CROP POST HARVEST PROGRAMME

Project Title: Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods

R No 7493 (ZB0199)

FINAL TECHNICAL REPORT

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Project Leader's institution: Natural Resources Institute

Executive Summary

The purpose that this project contributed to was '*Strategies developed which improve food security of poor households through increased availability and improved quality of horticultural foods and better access to markets'*. The project outputs were to assess and prioritise the economic and social importance, and safety and quality constraints of street-vended foods in peri-urban locations, and, to make recommendations on quality and safety risks associated with street-vended foods made, and identify areas where new knowledge is required.

The socio-economic survey of 334 vendors and a mini census indicated that street-vended foods do make an important contribution of the economy of Accra, the capital city. The street foods sector employs over 60,000 people with an estimated annual turnover of over US$100 million and an annual profit US$24 million. This was comparable to the findings from other studies in other cities such as Calcutta. Most (94%) of the vendors in Accra were women who had minimal or no education. The majority (75%) did not belong to vendors associations or pay taxes.

A food safety study screened 96 case study street-vended food samples (waakye, fufu and salad) from Accra for heavy metals, pesticides, micro-organisms and mycotoxins and 48 raw material samples from primary and secondary markets for heavy metals and mycotoxins. The project found that 40% of waakye samples contained the heavy metal lead above the draft Codex recommended maximum limit of 0.2 mg/kg and 70% contained the organophosphorous pesticide chloropyriphos. Lead contamination can result in learning difficulties and behaviour problems in children. Low but non-hazardous levels of mycotoxins and the heavy metal cadmium were detected in many street vended food samples. Some laboratories in Ghana, however, were not able to use current analytical methods such that the results for pesticides were indicative. Institutional support of laboratories is needed if reliable analysis of pesticide residues is available in Ghana. No mycotoxins or heavy metals were detected in the raw materials from primary and secondary markets.

The hygiene of street-vended food had deteriorated since the last survey sponsored by the FAO between 1994 and 1997. Waakye, in particular, had high counts. While 2,000 vendors had recently been trained in basic food hygiene with commercial sponsorship, this number falls well short of the 60,000 estimated to be working in the sector.

Maize is a commonly used ingredient in many street-vended foods. A HACCP (hazard analysis and critical control point) approach was developed to indicate how mycotoxins might be eliminated through moisture control.

A 2-day workshop was attended by 40 participants from organisations involved in street food vending, policy formulation, regulation, food standards and research. The major concern was the need for further research to identify the sources of heavy metal and pesticide contamination and methods for reducing the hazard.

A working group comprising the Ministry of Environment Science and Technology, Accra Metropolitan Assembly, Ghana Education Service, Ministry of Health and the Food Research Institute was formed as a result of the workshop. Its purpose is to implement improvements in the safety of street-food vendors and to develop its tourism potential. A priority is to

establish a pilot study to improve access to water, sanitation and refuse disposal for street food vendors.

Background

This project sought to provide knowledge that would sustain the livelihoods of those working in the sector and help to improve the safety of street vended foods for the consumer. The dramatic growth of urban populations in developing countries provides both opportunities and risks for resource-poor groups in urban and peri-urban environments. A feature of the urbanisation process has been the development of informal food supply systems. Resource-poor groups have developed livelihood strategies with limited capital assets to meet opportunities in urban areas. This is typified by the increase in ready-to-eat food prepared and sold by street-vendors in urban areas.

Street-vended food can contribute significantly to the food security of those involved in its production, particularly suppliers of raw produce, food processors and vendors. Women are often owners or employees of street food businesses. In certain countries (Benin, Ghana, Lesotho, Togo and Democratic Republic of Congo), they represent 70 to 90% of vendors. A majority of women indicated that they sold food in the street primarily to improve the food security of their household and for a degree of financial independence (Anon, 1997).

Street food consumers come from all levels of society. It was reported (Anon, 1997b) that while 38% of consumers in Kinshasa came from low-income groups, 62% had higher incomes and lived in apartments and individual homes. Similarly, 15% of consumers in Abidjan were unemployed while 51% were educated and employed. In Nigeria, street food accounted for 40 – 70% of the food intake of adolescents (Oguntona and Kanye, 1995).

The sale of street foods can make a sizeable contribution to the economy. In Calcutta, for example, 130,000 street-vendors make an estimated profit of nearly US$100 million per year. In Latin America and the Caribbean, the average monthly sales per vendor varied between US$150 and US$500. In Bangkok, it is thought that 120,000 vendors purchase between US$16 and US$41 of raw material each day with sales of US$20 to US$80 per day (Dawson *et al.* 1996; Anon, 1997a). Despite its growing presence, it is a sector that has rarely been the focus of strategic research initiatives that determine the importance and potential hazards of street-vended food, and what contribution it makes to the livelihoods of the urban and peri-urban poor (both producers and consumers).

In contrast to the potential benefits, it is also recognised that street foods are produced by those with limited knowledge of food safety practices and in environments that can compromise the hygienic preparation, storage and sale of the food. Newspaper reports of street food vendors being cleared from the streets because of health problems are common in Crop Post-Harvest Programme focus countries; for example an outbreak of cholera was recently associated with street-vended foods in Tanzania.

Street food vendors are frequently unlicensed and untrained in food hygiene or sanitation and work under very crude and unsanitary conditions (Anon 1997, Tinker 1997). Most research on the safety of street vended foods has focused on the microbiological risks. This can cause food poisoning as a consequence of the growth of S*taphylococcus aureus*, *Salmonella* spp., *Escherichia coli* and *Bacillus cereus* (Bryan, 1995; Bryan *et al.,* 1997; Anon 1997; Jermini *et al.,* 1997; Kampen *et al.,* 1998). There is a growing concern about fruits and vegetables as a

source of infectious food-borne disease (Roever, 1998); for example, enterotoxigenic *E. coli* was associated with carrots and botulism with chopped garlic. A HACCP approach to the microbiological safety of street foods in Ghana indicated that contamination can occur if products are not properly cooked and stored. Cooked products were at risk if served using contaminated serving utensils, plates and hands. Cross contamination from uncooked fish and meat was also common. Uncooked foods were also at risk if equipment was not cleaned and or if the vendor did not have access to clean water (Anon 1997).

Less is known about the hazards from non-microbiological contaminants. Aflatoxins have been reported in two surveys of street foods in Bangkok (Nednapis-Vatanasuchart, 1994; Dawson et al 1996). Heavy metals (lead and cadmium) have been found in green vegetables in Dar es Salaam at levels above those recommended by FAO/WHO (Raja *et al*., 1997) and lead has been found in Bangkok (Dawson et al 1996). In a survey of street foods in Calcutta, however, no lead was detected (Chakravarty and Canet 1996). Food sold close to the roadside might contain higher levels of lead because tetraethyl lead is still added to fuel in many developing countries; in Ghana, levels of lead close to the Kumasi-Accra highway decreased exponentially with increases in distance from the highway (Golow 1996). The pesticide tetradifon was identified in street foods from Bangkok (Nednapis-Vatanasuchart, 1994). Intestinal parasites such as the protozoans Entamoeba coli, Ciardia Lamblia [G. duodenalis] and Ascaris lumbricoides have been associated with 60% of vendors and 46% of consumers in Senegal (Faye et al. 1998) while 26% of water samples used by vendors contained parasites in Hyderabad City, India (Jonnalagadda and Bhat 1995). Unauthorised food additives reported in street foods include benzoic acid, coal tar colours and artificial sweeteners in samples of street food sold on the streets of Bangkok (Dawson and Canet 1991; Nednapis-Vatanasuchart, 1994) and metanil yellow (textile colour) as a substitute for saffron and saccharin in 15% of street food samples sold in Calcutta (Chakravarty and Canet 1996).

