumption levels for ultra-processed foods and snacks remains high. Livestock raised at the household level are usually sold, and protein consumption is inclined towards plant proteins, especially among rural dwellers and poor households. This consumption pattern is environmentally sustainable, but there is the need to promote complementary proteins and consumption of vitamin C foods with plant-sourced proteins to prevent anaemia and other essential amino acid deficiencies which are prevalent among the Ghanaian population [8]. These can be attained through strengthened agricultural production systems; however, pooled results from this rapid review suggest a decline in agricultural production fuelled by land acquisition changes that plunge the country into food importation of which majority are processed prior to importation.

Countrywide observations also suggest a focus on a limited number of crops, irrespective of land size and therefore, limited options exist for dietary diversification [48, 60, 62]. Bush burning, which contributes significantly to agriculture-related greenhouse emissions remains the main mode for preparing land for planting. Household-level production contributes significantly to dietary intake especially among rural households, and in urban households home grown foods complement foods purchased. There is much focus on staples like maize at the household level, while fruits and vegetables remain the least produced and consumed [26]. Fruits and vegetables are the most expensive food group, and home production for consumption is an avenue for achieving inexpensive, healthy diets. Nutrition education provides an opportunity for influencing dietary behaviour, but its level of incorporation into the curriculum is under-researched, and its impact is unknown. Indiscriminate use of pesticides especially in fruit and vegetable cultivation and fishing raises food safety concerns among the Ghanaian public especially regarding the safety of consumption of fruits and vegetables which further compounds the problem of inadequate intake [130].

Ghana is far from achieving the sustainable development goals, especially goal seven (7) which targets transitioning to clean and affordable domestic fuel use for the entire global population. More than a quarter of Ghanaian households use wood as a main





source of cooking, and in rural areas, the proportion is much higher. Household interventions should focus on making clean fuel affordable because cost remains the strongest barrier to clean fuel adoption [131]. Cooking fuel is often not mentioned in FBDG, but households that rely on wood fuel often face intermittent fuel shortages and are sometimes unable to cook at home resulting in the reliance on unhealthy street foods.

The area of food packaging remains under-researched, but the predominant preference and use of plastics as food packaging is problematic, and this unsustainable trend has a devastating impact and implications for food production and consumption. Current waste disposal services and practices are inadequate to effectively dispose of the tonnes of plastic waste produced by the consumption of sachet water alone. Waste disposal in the country remains conventional, further deepening the need for promoting reusable and recyclable food packaging.

Food-based dietary guidelines should be comprehensive, taking into account the sustainability implications on the environment and global environmental targets and not only focus on promoting healthy foods [132-134]. However, they should also be practical by considering the socio-economic and environmental contexts within which food consumption occurs [135-137]. Evidence from this review indicates that Ghana is far from attaining dietary targets set by international organizations like the World Health Organizations (WHO) and Eat Lancet recommendations regarding the usage of FBDG to achieve healthy food consumption and sustainable environments. Majority of food-based dietary guidelines do not meet global targets, but FBDG are based on consumption evidence, and countries including Ghana will have to transition gradually from its current stage to optimal recommendations set by international agencies [135, 136].

## CONCLUSION

The WHO recommends country-specific targets that are practical in each country's context. In Ghana's case, promoting complementary proteins, backyard farming for fruits and vegetables, nutrition education, clean fuel use, and reusable food packaging constitute an initial sustainable step in the development of FBDG for the country.



**Table 1: Search strategy and search terms used**

| Database                  | Date   | Search terms/combinations  |
|---------------------------|--|--|
| Google and google scholar | 20-24 <sup>th</sup> July, 2020                 | 1. Agriculture ‘OR’ farming ‘AND’ land use ‘AND’ trends ‘AND’ Ghana  |
| PubMed                    | 25-26 <sup>th</sup> July, 2020                 | 2. Food consumption ‘OR’ diet ‘AND’ animal ‘AND’ Ghana   |
| Science Direct            | 27 <sup>th</sup> -31 <sup>st</sup> July, 2020  | 3. Food consumption ‘OR’ diet ‘AND’ crop ‘OR’ plant ‘AND’ Ghana  |
| JSTOR                     | 3 <sup>rd</sup> – 4 <sup>th</sup> August, 2020 | 4. Crop farming ‘OR’ agriculture ‘AND’ method ‘AND’ Ghana  |
|                           |  | 5. Livestock ‘OR’ animal farming ‘AND’ method ‘AND’ Ghana  |
|                           |  | 6. Sustainable agriculture ‘AND’ Ghana   |
|                           |  | 7. Sustainable diet ‘OR’ food ‘AND’ Ghana  |
|                           |  | 8. Household ‘AND’ food waste ‘OR’ food loss ‘AND’ Ghana   |
|                           |  | 9. Disposal ‘AND’ household waste ‘AND’ Ghana  |
|                           |  | 10. Nutrition education ‘OR’ food ‘OR’ diet ‘AND’ School ‘AND’ Ghana ‘AND’ children                                    |
|                           |  | 11. Fuel ‘OR’ energy ‘AND’ household ‘AND’ food ‘AND’ preparation ‘OR’ cooking ‘AND’ Ghana                             |
|                           |  | 12. Food package ‘OR’ plastic ‘AND’ Ghana ‘AND’ sustainable ‘OR’ Planet, and Waste ‘AND’ manage ‘AND’ Ghana ‘AND’ Food |

**Table 2: Data Extraction table**

| Study title  | Author                                   | Sample size                  | Study site  | Mean age if reported | Study design                   | Main study methods  | Major findings  | QA       |
|--|--|------------------------------|---|----------------------|--------------------------------|---|---|----------|
| 1. Agricultural transformation and food and nutrition security in Ghana: Does farm production diversity (still) matter for household dietary diversity | Oliver Ecker, (2018)                     | 3994 in 2006<br>7223 in 2013 | Nationwide  | Not reported         | Cross-sectional                | Questionnaire   | Cultivated land size increased from 6.68 ±7.56 in 2006 to 7.19 ±7.04 in 2013.   | Strong   |
| 2. The poultry industry in the Wa municipality of the Upper West region of Ghana; Prospects and Challenges   | Agyemang, 2014                           | 10 poultry farmers           | Wa municipality Upper West                                | Not reported         | Cross-sectional                | Use of secondary and primary data<br>Key informant interviews<br>Focus group discussion | There is a high preference for imported chicken because it is affordable.   | Weak     |
| 3. Exploratory and multidisciplinary survey of the cowpea network in Tolon-Kumbungu district of Ghana: A food sovereignty perspective                  | Quaye <i>et al.</i> , 2009               | 86                           | Tolon-Kumbungu, Northern Region                           | Not reported         | Cross-sectional, questionnaire | Focus group discussion  | 47% of farmers reported cowpea as soil nitrogen booster, and this was ranked first as the chief role of cowpea in the farming system. | Moderate |
| 4. Socio-economic Characteristics of Subsistent Small Ruminant Farmers in Three Regions of Northern Ghana  | Faizal Adams, Kwasi Ohene-Yankyera, 2014 | 249                          | Northern region<br>Upper West region<br>Upper East Region | 47.29±16.00          | Cross-sectional                | Mixed methods   | The average area of farmland was 6.69±7.75 acres. (North 6.32±4.47, Upper East 3.55±3.33, Upper West 11.2 ± 12.87)                    | Moderate |



|  |   |                 |   |              |                 |   |  |          |
|--|---|-----------------|---|--------------|-----------------|---|--|----------|
| 5. Adaptation Strategies of Poultry Farmers to Rising Temperature in the Greater Accra Region of Ghana | Gbedemah <i>et al.</i> , 2018                         | 38              | Accra   | Not reported | Cross-sectional | Questionnaire   | Almost 80% of the farms have a capacity of more than five hundred birds.   | Weak     |
| 6. Is Deagrarianisation Real? A Study of Livelihood Activities in Rural Northern Ghana                 | Joseph Awetori Yaro, 2006                             | 600 households  | Northern Region   | Not reported | Cross-sectional | Qualitative and quantitative data, focus group discussion | Main crops cultivated include rice, soybeans, groundnuts, and gardening. Animals reared include poultry, sheep and goat.                         | Moderate |
| 7. Population and agriculture in the dry and derived savannah zones of Ghana                           | Samuel NiiArdeyCodjoe and Richard E. Bilsborrow, 2011 | 504 households  | Upper East and Ashanti Region<br>Kassena-Nankana district<br>Ejura-Sekyedumase district | 52.2 years   | Cross-sectional | Questionnaire   | Derived savannah households had considerably larger farm holdings, with a mean farm size of 0.6 ha vrs 2.1 ha.                                   | Moderate |
| 8. Agricultural commercialisation models, agrarian dynamics and local development in Ghana             | Yaro <i>et al.</i> , 2017                             | 3 farming areas | Western region, Eastern region  | Not reported | Cross-sectional | Interviews  | There has been a change in customary land acquisition as family heads prefer to sell land to strangers for profits than to other family members. | Moderate |
| 9. Synergies and trade-offs between cash crop production   | Anderman <i>et al.</i> , 2014                         | 250 households  | Ashanti region  | Not reported | Cross-sectional | Qualitative assessment,                                   | Significant negative relationship was  | Moderate |



|   |                             |   |                         |              |                          |   |  |          |
|---|-----------------------------|---|-------------------------|--------------|--------------------------|---|--|----------|
| and food security: a case study in rural Ghana  |                             |   |                         |              |                          | household survey  | found between a household's cash crop production and dietary diversity.  |          |
| 10. Land-Cover Dynamics in an Urban Area of Ghana   | Braimoh and Vlek, 2004      | Not reported                            | Northern Region, Tamale | Not reported | Land cover mapping       | Land cover modelling  | In 1984, cropland occupied over 57% (about 1400 ha) but decreased to about 51% in 1992.  | Moderate |
| 11. Land rights, sustainable natural resource use and agricultural productivity in Ghana                                      | Dzanku, 2008                | 11 districts in Ghana                   | Nationwide              | Not reported | Not reported             | Not specified   | Land rights tend to have no significant effect on the propensity to invest in irrigation and soil improvements.                                    | Strong   |
| 12. The association between the diversity of crop production and nutritional indicators of rural households in Northern Ghana | Argyropoulou, 2016          | Northern region Karaga District (rural) | 328 households          | 0-23 months  | Cross-sectional          | Dietary diversity score, crop diversity indicators          | 96.4% of children consumed grains, roots and tubers as their main foods.   | Moderate |
| 13. Assessing the land use and land cover changes due to urban growth in Accra, Ghana   | Yeboah <i>et al.</i> , 2017 | Accra                                   | Not reported            | Not reported | Land use land cover maps | Land satellite images, secondary data on aerial photographs | Agricultural lands which include both cultivated and irrigated lands, decreased from 94.7 km <sup>2</sup> in 1985 to 69.2 km <sup>2</sup> in 2010. | Moderate |
| 14. Fisheries and Food Security   | USAID, 2018                 | Nationwide review                       | Not reported            | Not reported | Not reported             | Review  | Fish supplies 60% of the animal protein in the national diet with annual per capita fish consumption in 2014 growing to 28kg.                      | Moderate |



|   |                                 |                           |                      |              |                            |   |  |          |
|---|---------------------------------|---------------------------|----------------------|--------------|----------------------------|---|--|----------|
| 15. Innovation for Sustainable Agricultural Growth in Ghana   | PARA, 2017                      | Nationwide review         | -                    | -            | Review                     | -   | 8% of total dietary energy supply comes from protein while 66% comes from cereals, roots and tubers.   | Strong   |
| 16. Ghana's Poultry Sector: Limited Data, Conflicting Narratives, Competing Visions                 | Sumberg <i>et al.</i> , 2013    | Nationwide trend analysis | -                    | -            | Trend Analysis             | Trend analysis of poultry production, consumption and trade | Between the period of 1970s and 1980s, Ghana was self-sufficient in chicken meat and eggs. But now there is high infiltration of frozen imported chicken.                        | Moderate |
| 17. Ghana Living Standards survey round 6   | Ghana Statistical Service, 2014 | Nationwide                | 18000 households     | Not reported | National survey            | National survey, household questionnaire                    | It is estimated that a little over half (51.5%) of households in Ghana own or operate a farm and this is higher in rural areas.  | Strong   |
| 18. Improvement in Crop Production in Ghana: Is it due to Area Expansion or Increased Productivity? | Akudugu <i>et al.</i> , 2013    | Nationwide                | -                    | -            | Analysis of secondary data | Time series data  | The results showed that improvements in the production of most staple crops in Ghana in recent years are largely due to area expansion rather than improvements in productivity. | Moderate |
| 19. Impact of adoption in Ghana of an improved fish processing technology on                        | Nti <i>et al.</i> , 2002        | 51 women                  | Greater Accra region | 46 years     | Cross-sectional            | 24-hour dietary recall,                                     | Protein intake, for example, was more than 200% of the RDA. This is obvious  | Moderate |