While most research has focused on microbiological hazards in street vended foods, the few publications on non-micobiological contaminants suggest they should be investigated. In this preliminary study, street vended foods in Accra, Ghana were investigated for the presence of heavy metals, aflatoxins and pesticide residues with a view to directing policy and regulation.

Project Purpose

The purpose that this project contributed to was '*Strategies developed which improve food security of poor households through increased availability and improved quality of horticultural foods and better access to markets'*. The objective of this project was to assess and prioritise the economic and social importance, and safety and quality constraints of street-vended foods in peri-urban locations and to make recommendations on quality and safety risks associated with street-vended foods made, and identify areas where new knowledge is required.

The objective was achieved through:

- Selecting case study products and vendors on the basis of perceived risk, volume traded and importance to consumers of street vended foods;
- Identifying supply chains for raw materials to the street vendor using informal rapid rural appraisal techniques;
- Assessing the significance of street vended products to the participants in the supply chain and the street vendors, and to the economy as a whole;

- Assess the food safety risks associated with street foods using the case study products;
- Dissemination of study outcomes to key stakeholders;
- Organise workshop for key stakeholders.

Achieving these outputs would provide policy makers and regulators would have knowledge regarding the contribution that the street food sector makes to the economy of Accra.

Research Activities

The research activities are listed by activity for outputs 1 and 2.

Output 1: Economic, social importance, safety and quality constraints of street-vended foods in peri-urban locations assessed and prioritised

1.1 Select case study products and vendors.

NGO's (Ghana Traditional Food Caterers Association), regulatory and food standards organisations (Food and Drug Board and Ghana Standards Board), local councils (Accra Metropolitan Assembly) and food research organisations (Food Research Institute, University of Ghana) were consulted in order to select street foods that were widely consumed and perceived to be a health risk. Furthermore, a 3-year FAO study on the safety of street vended foods in Ghana which involved four organisations in Ghana (Accra Metropolitan Assembly, Food Research Institute, Ghana Standards Board and the University of Ghana) (Anon 1997), supported the selection of these street foods.

1.2. Identify supply chains for raw materials to the street-vendor.

The supply chains from point of raw material product to the selected traders were identified for maize and to some extent rice and salads. This involved visits to the primary markets at Tamale, secondary markets at Techiman and Kumasi and tertiary markets at Accra in November 1999 and May 2000 by a multidisciplinary team comprised of a food technologist, food safety specialist and a socio-economist. Government extension officers were consulted regarding the role played by itinerant traders and wholesalers. A detailed account is given in appendix 1.

1.3. Assess the significance of street-vended products to the participants in the supply chain and the street-vendors, and to the economy as a whole.

This socio-economic aspects of street foods in Accra and its specific objectives were:
1. To establish the socio-economic characteristics of the street food vendors;
2. To establish the size and supply chain of the street food vendors;
3. To estimate the incomes generated by these street food vendors;
4. To estimate the employment generated by the food vendors.

The Sample

The survey of 334 vendors was limited to the Accra Metropolis and covered the whole of the city, which was divided into eight selected zones (table 1). The adoption of these zones was based on areas already identified by the Ghana Caterers Association of the Accra Metropolitan Assembly and supplemented with some new areas crowded with food hawkers. A simple random sampling technique was used where every other food-vendor is selected. The survey took place between November 1999 and January 2000. The survey excluded people who sell naturally prepared foods such as fruits and ice cold water.

Table 1: Zones in Accra

Zone	Name of Zone	Major Suburbs
1	Kaneshie	Kaneshie (South & North), Bubushie, Abossey Okai, Circle, Adabraka, Mateheko,
2	Nima	Nima, New Town, Abavana, Maamobi, Kanda, Abelenpke, Ridge,
3	La	La, Osu, Nungua, Spintex road,
4	Odorkor	Odaorkor (South & North), Sakaman, Darkuman, Abeka Lapaz, Awoshie, Malam, MaCarthy Hill, etc
5	Accra Central	Okaishie, Post-Office,Adabraka, Kinbu, Timber Market, Adendepko, Ministries etc
6	Dansoman	Dansoman, Mamprobi, Korle Gonno, Chorkor, Korle Bu, Sukura, Russia, etc
7	St John's	Tesano, Achimota, Domi, St John's, Tetra Hill, Ofankor, Alajo
8	Madina	Madina, Adenta, Legon, Opkonglo, Airport, Dworwulu etc

Data Collection

The questionnaire modules consist of open, half-open and pre-structured questions covering information on vendor demographics, costs, sales, and constraints. Each interview took approximately forty-five minutes per vendor and they were conducted at both day and night in order to encompass all vendors. The interviews were restricted to areas in the zones where street food patronage was high such as schools, construction sites, hospitals, lorry parks and, markets etc. The study also undertook a mini census (head count) of all the street food-vendors operating in the selected areas in Accra, with the aim of establishing an estimate of the total number of food vendors.

Data Analysis

Responses were coded and the Statistical Package for Social Science (SPSS) and Microsoft Excel were used to process the data. The statistical analysis involved simple pie charts, frequency counts, and percentages that are used to present the results and the relevant inferences made.

1.4 Assess the food safety risks associated with street foods

The following sampling strategies were employed to assess the risks in the marketing chain and in the product sold to the consumer. Street food samples, purchased between January and May 2000. Each component of the food sample was purchased separately. In the field, food samples were stored in a cool box with ice followed by storage at 4^{o}C. They were analysed for microbiological, heavy metal, mycotoxin and pesticide residue hazards.

- A total of 48 samples, comprising maize, rice and salad vegetables were purchased at the farms and markets (primary and secondary).
- Street foods (waakye, fufu, salad) were purchased from 96 vendors from each of eight zones in the Accra Metropolitan area. These were composited to form 32 samples (8 of waakye, 8 of fufu, 8 of soup of fufu and 8 of salad).

Microorganisms and mycotoxins analysis was carried out at the Food Research Institute while the pesticide residues and heavy metals were analysed at the Ghana Standards Board. Reports for the methodologies and results for heavy metals, pesticides and mycotoxins and microorganisms are given in appendices 2 and 3 respectively.

The methodology for the HACCP approach is given in appendix 4.

1.5 Analysis and documentation of case studies.

The analysis and documentation of the case studies are given in the outputs section of this report.

Output 2: Recommendations on quality and safety risks associated with street-vended foods made, and areas where new knowledge is required identified.

2.1. Disseminate study outcomes to key stakeholders

2.2. Organise workshop for key stakeholders

Activities 2.1 and 2.2 were combined in a two-day workshop for stakeholders, policyholders and regulators on the safety of street vended foods from 25 to 26th September 2000 in Accra Ghana.

The objectives of the workshop were:
1. Disseminate and discuss project outputs;
2. Agree on recommendations to improve the food safety and quality of street foods by these stakeholders without the need for further research;
3. Identify and agree on areas where new knowledge is required to ensure impact on livelihoods of target beneficiaries.

Over 40 people who represented NGO's, national and local government, food standards agencies, education and research attended the workshop. It was opened by Dr E Barnes, Chief Director, Ministry Environment Science and Technology and chaired by Professor A. Ayensu, Deputy Director General, Council for Scientific and Industrial Research. The workshop had widespread coverage in the media in Ghana (TV, newspapers and radio). Two major Ghanaian television channels (GBC and TV3) attended the opening ceremony. The workshop was the top story on both television channels, on the front page of the national newspapers the Chronicle,

Ghanaian Times and Daily Graphic and on national radio (GBC, Joy FM, Universe, Choice FM, Vibe, Top Radio, Peace FM and Radio Gold. The media coverage was beneficial as it highlighted the problems in the sector and was the driving force behind the formation of action groups.
Presentations given at the workshop were as follows:

- Socio-economic study of street vended foods in Accra (Mr P Obeng-Asiedu, University of Ghana);
- Heavy metals, pesticides and mycotoxins in street vended food (Mr K Tomlins, NRI);
- Street vended foods and hygiene (Dr R Myhara, NRI);
- A HACCP approach to the prevention of mycotoxins through moisture control. (Dr P-N. T Johnson, FRI);
- Street-food vending in Ghana: a historical perspective (Mr Ntiforo, GSB);
- Health- related problems with street-foods in Accra. Overview of recent cases (Dr A. Arde-Acquah, Metro Public Health Director);
- Problems faced by street-food vendors in Accra (Mr Apraku, Ghana Traditional Caterers Association);
- Improvements to street-food vending in Accra: (Mr J. Laryea, Principal Food Inspector, AMA);
- Street vended foods in Accra: a worker's concerns and expectations (Mr D. Asiedu, FRI);
- AMA by-laws and policies on street-food vending in Accra (Ms Selina Fenteng, Solicitor, AMA);
- Organochlorine pesticide residues and heavy metals contamination in some farming areas in the Ashanti Region (Dr .Osafo Acquaah, KNUST, Kumasi);
- The GES position on food sold to schoolchildren in Accra (Mrs Marian Adum-Atta, GES Metro Education).

Discussion groups then made recommendations to:
1. Improve the food safety and quality of street foods by these stakeholders without the need for further research;
2. Identify areas where new knowledge is required to ensure impact on livelihoods of target beneficiaries.

Outputs

Output 1. Economic and social importance, and safety and quality constraints of street-vended foods in peri-urban locations assessed and prioritised

1.1 Select case study products and vendors.
The case study street vended food products, including maize as a raw material, are given in table 2.

Table 2. Case study street foods

Street food product	Perceived risk	Hazards
Fufu (cooked cassava and plantain mixture pounded into a smooth elastic mass moulded into balls and served with soup (groundnut or palm nut)	High.	S. *aureus*, B. *cereus* attributed to poor handling, hygienic practices and storage.
Waakye (cooked rice and beans with added colour from red sorghum)	High	S. *aureus*, B. cereus and C. *perfringens* attributed to poor handling, hygienic practices and storage.
Salad (lettuce, onion, tomato)	High	Microbiological because of poor handling and hygienic practices and possible heavy metal (arsenic and mercury) contamination from irrigation water.
Maize (a common raw material in many street vended foods such as kenkey, akpler, breakfast porridges).	High	Mycotoxins and S. *aureus* (Jespersen *et al* 1994; Kpodo *et al* 1996; Anon 1997).

1.2. Identify supply chains for raw materials to the street-vendor.

The supply chains from point of raw material product to the selected traders was identified for maize and to some extent rice and salads. The marketing system was highly organised but flexible. Markets were of different sizes and performed varying functions. The smallest markets are primary markets and are located close to where the produce is grown. Secondary markets are located at market towns. Here produce is often bulked into larger quantities and drying might occur if applicable. Tertiary markets are usually the largest markets and act as distribution points close to urban centres (Accra, Kumasi). In most instances, the farmer sells the raw materials to the trader at the primary market (market at the place of production). Middlemen buy from these primary market traders and in turn transport it to the secondary market where traders and middlemen from the tertiary market purchase these raw food materials to the cities. Street food vendors then purchase these food items either directly from the market or from retail shops or hawkers. Street food vendors patronise the markets because the market prices are relatively cheap. Player and activities at each point in the marketing chain are summarised in table 3.

Table 3. Players and activities at each location in the marketing chain

Players	Location in marketing chain	Activity
Farmer	Farm	• Sells directly to vendor (if close to Accra) • Sells to itinerant trader • Transports produce to primary, secondary or tertiary market for direct sale
Itinerant trader	Farm, primary, secondary and tertiary markets	• Bulking and transport of produce • Storage • Drying (if required) • Sale to market traders
Wholesaler	Secondary and Tertiary markets	• Bulking and transport of produce • Storage • Drying (if required) • Sale to market traders
Market trader	Secondary and Tertiary markets, urban and peri-urban locations	• Sale of smaller quantities to consumer and vendors • Sorting and grading
Street vendor	Farm, primary, secondary and tertiary markets. Urban and peri-urban areas.	• Purchases produce from market traders, itinerant traders and farms

In this project, visits were make to primary markets at Tamale, secondary markets at Techiman and Kumasi and tertiary markets at Accra in November 1999 and May 2000 by a multidisciplinary team comprised of a food technologist, food safety specialist and a socio-economist. Government extension officers were consulted regarding the role played by itinerant traders and wholesalers. A detailed account is given in appendix 1.

1.3. Assess the significance of street-vended products to the participants in the supply chain and the street-vendors, and to the economy as a whole.

Estimating the Number of Street Food Vendors in Accra

Table 4 shows the estimated number of vendors counted during the mini-census. The total number of vendors was estimated at 15,960.

Table 4: Head Count of Street Food Vendors in Accra

AREA/FOOD	Kaneshie	Nima	Odorkor	La	Accra	Dansoman	St John's	Madina	Total
Waakye	123	96	90	114	231	45	96	63	**858**
Rice	203	154	156	120	321	64	103	102	**1223**
Roasted Plantain	212	96	113	102	215	37	78	52	**905**
Fried Plantain (Kelewele Tatale etc)	215	96	97	123	152	56	72	36	**847**
Banku	104	95	61	201	211	60	103	45	**880**
Kenkey (Ga/Fanti)	361	145	191	231	425	78	146	126	**1703**
Fried Yam	108	83	113	52	75	49	76	52	**608**
Roasted Yam	60	40	23	25	39	28	46	23	**284**
Fufu	236	90	40	95	356	28	72	45	**962**
Kokonte	88	72	30	45	102	28	46	23	**434**
Gari &Beans	156	123	109	152	361	36	75	59	**1071**
Kebab	184	103	62	105	125	38	50	20	**687**
Bread & Salad	134	62	58	54	102	28	34	12	**484**
Fula	62	42	30	25	25	9	16	5	**214**
Koko, Ricewater, Oblayoo	169	102	95	205	203	46	88	56	**964**
Fried Fish	130	112	58	215	356	68	105	50	**1094**
Fried Pork	91	67	75	65	123	46	39	14	**520**
Akpler	25	12	29	3	12	7	10	6	**104**
Boiled Yam, Cocoyam, Plantain & Stew	145	41	40	65	95	12	25	25	**448**
Roasted Peanut	238	152	152	215	354	60	138	91	**1400**
Total	**3044**	**1783**	**1622**	**2212**	**3883**	**823**	**1418**	**905**	**15690**

Analysis of vendor questionnaires

Analysis of the questionnaires showed that street food vendors (itinerant, semi-itinerant and fixed-stall operators) had the following characteristics.

***Age*:** the ages of street food vendors in Accra range between 19 and 70 years of age with 36% between the ages 31 - 40 years, 30% between 41 - 50 years and 29% falling between 21 - 30 years.

***Gender**:* females dominate the SFB in Accra forming 94% of the vendors while the male population was only 6% of the respondents. This agrees with the FAO study (FAO 1997) attesting to the fact that women bear the brunt of inadequate finances for house keeping and

are therefore usually compelled to go into business to generate funds to support their families (ibid.).