|  |                            |                       |  |                 |                    |   |  |          |
|--|----------------------------|-----------------------|--|-----------------|--------------------|---|--|----------|
| household income, health and nutrition   |                            |                       |  |                 |                    |   | because of access to and high fish intake by the respondents adopting the improved fish preservation technology.   |          |
| 20. Food and nutrient gaps in rural Northern Ghana: Does production of smallholder farming households support adoption of food-based dietary guidelines? | Jager <i>et al.</i> , 2018 | 329 households        | Northern region, Karage sub-district   | 11.6±8.2 months | Cross-sectional    | Interviews, dietary diversity score, (Ecker and Fang, 2016)   | Own food production allowed 60% of households to cover their maize and groundnut needs, less than 40% for rice and sorghum, and less than 5% for cowpea and okro.                                    | Moderate |
| 21. Seasonal migration and land-use change in Ghana  | BRAIMOH, 2004              | 42 farming households | Northern Region, (rural)   | Not reported    | Cross-sectional    | Questionnaire, Land stat TM   | There was an increase of over 14 per cent in cultivated land in the second period (1992–1999).   | Weak     |
| 22. Promoting sustainable agriculture in Africa through ecosystem-based farm (Nchanji, 2017) management practices: evidence from Ghana                   | Agula <i>et al.</i> , 2018 | 300 households        | Upper East Region, Kassena-Nankana West District and Kassena-Nankana East District | 42±11 years     | Cross-sectional    | Qualitative and quantitative methods; focus group discussion, questionnaire, key informant interviews | One of the major problems in terms of distance is that most farmers usually find it difficult to transport organic manure. As such, only few farmers can apply organic manure on farms that are far. | Moderate |
| 23. Sustainable Urban Agriculture in Ghana: What Governance System Works?  | Nchanji, 2017              | 40                    | Northern Region, Tamale  | Not reported    | Ethnographic study | Informal conversations, focus groups  | Some farmers cultivate on government lands,  | Moderate |



|  |                               |                |                             |              |                 |   |   |          |
|--|-------------------------------|----------------|-----------------------------|--------------|-----------------|---|---|----------|
|  |                               |                |                             |              |                 | discussions, interviews   | communal lands (by accessing plots of land through chiefs, family heads or clans).  |          |
| 24. Urbanisation and its impact on agricultural lands in growing cities in developing countries: a case study of tamale in Ghana | NAAB <i>et al.</i> , 2013     | Not specified  | Northern region, Tamale     | Not reported | Cross-sectional | Questionnaire, secondary data, observations                                   | Rapid urbanization has caused a drastic change in the land holding arrangements in Tamale. Demand for land has increased leading to increase in value prices of such lands.       | Moderate |
| 25. Assessment of postharvest fish losses: The case study of Albert Bosomtwi-Sam fishing harbour, Western Region, Ghana          | Gyan <i>et al.</i> , 2020     | 330            | Western, Sekondi            | 31-69 years  | Cross-sectional | Questionnaire, interviews, informal fish loss assessment, direct observation, | Postharvest fish loss from 2010 to 2016 was estimated to be 92 tonnes.  | Moderate |
| 26. Meat Consumption Trends in Some Selected Households in Accra Ghana   | Nkegbe <i>et al.</i> , 2013   | 188 households | Greater Accra Region, Accra | Not reported | Cross-sectional | Questionnaire,  | Only 8.5% of the 188 households used meat in their menu daily, 53.2% used meat in their menu once a week, 2.9% used meat only during weekends. 9% rarely used meat in their menu. | Moderate |
| 27. Fish consumption and implications for household  | Quagraine <i>et al.</i> , N.D | 4011           | Nationwide                  | Not reported | Cross-sectional | Food consumption score,   | The average improvement in food   | Strong   |



|  |                                  |               |   |              |                 |   |  |          |
|--|----------------------------------|---------------|---|--------------|-----------------|---|--|----------|
| nutrition and food security in Tanzania and Ghana  |                                  |               |   |              |                 | secondary data  | security is between 13.9 and 15.5 points.  |          |
| 28. Meat production and consumption in the Wa Municipality of Ghana  | Mahaboubil-Haq and Adzitey, 2016 | 110           | Upper West, Wa  | 21-50 years  | Cross-sectional | Semi-structured questionnaire   | The results showed that beef was the most preferred type of meat, followed by chicken, chevon (goat meat), mutton, pork and guinea fowl.   | Weak     |
| 29. Adoption and Impacts of Improved Maize Production Technology: A Case Study of the Ghana Grains Development Project | Morris <i>et al.</i> , 1999      | 420 farmers   | Nationwide  | Not reported | Cross-sectional | Socio-demographic factors,  | Maize is the most widely consumed staple food in Ghana.  | Moderate |
| 30. Changes in Ghanaian Farming Systems Stagnation or a Quiet Transformation?  | Houssou <i>et al.</i> , 2016     | Not reported  | Ejura–Sekyedumase Ashanti region<br>Savalegu–Nanton Northern region (Rural) | Not reported | Cross-sectional | Key informant interviews, focus group discussion, land stat images, mapping out of farm systems | In Hiawoanwu, farmers indicated that anyone who needs farmlands must now buy them. Likewise, in Tindang, no more land is available, and farmers are forced to move far into neighbouring land abundant communities to acquire new lands. | Moderate |
| 31. Economic Development and Nutrition Transition in Ghana: Taking Stock of Food Consumption Patterns and Trends       | Ecker and Fang, 2016             | Not specified | Nationwide  | Not reported | Review          | Dietary trend analysis  | Large shares of the foods consumed in Ghanaian households are own produced on households' farms.   | Moderate |



|  |                                    |                |   |               |                 |  |   |          |
|--|------------------------------------|----------------|---|---------------|-----------------|--|---|----------|
| 32. Improving Nutrition and Health through Non-timber Forest Products in Ghana   | Ahenkan and Boon, 2011             | 200 households | Western region, Bibiani-Bekwai and Sefwi Wiaso              | Not reported  | Cross-sectional | Questionnaire, interviews, previous farming practice, observations | Crops grown were cocoa, maize, oil palm, cassava, cocoyam. 44.4% of respondents engaged in beekeeping.  | Moderate |
| 33. Household food security, food consumption patterns, and the quality of children's diet in a rural northern Ghana community | Armar-Klemesu <i>et al.</i> , 1995 | 20 households  | Upper East  | Not reported  | Cross-sectional | Weighed food record,   | Guinea corn, millet, and groundnuts were the main staples and energy sources of the area. Shea butter and, to some extent, groundnuts were the main and sources of oil. | Weak     |
| 34. Animal and Meat Production in Ghana-An Overview  | Adzitey, 2013                      | Not specified  | nationwide  | Not specified | Review          | Analysis of animal and meat production within a ten-year period    | Animals produced in Ghana are solely for local consumption.   | Moderate |
| 35. Agricultural Production Survey for the Northern Regions of Ghana: 2013-2014 Results  | Amanor-Boadu <i>et al.</i> , 2015  | 527 households | Upper West, Upper East, Northern region, Brong Ahafo region | Not reported  | Cross-sectional | Diary approach, provision of periodic information, questionnaire   | The average size of household land holding was about 2.9 ha, and ranged from under a tenth of a hectare to 63.1 ha.   | Moderate |
| 36. Dietary diversity and nutritional adequacy of under-fives in a fishing community in the central region of Ghana            | Bandoh and Kenu, 2017              | 250            | Central region  | 27 months     | Cross-sectional | Dietary intake assessment, food frequency questionnaire,           | The main food group consumed daily was foods from flesh foods group (meat, and fish consumption   | Moderate |