***Origins*:** the largest number of vendors originated from the Greater Accra region (30%) whilst vendors from the nine other regions formed 70% of the respondents, with the Volta Region accounting for 20%. This could be attributed to the regional distribution of the population in Accra and tends to indicate that street food vendors cater for their ethnic groupings. (Table 5)

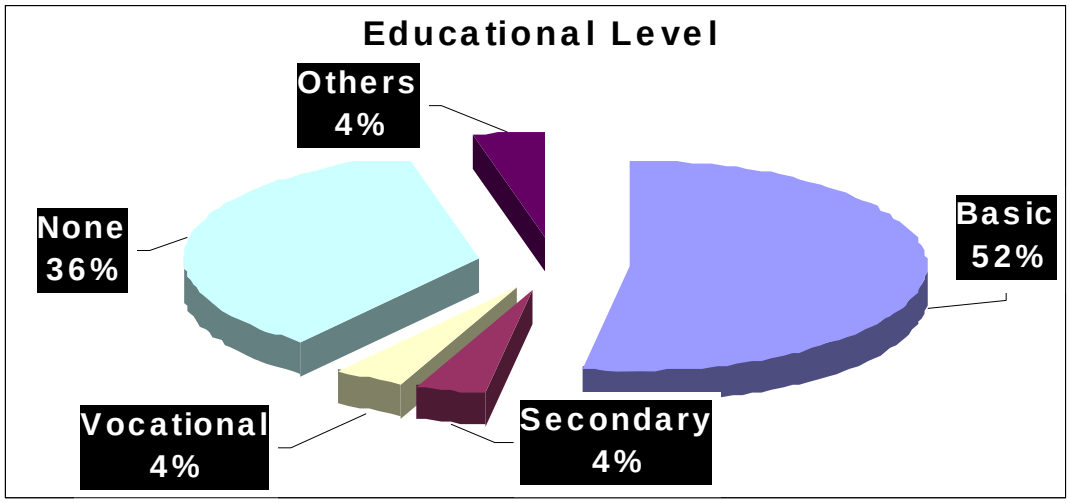
Table 5: Region of Origin of Street Food Vendors

Region	Number	Percentage
Greater Accra	101	30
Eastern	47	14
Central	37	11
Western	4	1
Ashanti	25	7
Brong-Ahafo	2	1
Northern	38	11
Upper-east	8	2
Volta	66	20
Upper-west	10	3

***Marital status*:** 62% of the vendors were married women and 21% were single, with divorced and widows making up the remainder

***Education*:** 53% of the street food vendors had basic education and 36% had no education at all. Those who have some form of secondary and vocational education numbered 8% (Figure 1).

Figure 1: Pie Chart Showing the Educational Level of Street Food Vendors.



***Religion*:** the survey results indicated that majority of the street food vendors were Christians.

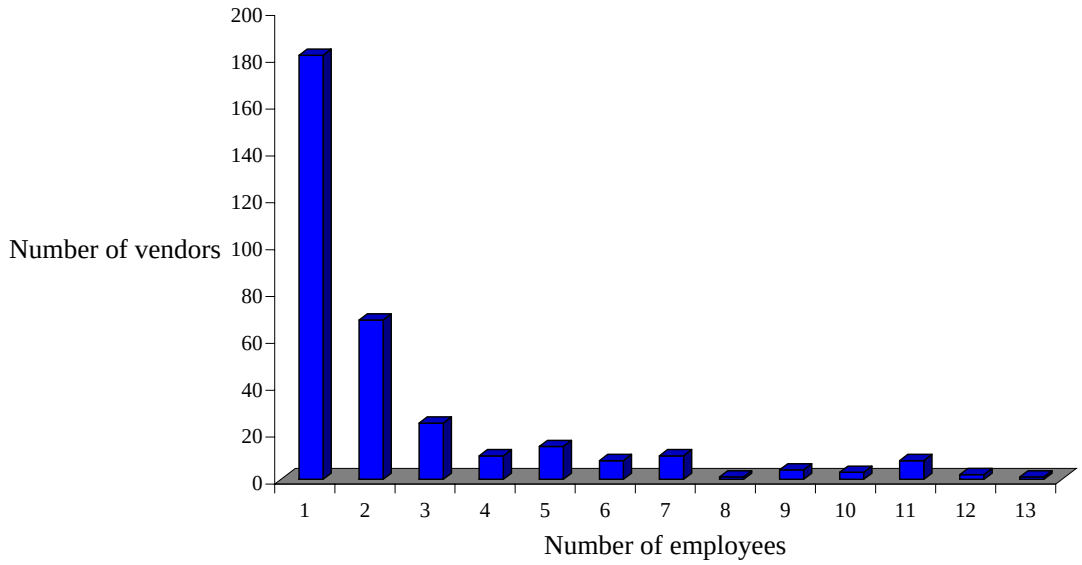
***Selling methods*:** fixed stall operators were in the majority accounting for 83.5%, while 10.7% were semi-itinerant and 5.8% were itinerant. All the fixed stall operators were females while few females and males operated as either semi-itinerant or itinerant vendors.

***Types of meals*:** except for itinerant vendors; other street food vendors (SFV) usually handled complete meals where consumers sat down to eat. The types of food sold on the street include *Koko, Kenkey, Fufu, Ampesi, Banku, Waakye, Rice and salad, Tuo zaafi, Bread and salad etc.* (see Appendix 3).

***Sources of capital*:** the initial capital for 64% of the respondents for starting the SFB came from family savings and only 17% came from a spouse. Fixed stall operators formed 84% of vendors who started the business with capital from family savings, 9% were semi-itinerants and 7% were itinerants.

***Employment and wages*:** a SFV employs an average of 3 people with a minimum mean wage of ¢2500.00 (equivalent of US$0.6 - at February 2000 exchange rate) per day. About 94% of the respondents pay their employees in cash and 6% pay in kind. Other benefits given to employees include free meals, clothing and shelter. The number of SFV employing workers was 46% of the vendors interviewed (Figure 2).

Figure 2: Graph Showing the Number of Workers Employed by SFVs



***Taxation*:** the average monthly tax paid by SFV is ¢7,000 (US$1.6) and a daily average tax of ¢1,000 (US$0.23). The SFVs who paid tax accounted for 54.5% of the sample, the remainder do not pay tax at all. Taxes paid ranged between ¢6000 (US$1.4) to ¢25000 (US$5.8) per month. The study found that 25% of vendors belonged to an SFV Association and approximately 95% of these pay taxes. Those who operate on licence were 40.6% of the respondents.

***Raw material sourcing*:** a large majority of SFVs buy raw materials and ingredients from the market while a small proportion buy from the farm. Some 37% of the respondents bought

from the market because the materials were readily available on the market, whereas 32% also buy from the market because the materials are cheap. Many, 24%, buy from the market because of good credit facilities and only 1.6% of street food vendor's buy from the farm because according to them, they are cheap and readily available. Five per cent buy from the market because of good quality.

***Working hours*:** the mean working hours for a street food vendor was 8 hours a day whilst on the average, a street food vendor sold food for 6 days each week. Street food vendors who expressed the desire to remain in the business were 67%, and 33% indicated that if given the choice, they would prefer an office work.

***Income*:** the average total cost incurred by a street food vendor per batch[1] was estimated to be 18,700 cedis (US$4.80) per day. An average sale of 22,700 cedis (US$5.76) per batch per day is also realised by vendors. A net profit of 4000 cedis (US$1.02) per batch is made. On the average, a street food vendor can sell five (5) batches per day, yielding a daily net profit of 20,000 cedis (twenty thousand), an equivalent of US$5.06 per day (Table 6). Foods are usually purchased for breakfast, lunch, and supper and for snacks. The most common item purchased for breakfast was *koko* (a cereal porridge), *fufu*, *banku*, and *kenkey*, which can either be used for lunch or supper.

Table 6: Average Cost and Profit per batch

Item	Costs/batch (cedis)	Sales/batch (cedis)
Raw materials	10200	22700
Other ingredients	4000	
Fuel	1600	
Transport	200	
Labour	1500	
Tax	200	
Rent	1000	
Total	**18700**	**22700**
Net Profit/batch	**4000 (cedis)**	

Income of the street food sector as a whole

To compute the annual turnover (based on cost) of the street food sector the value in cedis was converted into US$ at an exchange rate of 3,900 cedis = 1US$. This enables comparisons with street vendors in other regions. Hence, the costs per batch are 18,700 cedis or US$4.80, of which the average vendor sells 5 each day. In Accra, it is estimated that there are 15,690 vendors who trade 6 days a week for 50 weeks a year. The estimated turnover is therefore 4.80 x 5 x 15690 x 6 x 50 = US$113 million.

Considering the annual profit made by the street food sector in Accra (net profit of 4,000 cedis per batch), the estimated annual profit is (4,000/3,900) x 5 x 15690 x 6 x 50 = US$24 million. This was comparable to studies in other cities such as Calcutta where in 1994, 130,000 vendors made an annual profit of US$100 million.

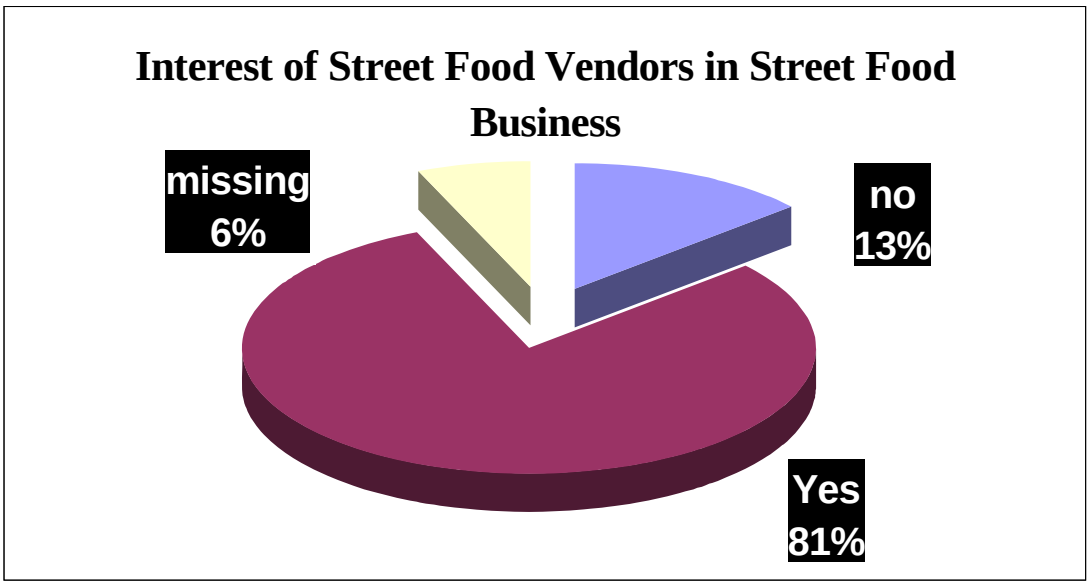
***Marketing structure*:** the marketing structure begins with the farmer who sells the raw materials to the trader at the primary market (market at the place of production). Middlemen

[1] A batch is a number of meals prepared at 'one go' for sale.

buy from these primary market traders and in turn transport it to the secondary market where traders and middlemen from the tertiary market purchase these raw food materials to the cities. Street food vendors then purchase these food items either directly from the market or from retail shops or hawkers. The results indicate that a lot of the SFVs patronise the markets because the market prices are relatively cheap.

***Market performance*:** most of the vendors indicated that they would want to continue with the job showing that they are happy with the work that they are doing (Figure 3). Studies done by Opare-Obisaw (1998) and the FAO (1997) also indicate the high patronage of the street foods by consumers. The vendors make profit in the trade, which is a sign that the activity and market are performing well.

Figure 3: Pie Chart Showing the Interest of Vendors in SFB.



***Ranking of foods*:** Accra is a multiethnic city where the various suburbs are known for their ethnic groupings and hence type of foods sold. For example, a suburb dominated by Ashantis will have *fufu* and *ampesi* as the food highly patronised by consumers whereas *tuo zaafi* (a meal prepared from millet) will be highly patronised in areas dominated by people from northern Ghana.

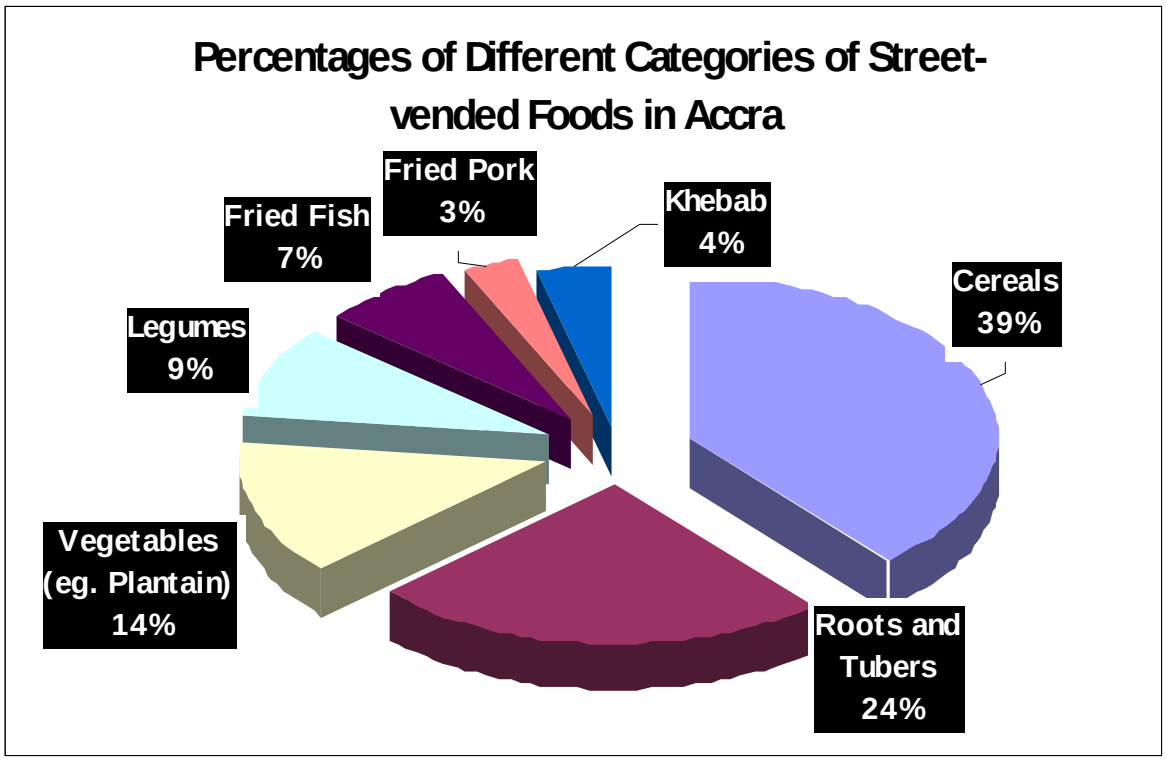
For the Accra Metropolitan area as a whole the ranking of food sold as per cent of vendors is given in table 7. The most common foods sold are kenkey, roasted peanut, rice, fried fish, gari &beans, koko, fufu, roasted plantain, banku and waakye.

Table 7. Types of food most commonly vended on the streets of Accra

Street vended food	vendors (%)
Kenkey (Ga/Fanti)	10.9
Roasted Peanut	8.9
Rice	7.8
Fried Fish	7.0
Gari &Beans	6.8
Koko, Ricewater, Oblayoo	6.1
Fufu	6.1
Roasted Plantain	5.8
Banku	5.6
Waakye	5.5
Fried Plantain (Kelewele Tatale etc)	5.4
Kebab	4.4
Fried Yam	3.9
Fried Pork	3.3
Bread & Salad	3.1
Boiled Yam, Cocoyam, Plantain & Stew	2.9
Kokonte	2.8
Roasted Yam	1.8
Fula	1.4
Akpler	0.7

Figure 4 shows that cereals form the bulk of the food prepared by most street food vendors. Cereals alone form 39% of the Ghanaian diet followed by roots and tubers, which form 24%. Legumes, fried fish and *kebab* such as grilled mutton which could balance the food with proteins form only 9%, 7% and 4% respectively. Vegetables form only 14% of street vended foods in Accra.