|   |                                |                |                            |              |                 |  |  |          |
|---|--------------------------------|----------------|----------------------------|--------------|-----------------|--|--|----------|
|   |                                |                |                            |              |                 | dietary diversity score                      | 79.8%). Daily fish consumption was 78% (195 of 250) and accounting for the high consumption of flesh foods daily.  |          |
| 37. Accra: urban agriculture as an asset strategy, supplementing income and diets                                     | Armar-Klemesu and Maxwell, N.D | 559            | Greater Accra              | Not reported | Cross-sectional | Household survey                             | A total of 88 reported a family member being engaged in some form of agriculture; 11 reported fishing as a livelihood.   | Moderate |
| 38. Vegetable production, consumption and its contribution to diets along the urban-rural continuum in Northern Ghana | Chagomoka <i>et al.</i> , 2015 | 240 households | Tamale                     | Not reported | Cross-sectional | Dietary diversity score, 24-hour recall      | Vegetables cultivated included okro, pepper, tomatoes, roselle, jute mallow, egusi, amaranth, onion, garden eggs. They were mainly cultivated for subsistence, as most households sold less than 50% of the crops and consumed the rest. | Moderate |
| 39. Household dietary practices and family nutritional status in rural Ghana  | Nti, 2008                      | 400            | Eastern Region, ManyaKrobo | 28.3 years   | Cross-sectional | Food frequency questionnaire, 24-hour recall | The main starchy staples consumed are cassava, plantain, yam and cocoyam, with cassava being the most frequently consumed. Fish was found to be the main   | Moderate |



|   |                                 |                 |  |                |                      |   |   |          |
|---|---------------------------------|-----------------|--|----------------|----------------------|---|---|----------|
|   |                                 |                 |  |                |                      |   | source of animal protein.   |          |
| 40. Fuel-wood usage assessment among rural households in Ghana  | Wiafe and Kwakwa, 2010          | 207             | Ashanti, Eastern, Western, Northern, Volta, Upper West | 38.1±18.1      | Cross-sectional      | Semi-structured questionnaire           | 67.6% used charcoal for cooking while 80% used firewood for cooking.  | Moderate |
| 41. Rural-urban differences in cooking practices and exposures in Northern Ghana  | Wiedinmyer <i>et al.</i> , 2017 | Not reported    | Upper East Region                                      | Not reported   | Interventional study | Household survey                        | 100% of the rural sample used wood as a main source of cooking. For urban households, the percentages were 10% for wood, 60% for charcoal and 29% used LPG. | Moderate |
| 42. Environmental effects and waste management practices of local food packaging materials in the Birim Central Municipal, Ghana. | Awusi and Kyei, 2017            | 300 respondents | Eastern Region, Akyem Oda                              | 15-47 years    | Cross-sectional      | Questionnaire, site observation         | 264 (88%) of respondents used plastics mostly bags, 20(6.7%) used glass, 11(3.7%) used paper, and 5 (1.7%) used leaves to package local foods.              | Moderate |
| 43. Perceptions of the use of indigenous leaves as packaging materials in the ready-to-eat cornmeals                              | Mensah <i>et al.</i> , 2012     | 230             | Ashanti region (Urban areas)                           | 15 years above | Cross-sectional      | Questionnaires, observation, interviews | Eleven available leaves-packaged corn meals were identified in the market.  | Moderate |
| 44. Primary school-based nutrition education intervention on nutrition knowledge, attitude and                                    | Antwi, 2020                     | 351             | Greater Accra, Eastern region                          | 6-12 years     | Interventional study | Assessment of nutrition KAP. Nutrition  | The six-week nutrition education intervention significantly   | Moderate |





|   |                                    |                                 |                                   |              |                    |  |   |          |
|---|------------------------------------|---------------------------------|-----------------------------------|--------------|--------------------|--|---|----------|
| practices among school-age children in Ghana  |                                    |                                 |                                   |              |                    | intervention;<br>The intervention encompassed six nutrition topics.                                  | improved children's nutrition knowledge in both the lower and upper primary levels in the intervention group.                         |          |
| 45. Understanding drivers of urban bushmeat demand in a Ghanaian market   | McNamara <i>et al.</i> , 2019      | Not reported                    | Ashanti Region Atwemonom, Kumasi  | Not reported | Longitudinal study | Market survey  | Herrings were the most commonly consumed of all marine and freshwater species. The consumption of bushmeat is elastic to their price. | Moderate |
| 46. Environmental risk assessment of pesticides currently applied in Ghana  | Onwona-Kwakye <i>et al.</i> , 2020 | Not reported                    | Eastern and Greater Accra regions | Not reported | Not reported       | Pesticide Risks in the Tropics to Man, Environment and Trade; risk assessment performed using primet | Many pesticides might pose an acute risk to aquatic ecosystems adjacent to the treated fields.  | Weak     |
| 47. Climate change adaptation strategies and fish catchability: The case of inland artisanal fishers along the Volta Basin in Ghana | Mabe and Asase, 2020               | 397                             | Brong Ahafo region                | 41.6±11.9    | Cross-sectional    | Questionnaire  | Out of 397 respondents, 72.7 % catch smaller fish to compensate for the unavailability of bigger fishes due to climate change.        | Moderate |
| 48. The importance of bushmeat in the livelihoods of cocoa farmers living in a wildlife   | Björn, 2011                        | 63 households (791 individuals) | Western Region                    | Not reported | Cross-sectional    | Questionnaire, farm and  | The harvest of bushmeat in the Sui FR was limited to 15   | Moderate |



|   |                                 |              |   |              |  |                                     |  |          |
|---|---------------------------------|--------------|---|--------------|--|-------------------------------------|--|----------|
| depleted farm-forest landscape, SW Ghana  |                                 |              |   |              |  | hunter trap surveys                 | mammal species, indicating that 55% or 56% of mammalian forest species present in nearby protected areas were locally extinct in the study area.   |          |
| 49. Unravelling the Pangolin Bushmeat Commodity Chain and the Extent of Trade in Ghana  | Boakye <i>et al.</i> , 2016     | Not reported | Western Ashanti<br>Brong Ahafo<br>Eastern Central | Not reported | Cross-sectional                              | Direct observation<br>Questionnaire | A total of 341 pangolins were recorded to have been traded by hunters, chop bar operators and wholesalers between September 2013 and January 2014.   | Moderate |
| 50. Pesticide Use Practices and Perceptions of Vegetable Farmers in the Cocoa Belts of the Ashanti and Western Regions of Ghana | Afari-Sefa <i>et al.</i> , 2015 | Not reported | Ashanti region<br>And<br>Western region           | 10-69 years  | In-depth interviews, focus group discussions | 437                                 | 77.4% of farmers use the same pesticides. It appears that even those who claim to have received some form of official training seemed to be still misusing and abusing pesticides in their vegetable fields. | Moderate |
| 51. An exploration of the role of bushmeat in Ghana's rural communities, MSc thesis   | Alexander, 2015                 | 177          | Ashanti region                                    | Not reported | Cross-sectional                              | Questionnaires, interviews          | During the household interviews a total of 37 in Kwaman and 11 households in Jachie  | Moderate |