Figure 4: Different Categories of Street Foods in Accra



***Constraints*:** 46% of street food vendors said the high cost of raw materials was their major constraint while 45% mentioned capital. The remainder indicated various problems such as high tax (5%), lack of adequate selling space (3%), and high transportation cost (1%).

1.4 Assess the food safety risks associated with street foods

The food safety risks associated with street vended foods were those of heavy metals, pesticides and mycotoxins and hygiene. A HACCP approach was also used to illustrate how control the occurrence of mycotoxins in maize might occur.

Heavy metals, pesticides and mycotoxins in street vended food

Lead.

Potential hazards to health from lead contamination include poor learning in children and behaviour problems. Of the 28 street food samples analysed, lead was detected in 3 out of 8 waakye samples and 1 fufu sample (fufu and soup) at levels between 4.0 and 72 mg/kg (Table 8). The draft Codex Alimentarius Commission maximum levels for lead vary between 0.02 mg / kg for milk and 0.2 mg / kg for cereals. Lead detected in these samples was well above the draft codex maximum levels.

Table 8: Lead and cadmium in street food samples

Type of street food	Zone in Accra	Lead as Pb^{2+} (mg/kg)	
Waakye	1 (Kaneshie)	n.d.	
	2 (Nima)	n.d.	
	3 (Odorkor)	71.0	(± 0.2)
	4 (La)	n.d.	
	5 (Accra Central)	72.0	(± 0.1)
	6 (Dansoman)	n.d.	
	7 (St. John's)	4.0	(± 0.1)
	8 (Madina)	n.d.	
Fufu	1 (Kaneshie)	n.d.	
	2 (Nima)	n.d.	
	3 (Odorkor)	n.d.	
	4 (La)	n.d.	
	5 (Accra Central)	n.d.	
	6 (Dansoman)	n.d.	
	7 (St. John's)	46.0	(± 1.3)
	8 (Madina)	n.d.	
Soup of Fufu	1 (Kaneshie)	n.d.	
	2 (Nima)	n.d.	
	3 (Odorkor)	n.d.	
	4 (La)	n.d.	
	5 (Accra Central)	n.d.	
	6 (Dansoman)	n.d.	
	7 (St. John's)	6.8	(± 0.3)
	8 (Madina)	n.d.	
Bread and salad	1 (Kaneshie)	n.d.	
	2 (Nima)	-	
	3 (Odorkor)	n.d.	
	4 (La)	-	
	5 (Accra Central)	n.d.	
	6 (Dansoman)	-	
	7 (St. John's)	-	
	8 (Madina)	n.d.	

Where: values in brackets = standard deviation, n.d. =not detected, - = samples not sold in the zone.

The source of the lead was not investigated in this study. Potential sources of lead-contamination, however, include ceramics and cooking pots, air, water, soil and lead-based paint.

Considering ceramics and cooking pots as a possible source of contamination, ceramics are now the largest source of lead contamination in food in the USA. In Ghana, circumstantial evidence suggests that local small-scale smelters of aluminium cooking pots, of the type commonly used by street vendors, add lead in their manufacture. The lead is often added to reduce the melting point of the metal to that within the capacity of their furnaces. Analysis of the lead content of a single cooking pot by atomic absorption spectroscopy indicated that the pot contained lead at a concentration of 100 mg per kg. While a leaching test (Anon 1984) is required to confirm the extent of transfer of lead to the food product, the presence of lead indicates that the pot is a possible source of contamination.

Air is a potential source of contamination since most vehicles run on leaded fuel in Ghana. Street foods are usually sold close to the roadside in areas heavily congested with motor vehicles. Studies in Ghana (Kumasi-Accra highway), have shown that levels of lead are highest at the edge of a road (Golow 1996). The mean level of lead in the hair of school children in the Kumasi municipal area correlated with age and distance that their homes were from the road (Golow and Kwaansa-Ansah 1994). In countries (USA) where leaded fuel has been phased out, emissions of lead in air declined by 90%. Hence, if lead in the air is contributing to the lead contamination of street foods in Ghana, its removal from petrol might lower its occurrence.

Lead contamination can occur from lead-containing components in plumbing. Lead and lead-based compounds show a wide range of solubility and are highly persistent in water, with a half-life of over 200 days. While source water rarely contains high concentrations of lead, chemical reactions between the water and lead connectors, water pipes and materials including solder, brass and some plastics may result in lead leaching into the distribution system.

Cadmium

Although cadmium was detected in the street vended foods, the levels were below the maximum levels recommended by the draft Codex Commission of 0.1 mg/kg.

Pesticides in street vended foods

The organophosphorous pesticide chloropyrifos (dursban) was detected in 6 out of 8 waakye and 1 out of 8 fufu samples (table 9). The method and facilities at the Ghana Standards Board meant that the method, however, was indicative, not quantitative. The FAO Codex Alimentarius maximum residue limit for maize, rice and sorghum is 0.2 mg / kg. Mild poisoning with chloropyrifos can cause viral-like symptoms such as headaches, sweating, gastrointestinal upset and weakness in the limbs. Severe poisoning can cause convulsions, respiratory failure and death. This preliminary study suggests that further work is required to identify the concentration of the pesticide and hence extent of the hazard, and the source of the contamination. This type of pesticide is often used during storage of dried foods, for example rice.

Table 9: Organophosphorous pesticide residues (chloropyrifos) in street food samples

Type of street food	Zone in Accra	Detected
Waakye	1 (Kaneshie)	Yes
	2 (Nima)	Yes
	3 (Odorkor)	Yes
	4 (La)	Yes
	5 (Accra Central)	Yes
	6 (Dansoman)	No
	7 (St. John's)	No
	8 (Madina)	Yes
Fufu	1 (Kaneshie)	No
	2 (Nima)	No
	3 (Odorkor)	No
	4 (La)	No
	5 (Accra Central)	No
	6 (Dansoman)	Yes
	7 (St. John's)	No
	8 (Madina)	No
Soup of Fufu	1 (Kaneshie)	No
	2 (Nima)	No
	3 (Odorkor)	No
	4 (La)	No
	5 (Accra Central)	No
	6 (Dansoman)	Yes
	7 (St. John's)	No
	8 (Madina)	No
Bread and salad	1 (Kaneshie)	No
	2 (Nima)	-
	3 (Odorkor)	No
	4 (La)	-
	5 (Accra Central)	No
	6 (Dansoman)	-
	7 (St. John's)	-
	8 (Madina)	No

Where: - = samples not sold in the zone.

Aflatoxins in street vended foods

Aflatoxins are highly toxic fungal metabolites. The ingestion of these toxins can have a deleterious effect on the health and productivity of man and can cause death when consumed in sufficiently high quantities. The maximum aflatoxin levels recommended for foods for human consumption by the EU are 4 ppb ($B_1 + B_2 + G1 + G_2$) of which B_1 must not exceed 2 ppb. In this study, all the samples analysed were below this limit (table 10). While the levels of aflatoxin were below these limits, aflatoxins have been previously detected in fermented maize products such as kenkey and may exceed these levels when grains and nuts are harvested during the wet season, particularly if they are not sufficiently dried.