|   |                             |      |                |   |                                |                                |  |          |
|---|-----------------------------|------|----------------|---|--------------------------------|--------------------------------|--|----------|
|   |                             |      |                |   |                                |                                | reported 'actively hunting' on their farms.  |          |
| 52. Analysis of the determinants of fish consumption by households in Ghana                 | Akuffo <i>et al.</i> , 2020 | 2185 | Nationwide     | Not reported                            | Cross sectional secondary data | Secondary data from the GLSS 6 | For traditional families, fish is complementary to chicken but a substitute for red meat. Non-traditional families also think of poultry as a supplement to fish, yet red meat and pork are the substitutes. | Strong   |
| 53. Lacking in abundance: undernutrition in a Peri-urban fishing community in Coastal Ghana | Bandoh <i>et al.</i> , 2018 | 250  | Central region | 6-59 months<br>28.7±9.5 for care givers | Cross-sectional                | Questionnaire,                 | Of the two hundred and fifty respondents, 79.2% consumed fish more than three times in the past week, while 85.6% consumed staples more than three times in the past week.                                   | Moderate |
| 54. Climate Change and Variability in Ghana: Stocktaking                                    | Asante <i>et al.</i> , 2015 | -    | Nationwide     | -                                       | -                              | Review                         | In the year 2000, the total direct greenhouse gas emission in Ghana was estimated at 12.2 MtCO <sub>2</sub> e (based on carbon dioxide, methane, nitrous oxide and perfluorocarbons                          | Strong   |



|   |                                       |              |                                  |              |                 |                             |  |          |
|---|---------------------------------------|--------------|----------------------------------|--------------|-----------------|-----------------------------|--|----------|
| 55. Food and nutrition security   | Laven <i>et al.</i> , 2018            | -            | Nationwide                       | -            | Cross sectional | Dietary diversity score     | Eggs and condiments are available throughout the year and are consumed in small quantities. Dairy, fish, and meat are generally available but unaffordable.  | Moderate |
| 56. Determination of organochlorine pesticide residue in sediment and water from the Densu river basin, Ghana | Kuranchie-Mensah <i>et al.</i> , 2011 | Not reported | Eastern region and Greater Accra | Not reported | Cross-sectional | Collection of water samples | The mean levels of gamma-HCH were relatively similar at all sites with Nsawam detecting the highest concentration of 0.608 lg kg <sup>1</sup> .              | Moderate |
| 57. Fishery value chain analysis-Ghana  | Antwi-Asare and Abbey, 2011           | -            | Nationwide                       | -            | Review          |                             | Fish output increased appreciably in the late 1960s, thus the marine fish caught between the year 1967-1972 increased from around 105,100 to 301,762 tonnes. | Moderate |
| 58. Greenhouse Gas Emissions in Ghana   | USAID                                 | -            | Nationwide                       | -            | Review          |                             | Ghana's GHG profile is dominated by emissions from the land-use change and forestry sector.  | Strong   |
| 59. Climate change, agriculture, and food crop production in Ghana  | Pinto <i>et al.</i> , 2012            | -            | Nationwide                       | -            | -               | -                           | Agriculture is estimated to be the second largest contributor to   | Moderate |



|   |                            |   |            |   |                            |        |  |          |
|---|----------------------------|---|------------|---|----------------------------|--------|--|----------|
|   |                            |   |            |   |                            |        | Ghana's greenhouse gas emissions.  |          |
| 60. Is there a causal effect between agricultural production and carbon dioxide emissions in Ghana? | Owusu <i>et al.</i> , 2017 | - | Nationwide | - | Analysis of secondary data | -      | There was evidence of a long-run equilibrium relationship running from copra production, corn production, green coffee production, milled rice production, millet production, palm kernel production and sorghum production to carbon dioxide emissions. | Moderate |
| 61. The decline of a regional fishing nation: The case of Ghana and West Africa                     | Atta-Mills, 2004           | - | Nationwide | - | -                          | Review | Much of the fish that is currently imported is frozen (more than 100,000 tonnes annually) and not of high value (approximately US\$ 19.4 million or US\$ 1,330 per tonne) (FAO, 1998).   | Moderate |



|  |   |              |                                |              |                 |  |   |          |
|--|---|--------------|--------------------------------|--------------|-----------------|--|---|----------|
| 62. Structure and Operation of a Bushmeat Commodity Chain in Southwestern Ghana  | Cowlishaw <i>et al.</i> , 2004          | 70           | Western region                 | Not reported | Cross-sectional | Interviews, direct observation,        | The estimated monthly volume of bushmeat sales by market traders and chop bars in Takoradi was 15,859 kg.       | Moderate |
| 63. Health Risk Associated with Pesticide Contamination of Fish from the Densu River Basin in Ghana  | Fianko <i>et al.</i> , 2010             | Not reported | Eastern and Greater Accra      | Not reported | Cross sectional | Analysis of contaminants from fish     | Farmers were not knowledgeable in pesticide application and applied pesticides without reading instructions.    | Moderate |
| 64. Rural protein insufficiency in a wild life depleted West African farm-forest landscape   | Schulte-Herbrüggen <i>et al.</i> , 2017 | -            | Western region                 | -            | Cross-sectional | Protein consumption estimation         | Protein derived from food crops and animals contributed 53% and 47% to total protein consumption, respectively. | Moderate |
| 65. Nutrition knowledge and food consumption practices and barriers in rural Ghana: The case of foods for preventing vitamin A and iron deficiencies | Omari, 2017                             | 300          | Brong Ahafo and Ashanti region | Not reported | Cross-sectional | Focus group discussions                | In all the communities, game (bush meat), frozen poultry, and fish were usually consumed.                       | Moderate |
| 66. Organochlorine Pesticides in Water, Sediment, Crops, and   | Ntow, 2000                              | Not reported | Ashanti                        | Not reported | Cross sectional | Analysis of organochlorinates in water | Endosulfan sulfate was the most frequently  | Moderate |





|   |                              |    |                |              |                   |   |   |          |
|---|------------------------------|----|----------------|--------------|-------------------|---|---|----------|
| Human Fluids in a Farming Community in Ghana  |                              |    |                |              |                   | and human fluids                        | occurring (78%) Organochloride in water with a mean concentration of 30.8 ng/L.   |          |
| 67. Pesticides Use and Policies in Ghana An Economic and Institutional Analysis of Current Practice and Factors Influencing Pesticide Use                             | Gerken <i>et al.</i> , 2001  | -  | Nationwide     | -            | -                 | Review                                  | The study results show that the situation with pesticide in Ghana is similar to those in many other African countries.                    | Moderate |
| 68. Dietary behaviours in the context of nutrition transition: a systematic review and meta-analyses in two African countries   | Rousham <i>et al.</i> , 2019 | -  | Nationwide     | -            | Systematic Review | -                                       | In Ghana, one study reported dairy product consumption of 50.1 g/d (95 % CI 47.4, 52.9, equivalent to 350 g/week.                         | Moderate |
| 69. Light Fishing Operations in Small-scale Fishing in Ghana – A case study of the Chorkor and Teshie–Nungua fishing communities in the Greater Accra Region of Ghana | Agyekum, 2016                | 40 | Greater Accra  | Not reported | Cross-sectional   | Observation, interviews, questionnaires | Light fishing is the main reason for the destruction of the country's fishing stocks because of the frequent harvesting of juvenile fish. | Moderate |
| 70. Dietary patterns and type 2 diabetes among Ghanaian migrants in Europe and their  | Galbete <i>et al.</i> , 2018 | -  | Ashanti region | -            | -                 | -                                       | In urban Ghana, carbohydrates supplied most of  | Moderate |



|   |                                |                |                        |   |                 |   |   |          |
|---|--------------------------------|----------------|------------------------|---|-----------------|---|---|----------|
| compatriots in Ghana: the RODAM study   |                                |                |                        |   |                 |   | the daily energy; and in rural Ghana, energy intake from carbohydrates is much higher.  |          |
| 71. Assessment of Greenhouse Gas Emissions from Different Land-Use Systems: A Case Study of CO <sub>2</sub> in the Southern Zone of Ghana | MacCarthy <i>et al.</i> , 2018 | -              | Greater Accra          | - | Cross-sectional | Assessment of co <sub>2</sub> using gas entrapment methods, measurement of soil temperature and soil moisture | The highest CO <sub>2</sub> emission was observed from the cattle kraal, followed by the paddy rice and the forest ecosystem.                                 | Moderate |
| 72. Adoption of organic agriculture: Evidence from cocoa farming in Ghana   | -                              | Eastern region | 48.7                   | - | Cross sectional | -   | 30% of organic farmers experienced CSSVD, less 20% of conventional farmers experienced the disease.   | Moderate |
| 73. Climate-smart agricultural practices in Ghana   | Naaminong <i>et al.</i> , 2016 | -              | Upper West and Ashanti | - | Cross sectional | Profiling of technology practices   | Participants identified 61 and 21 CSA technologies and practices in the Guinea Savannah and the Forest zones respectively and recommended scaling up of these | Moderate |



|   |                              |   |              |   |                 |                                |  |          |
|---|------------------------------|---|--------------|---|-----------------|--------------------------------|--|----------|
|   |                              |   |              |   |                 |                                | technologies in other zones.   |          |
| 74. Can Local Products Compete against Imports in West Africa? Supply- and Demand-side Perspectives on Chicken, Rice, and Tilapia in Accra, Ghana | Andam <i>et al.</i> , 2019   | - | Accra        | - | Cross sectional | Consumer survey, questionnaire | Three-quarters of respondents eat rice more than once a week, and 20 percent eat rice every day.   | Moderate |
| 75. A Chicken and Maize Situation; The Poultry Feed Sector in Ghana   | Andam <i>et al.</i> , 2017   | - | - Nationwide | - | Review          | -                              | Maize is Ghana's most important cereal crop and is grown by the vast majority of rural households. It is widely consumed throughout the country and is the second most important staple food in Ghana. | Moderate |
| 76. Status of Disease Management and Veterinary Service Delivery for Increase Poultry Production in Ghana*  | Akunzele <i>et al.</i> , N.D | - | Nationwide   | - | Review          | -                              | There is under-utilized capacity along the chain (day-old-chick production, veterinary services, feed production, marketing).  | Moderate |
| 77. Eggs before Chickens? Assessing Africa's Livestock Revolution with an Example from Ghana  | Andam <i>et al.</i> , 2017   | - | Nationwide   | - | Review          | -                              | 318 commercial poultry farms were identified in Dormaa Ahenkro. These farms focus on egg   | Moderate |



|  |                                   |                     |            |   |  |                              |  |          |
|--|-----------------------------------|---------------------|------------|---|--|------------------------------|--|----------|
|  |                                   |                     |            |   |  |                              | production, with seasonal production of broilers for chicken meat.   |          |
| 78. Structure of Ghana's Chicken Industry in 2015  | Amanor-Boadu <i>et al.</i> , 2016 | 4,000 poultry farms | Nationwide | - | Cross-sectional                              | Interview                    | Day-old chicks and deep-litter flooring are the preferred stocking and housing methods in Ghana's chicken industry. About 87 percent of the about 1,500 commercial broiler chicken farms were small. | Moderate |
| 79. Poultry Inputs, Production Costs, and Marketing Channels in Ghana: Findings from a Targeted Field Assessment | GSSP and IFPRI, 2015              | -                   | Nationwide | - | Field assessment, Analysis of secondary data | Assessment of egg production | Chicken consumption increased from 1.27 kg in 1991/1992 to 7.98 kg in 2011/2012, while egg consumption has almost doubled from 0.56 kg to 1.2 kg over the same period.                               | Moderate |
| 80. Analysis poultry sector Ghana 2019 < An update on the opportunities and Challenges                           | RVO, 2019                         | -                   | Nationwide | - | Review                                       | -                            | There are 29 large scale commercial poultry farms currently in Ghana and mostly found in the Ashanti region (13), Brong Ahafo (12) and Greater Accra region (4). These form about 20                 | Moderate |



|   |  |                 |                         |              |                        |  |  |          |
|---|--|-----------------|-------------------------|--------------|------------------------|--|--|----------|
|   |  |                 |                         |              |                        |  | per cent of the total poultry sector, producing mainly eggs.   |          |
| 81. An assessment of house-hold solid waste management in a large Ghanaian district   | Stephen T. Odonkor, Kwasi Frimpong, Napoleon Kurantin (2020) | 600 respondents | Large Ghanaian district | Not reported | Cross-sectional design | A self-administered questionnaire was used but paraphrased into local language for respondents who for literacy reasons could not answer in English. | Majority (57.3%) of the respondents indicated that communal waste collection bins were far from households. Majority (56.5%) of the households walked a distance of 11-15 min before reaching the refuse site. | Moderate |
| 82. Households' source separation behaviour and solid waste disposal options in Ghana's Millennium city                       | Alhassan, H., kwakwa, P.A and Owusu-Sekyere, E. (2020)       | 525             | Accra                   | Not reported | Cross-sectional        | A structured questionnaire was used to collect data. A three-staged sampling design was used to select 525 households heads and/or and               | The results revealed that majority (58.1%) of the respondent separate waste informally at source. Waste separation among low-income households is motivated by monetary incentive (63%).                       | Moderate |
| 83. Behaviour of households in Accra-Ghana to source separation and recycling in achieving sustainable solid waste management | Doris Baah and Kharlamova (2017)                             | 60 respondents  | Accra                   | -            | Descriptive research   | A mixture of survey, literature and reports review were used as  | The household is the first level for waste separation at source in Accra. Willingness to separate waste at   | Moderate |