Table 10: Aflatoxin in street food samples

Type of street food	Zone in Accra	Aflatoxin B_1 μg/kg	B_2	G_1	G_2	Total
Waakye	1 (Kaneshie)	n.d.	n.d.	n.d.	n.d.	0.00
	2 (Nima)	n.d.	0.01	1.00	n.d.	1.01
	3 (Odorkor)	n.d.	n.d.	n.d.	0.68	0.68
	4 (La)	n.d.	0.14	n.d.	0.21	0.35
	5 (Accra Central)	n.d.	n.d.	n.d.	n.d.	n.d.
	6 (Dansoman)	n.d.	n.d.	n.d.	n.d.	n.d.
	7 (St. John's)	n.d.	n.d.	n.d.	n.d.	n.d.
	8 (Madina)	0.45	0.30	n.d.	n.d.	0.75
Fufu	1 (Kaneshie)	n.d.	n.d.	n.d.	n.d.	0.00
	2 (Nima)	0.60	0.30	n.d.	n.d.	0.90
	3 (Odorkor)	n.d.	n.d.	0.93	0.26	1.19
	4 (La)	n.d.	n.d.	n.d.	n.d.	0.00
	5 (Accra Central)	n.d.	0.05	n.d.	n.d.	0.05
	6 (Dansoman)	n.d.	n.d.	n.d.	n.d.	0.00
	7 (St. John's)	n.d.	n.d.	n.d.	n.d.	0.00
	8 (Madina)	0.96	n.d.	n.d.	n.d.	0.96
Soup of Fufu	1 (Kaneshie)	n.d.	n.d.	n.d.	n.d.	0.00
	2 (Nima)	n.d.	n.d.	n.d.	n.d.	0.00
	3 (Odorkor)	n.d.	n.d.	n.d.	n.d.	0.00
	4 (La)	n.d.	0.03	n.d.	0.15	0.18
	5 (Accra Central)	n.d.	n.d.	n.d.	n.d.	0.00
	6 (Dansoman)	n.d.	n.d.	n.d.	n.d.	0.00
	7 (St. John's)	n.d.	0.14	0.60	0.40	1.14
	8 (Madina)	n.d.	0.05	1.70	0.20	1.95

Where: n.d. =not detected; Note: Salad items were not analysed for aflatoxin

Street vended foods and hygiene

Microbiological analysis of Waakye, Fufu and Salad was carried out in all eight zones in Accra.

Eschcerichia coli

In this study, Waakye contained an average *E.coli* count of 5441 cfu/g (Table 11), fufu (Table 12) 9636 cfu/g and salad (Table 13) 11000 cfu/g. The analysis carried by the SFSIG study in 1994-1997 did not detect *E.coli* in waakye, but found lower counts of 10 cfu/g in Fufu. The *E.coli* bacterium is described as faecal coliforms, and is an indication of the presence of faecal contamination. Faecal contamination can arise through the use of contaminated water, poor hygiene of food workers in contact with the food product, or through contact with flies or other insect pests. Certain strains of *E. coli* are considered pathogenic, and can be dangerous when ingested by young children or the elderly. In comparison with the lower levels of *E.coli* found in the earlier SFSIG study, it indicates a general deterioration in the hygienic level of this food product.

Staphylococcus aureus

This study found 8296 cfu/g of *S. aureus* in Waakye, 2075 cfu/g in Fufu and 538 cfu/g in Salad. In comparison, the SFSIG study found lower counts of 10 cfu/g of *S. aueus* in waakye and fufu but higher counts of 200000 cfu/g in salad. *Staphylococcus aureus* is an opportunistic bacterium, found on the skin and on mucous membranes (*e*.g. the nose). The bacteria, which can only grow at warm temperatures, produces a toxin when found in large numbers. Although intoxication from *S. aureus* is not normally considered dangerous, it can produce severe symptoms of food poisoning. Results from the present study would indicate that sanitary handling of Waakye and Fufu have deteriorated, while that of salad has improved.

Bacillus cereus and Clostridium perfringens

The trend for the three street-vended foods for *B. cereus* and *C. perfringens is similar to S. aureus*. In general waakye and fufu have deteriorated, while that of salad has improved. Both *B. cereus* and *C. perfringens* are spore forming rods which grow in food which has been cooked, but then stored at room temperatures. Both these bacteria produce toxins which, although not considered dangerous, can produce severe food poisoning symptoms. *C. perfringens* is anaerobic. *B. cereus* can grow both in aerobic and anaerobic conditions.

Salmonella

Salmonella was not detected in waakye, fufu or salad. *Salmonella*, like *E. coli* is an indication of the presence of faecal contamination. Faecal contamination can arise through the use of contaminated water, poor hygiene of food workers in contact with the food product, or through contact with flies or other insect pests. Most species of *Salmonella* are considered pathogenic, and can be dangerous when ingested.

Table 11. Waakye

Zone in Accra	***E.coli* (MPN)**	**/g *Staph. aureus* /g**	***Bacillus cereus* /g**	***Clostridium perfringens* /g**	***Salmonella* /25 g**
Zone 1 Kaneshie	11000	110	110	10	nd
Zone 2 Nima	110	100	100	1000	nd
Zone 3 Odorkor	11000	200	100	10	nd
Zone 4 La	10	100	750	10	nd
Zone 5 Accra Central	200	10000	100	10	nd
Zone 6 Dansoman	11000	110	100	10	nd
Zone 7 St. John's	10000	55000	100	20	nd
Zone 8 Madina	210	750	550	10	nd
Mean Present study	**5441**	**8296**	**239**	**135**	**nd**
SFSIG study	**0**	**10**	**10**	**10**	**n.a.**

nd = Not detected, n.a. = Not available

Table 12. Fufu

Zone in Accra	***E.coli* (MPN)**	**/g *Staph. aureus* /g**	***Bacillus cereus* /g**	***Clostridium perfringens* /g**	***Salmonella* /25 g**
Zone 1 Kaneshie	11000	3700	100	410	nd
Zone 2 Nima	11000	300	100	100	nd
Zone 3 Odorkor	11000	2900	100	10	nd
Zone 4 La	11000	7400	100	40	nd
Zone 5 Accra Central	11000	600	100	190	nd
Zone 6 Dansoman	11000	1500	100	10	nd
Zone 7 St. John's	11000	100	100	20	nd
Zone 8 Madina	90	100	100	10	nd
Mean Present study	**9636**	**2075**	**100**	**99**	**nd**
SFSIG study	**10**	**1005**	**1005**	**100**	**n.a.**

Table 13. salad

Zone in Accra	***E.coli* (MPN)**	**/g *Staph. aureus* /g**	***Bacillus cereus* /g**	***Clostridium perfringens* /g**	***Salmonella* /25 g**
Zone 1 Kaneshie	11000	200	100	10	nd
Zone 2 Nima	n.a.	n.a.	n.a.	n.a.	nd
Zone 3 Odorkor	11000	250	300	10	nd
Zone 4 La	n.a.	n.a.	n.a.	n.a.	nd
Zone 5 Accra Central	11000	1500	5000	10	nd
Zone 6 Dansoman	n.a.	n.a.	n.a.	n.a.	nd
Zone 7 St. John's	n.a.	n.a.	n.a.	n.a.	nd
Zone 8 Madina	11000	200	100	10	nd
Mean Present study	**11000**	**538**	**1375**	**10**	**nd**
SFSIG study	**n.a.**	**200000**	**n.a.**	**n.a.**	**n.a.**

nd = Not detected, n.a. = Not available

The results found in the present study indicate that microbial hazards are not presently under control in Waakye, Fufu or Salad. The SFSIG study of 1994-97 identified several areas of infrastructure related to sanitation and hygienic which needed attention. These infrastructural areas included access to clean water, proper disposal of sewage, regular refuse collection and access to refrigeration. Many of the hazards identified by the SFSIG study were related to these areas and were included in their HACCP plan. The present study would tend to indicate that many of these infrastructural areas have not been addressed, and that the HACCP plan has not been implemented.