|  |   |  |                                   |              |  |  |   |          |
|--|---|--|-----------------------------------|--------------|--|--|---|----------|
|  |   |  |                                   |              |  | well as information from stakeholders in the waste management sector.  | source is to base on financial gains from the sale of the materials.  |          |
| 84. Domestic waste disposal practice and perceptions of private sector waste management in urban Accra                         | Yoada, R., M., Chirawurah, D. and Adongo, P. B (2014) | 364 households heads                                 | Nkwantana a electoral area, Accra | 31 – 40 yrs  | Cross-sectional design                   | A mixed-method approach using a survey questionnaire and in-depth interviews   | Majority (93.1%) of the households disposed of food debris as waste and 77.8% disposed of plastic materials as waste. | Moderate |
| 85. Correlates of domestic waste management and related health outcomes in Sunyani, Ghana: a protocol towards enhancing policy | Addo <i>et al.</i> , 2017                             | 700 households                                       | Sunyani, Brong Ahafo              | Not reported | Descriptive cross-sectional study design | A structured questionnaire was used in the data collection waste recycling, cost of disposing waste and distance to dumpsite were assessed | Each surveyed household generated 0.002 t of waste per day, of which 29% are both organic and inorganic.              | Moderate |
| 86. Stakeholders' views on waste and its management in Tamale Metropolis, Ghana  | Adongo <i>et al.</i> , 2015                           | 11 stakeholders from both private and public sectors | Tamale Metropolis, Northern       | Not reported | Cross-sectional                          | Primary data was collected using a questionnaire   | Metropolis. The major problem reported by the stakeholders is the improper disposal of waste.                         | Weak     |
| 87. Household solid waste generation and disposal in some selected communities in  | Asare <i>et al.</i> , 2015                            | 100 households                                       | Kwamo, Ejisu and FumesuaAs hanti  | Not reported |  | A mix method approach was used for the data collection,  | The results indicated that there were high levels of putrescible  | Weak     |





|   |                                   |                  |  |              |                            |   |  |          |
|---|-----------------------------------|------------------|--|--------------|----------------------------|---|--|----------|
| Ejisu-Juaben Municipality, Ghana  |                                   |                  |  |              |                            | it includes field investigation, survey, face-to-face interviews and the use of semi-structured questionnaire | waste in all the selected towns.   |          |
| 88. An econometric model of factors influencing households willingness to pay for improved Solid Waste Management Service within the Sekondi-Takoradi Metropolis in the Western Region of Ghana | Padi <i>et al.</i> , 2015         | 300 respondents  | Sekondi-Takoradi Metropolis (Effiakuma Western | Not reported | Cross-sectional            | A survey questionnaire was used   | The study revealed that the factors which influenced households willingness to pay for an improved SWM service were environmental awareness, occupation, income, perception and house ownership. | Moderate |
| 89. Do socioeconomic factors influence households' solid waste disposal systems? Evidence from Ghana  | Adzawla <i>et al.</i> , 2018      | 16767 households | nationwide                                     | 46 years     | Analysis of secondary data | The study used data from the Ghana Living Standard Survey round six collected in 2012/2013                    | About 48% of the respondents dispose of garbage at public dumps, 19.9% bury or burn their trash and 19.1% dump at open places such as gutters, water bodies and streets.                         | Moderate |
| 90. Fee-based solid waste collection in economically developing countries: The case of Accra metropolis   | Oduro-Appiah <i>et al.</i> , 2013 | 5382 households  | Ablekuna South (Accra)                         | Not reported | Cross-sectional            | Information was obtained through survey and   | Results from the questionnaire showed that households that were willing to   | Moderate |



|   |   |  |  |              |                       |   |  |          |
|---|---|--|--|--------------|-----------------------|---|--|----------|
|   |   |  |  |              |                       | questionnaire from residents across the socio-economic divide to determine willingness and ability to pay for solid waste collection services                         | participate and had the ability to pay for solid waste collection services.                              |          |
| 91. Missing links in solid waste management in the Greater Accra Metropolitan Area in Ghana | Oteng-Ababio, 2010                              | -  | Greater Accra Metropolitan area (AMA, TMA and GDA) | Not reported | Mixed methods         | This study uses primary and secondary data from literature. Solid waste management practices were observed to determine how each stakeholder cooperate in the process | In both low-income and high-income areas, wastes were lumped together before it is sent to the dumpsite. | Moderate |
| 92. Dumping on the poor: the ecological distribution of Accra's solid-waste burden          | Baabereyir, A., Jewitt, S. and O'Hara, S (2012) | 450 households, Senior staff of the waste management departments | Accra  | -            | Mixed-method approach | A multi method approach involving interviews, a household questionnaire,  | There is a high level of indiscriminate waste disposal which is higher in low-income areas.              | Moderate |



|   |                              |                              |  |                                |                       |   |  |          |
|---|------------------------------|------------------------------|--|--------------------------------|-----------------------|---|--|----------|
|   |                              |                              |  |                                |                       | direct field observation and documentary analysis   |  |          |
| 93. Characteristics and management of household solid waste in urban areas in Ghana: the case of WA | Monney <i>et al.</i> , 2013  | 15 households                | Upper West   | The modal age is 36 – 60 years | Cross sectional       | A structured questionnaire was administered to residents, the waste management department and the only private waste management company in waste. | The rate of waste generation in Wa is $0.68 \pm 0.24$ kg/cap/day with an average bulk density of $44.9 \pm 28$ kg/m <sup>3</sup> . The household waste generated involves organic waste (48%) and inert materials (33%). | Weak     |
| 94. Characteristics of diverted solid waste in Kumasi: A Ghanaian city                              | Wahabu <i>et al.</i> , 2014  | Seven informal waste pickers | Kumasi Metropolis Ashanti                            | Not reported                   | Cross sectional       | The study involves a quantitative measurement of diverted waste by informal waste pickers at communal collection points                           | The study shows a daily diversion rate of $19.4 \pm 9.2$ kg per informal waste picker per day with no statistically significant difference.  | Weak     |
| 95. Comparative Analysis of Households Solid Waste Management in rural and urban Ghana              | Boateng <i>et al.</i> , 2016 | 400 households               | Rural and urban districts in the Ashanti and Greater | Not reported                   | Cross-sectional study | Face-to-face interviewer-administered structured questionnaires   | The results revealed that location significantly affects solid waste management in   | Moderate |



|   |                                    |                                |                             |              |  |   |  |          |
|---|------------------------------------|--------------------------------|-----------------------------|--------------|--|---|--|----------|
|   |                                    |                                | Accra regions of Ghana      |              |  | were used to collect field data   | Ghana. Urban communities had lower mean scores than rural communities for poor solid waste situation in homes.   |          |
| 96. Urban households' willingness to pay for improved solid waste disposal services in Kumasi Metropolis, Ghana   | Awunyoo-Vitor <i>et al.</i> , 2013 | 600 respondents                | Kumasi Metropolitan Ashanti | Not reported | Cross-sectional                                  | Data was collected through individual interviews using a well-structured questionnaire                                    | The logistic model shows that income, age, number of children, quantity of waste generated and education have significant effects on the willingness to pay. | Moderate |
| 97. Environmental and health impacts of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana | Boadi and Kuitunen (2005)          | 960 female heads of households | Accra                       | Not reported | Cross-sectional                                  | Detailed structured questionnaire was used to collect information on household solid waste storage and disposal practices | Majority of the respondents store solid waste in plastic bags and open containers inside their homes whilst only 22.6% store it outside the house.           | Moderate |
| 98. Awareness and practice of solid waste management in the Winneba municipality of Ghana   | Twumasi, A. K (2017)               | 120 respondents                | Winneba Central             | Not reported | A descriptive cross-sectional survey was used to | A well-designed and validated questionnaire was used for data collection  | Attitudes towards social commitment to participate in solid waste management was low.  | Moderate |



|  |                              |                   |   |              |   |   |  |          |
|--|------------------------------|-------------------|---|--------------|---|---|--|----------|
|  |                              |                   |   |              | identify various methods of waste management employed | as well as interviews   |  |          |
| 99. Household willingness-to-pay for improved solid waste management services in four major metropolitan cities in Ghana               | Boateng <i>et al.</i> , 2019 | 1560 households   | Accra, Takoradi, Kumasi and Tamale<br>Accra, Western, Ashanti | -            | Cross-sectional multi-center study                    | A structured questionnaire was used   | The overall Willingness To Pay (WTP) was 53.7% with variations across the different cities. WTP was associated with socio-economic factors.  | Moderate |
| 100. Households' demand for better solid waste disposal services: Case study of four communities in the New Juaben Municipality, Ghana | Alhassan and Mohammed (2013) | 200 respondents   | Four communities in the New Juaben Municipality, Ashanti      | 45 years     | Cross-sectional                                       | The contingent evaluation method used to assess respondents' Willingness-To-Pay (WTP) for improved solid waste disposal | From the pre-test results, four denominations were chosen as the amount participants are willing to pay. Participants were willing to pay a small token for improved waste disposal. | Moderate |
| 101. Rethinking waste as a resource: insights from a low-income community in Accra, Ghana  | Oteng-Ababio (2014)          | 25 key informants | Accra   | Not reported | Mixed methods   | Key informant's interviews, participants observations and a comprehensive review of documents to                        | The results showed that a greater part of the waste can be recycled and that a well-coordinated program will ensure an immense reduction of waste volume.                            | Moderate |



|  |                             |                                   |  |              |   |  |   |          |
|--|-----------------------------|-----------------------------------|--|--------------|---|--|---|----------|
|  |                             |                                   |  |              |   | generate empirical data  |   |          |
| 102. Examination of household solid waste management in Nadowli township in Ghana: A waste management hierarchy approach                 | Bukari <i>et al.</i> , 2017 | 100 respondents                   | Upper West region Nadowli                  | -            | Cross-sectional study design with quantitative and qualitative approaches | The study used questionnaire, observation and interview guides   | Waste disposal is the least preferred but most practiced method. Avoidance, reduction, reuse and recycling were less practiced.   | Moderate |
| 103. Towards a zero waste: assessing solid waste management in the LedzokukuKrowor Municipal Assembly in the Greater-Accra region, Ghana | Acquah, 2015                | 82 respondents, and 14 informants | Ledzokuku Krowor Municipal Assembly, Accra | Not reported | Cross-sectional   | Qualitative methods were used with questionnaire, semi-structured interviews and observations to gain a deeper understanding of solid waste management | The study showed that apart from the main actors there are other actors in solid waste management who play various roles that are not seen. For example, people who operate with tricycles. | Moderate |
| 104. Solid waste management in coastal Ghana   | Akuoko, 2018                | 44 households                     | Tertrem, Elmina, Central                   | Not reported | Cross-sectional   | Use of household interviews and waste quantification and characterization.   | Findings from the preliminary research showed that the highest waste present was organics (48.07%), followed by inert (22.25%) and then plastics (14.92%).                                  | Moderate |





|   |                              |                            |   |                 |                         |  |  |          |
|---|------------------------------|----------------------------|---|-----------------|-------------------------|--|--|----------|
| 105. Solid medical waste: a cross sectional study of household disposal practices and reported harm in Southern Ghana | Udofia <i>et al.</i> , 2017  | 600 households             | Ga South Municipal Assembly, Accra                                | Modal age 45+   | Cross-sectional design  | A survey questionnaire was used                                    | 80% and 89% of respondents disposed unwanted medicines and sharps in household refuse bins respectively. A corresponding 23% and 35% of respondents discarded these items without a container. respectively. | Moderate |
| 106. The impacts of reducing food loss in Ghana: a scenario study using the global economic simulation model MAGNET   | Rutten and Verma (2014)      |                            | nationwide  | Not reported    |                         | We specifically implemented a set of food loss reduction scenarios | When Ghana reduces food loss by 50% by the year 2025, at all stages of supply chains, consumers will benefit from price reduction.   | Moderate |
| 107. Estimation of packaged water consumption and associated plastic waste production from household budget surveys   | Wardrop <i>et al.</i> , 2017 | 18, 000 households         | Nationwide (1200 enumeration areas were selected from 10 regions) | Not reported    | Secondary data analysis | Data from 2012-13 Ghana Living Standards Survey Round 6 was used.  | In Ghana, 11.3% (95% C: 10.3 – 12.4) ML per day of sachet water were consumed. This generated over 28, 000 tonnes per year of plastic waste.   | Strong   |
| 108. The role of hunting in village livelihoods in the Ashanti region, Ghana: environmental and ecological economics. | Crookes <i>et al.</i> , 2007 | 468 hunter and non-hunters | Ashanti region  | 42.4±11.4 years | Cross-sectional         | Interview  | Hunting is an important contributor to total income in the villages, particularly for poorer households. Hunting increases during lean seasons.  | Moderate |



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