The Accra Metropolitan Assembly in conjunction with the Traditional Food Vendors Association has sponsored many excellent workshops, instructing their member street-vendors on proper methods of food handling and hygiene. The present study, however, has shown that only about 25% of the street-vendors surveyed in this study belong to this, or any association, providing instruction in food handling and hygiene.

A HACCP approach to the prevention of mycotoxins through moisture control.

The following case study covers the production of maize, destined for human consumption, in Ghana. Hazard analysis and critical control points are used to prevent mycotoxin contamination by controlling moisture content. The case study follows, task by task.

Task 1 - Assemble HACCP team.
An appropriate HACCP team should be composed of the producer, an HACCP specialist, a Ministry of Agriculture extension officer, a socio-economist, a representative of the maize industry in the public and private sectors.

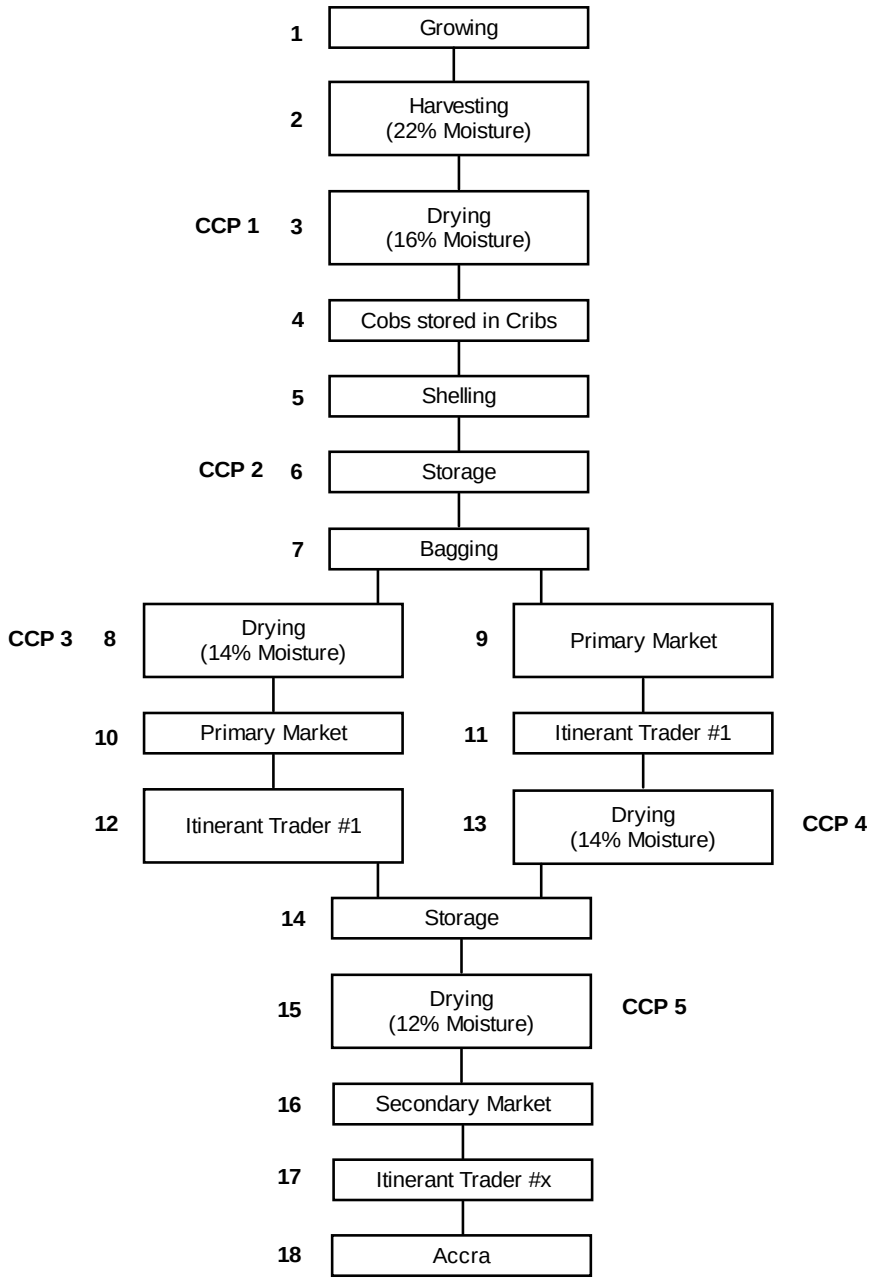
Tasks 2 and 3 - Product Description and Intended Use.
The product description and intended use is given in Table 14.

Table 14. Product description and intended use of yellow maize kernels

Name of Product	**Maize for human consumption**
Description	Maize kernels
Critical Properties	Cobs in "cribs" Shelled, bulk in heaps or silos Shelled and bagged in palleted stacks
Shelf Life	Cobs, 1 month if moisture content is ≤16% 3 months if moisture content is =14% 3 years if moisture content is <12%
Intended use	Milled, as ingredient in fermented products e.g. *Kenkey*, *banku* or *koko*
Packaging	Hessian or polypropylene bags or bulk.
Target Consumer	Street vended foods

Tasks 4 and 5 - The Commodity Flow Diagram (CFD), Verified
The CFD will be established using information provided by members of the HACCP team, notably the Ministry of Agriculture extension officer. It will be verified by visiting major maize production centres and interviewing farmers, traders, and silo and feed mill managers and observing their practices. An example of a typical commodity flow diagram is given in Figure 5.

Figure 5. Production flow-chart for maize production and storage.



Task 6: List hazards associated with each step.

Hazard Analysis
Maize is very susceptible to mould growth. The moisture content, at which moulds will grow, depends upon the water activity (a_w) of the maize. Moulds grow at a_w levels above 0.82 at 25°C, which corresponds, in maize, to an equilibrium moisture content of about 14% moisture. During their growth, moulds can produce mycotoxins, which contaminate the maize. Maize has been shown to be contaminated with up to six different mycotoxins at one time. Mycotoxins such as aflatoxin have been classified as a human carcinogen and are the subject of worldwide regulation.

Identification of steps in the Commodity Flow Diagram (CFD) (Figure 5) where mycotoxin contamination is most likely to occur.

Steps 1 and 2. On farm growing and harvest.
Pre-harvest aflatoxin contamination is associated with drought stress and insect damage (Fortnum, 1986 and McMillian 1986) during the final growing period. In South East Asia, the dry-season crop was more prone to these conditions, but was found to be only moderately susceptible to significant levels of pre-harvest aflatoxin contamination, even when the moisture content was 22%. Surveillance and field drying studies (Nagler. *et al*, 1988) both indicated that levels of aflatoxin were very low at harvest in the rainy season crop, certainly in the locations under study and over the three year study period. It is concluded that the risk of pre-harvest aflatoxin contamination is low, especially for maize produced in the rainy season.

Steps 3 and 4. On-farm drying and storage of cobs.
Surveillance and on-farm storage studies (Nagler *et al* 1988) indicated that mould growth and aflatoxin B_1 levels rose to unacceptable levels (60 to 90 µg/kg) when cobs were taken directly from the field and stored over a 1 to 6 month period. The moisture levels of these cobs were greater than 16% moisture. It was concluded that aflatoxin contamination is very likely to occur unless the moisture content was reduced to 16% or less. Short-term storage should not exceed 1 month.

Step 5. Shelling
No aflatoxin contamination is likely at this step. However if the percentage of broken grains produced was high, then this could pre-dispose the grain to mould growth at a subsequent step.

Step 6. On-farm Storage
Aflatoxin levels of freshly shelled maize rise very rapidly if the 'safe' moisture content (14%) is not attained within 48 hours. Surveys during the rainy season confirmed that aflatoxin contamination is extremely likely at this step (Nagler *et al* 1988). Short-term storage should not exceed three months.

Step 7. Bagging
No aflatoxin contamination is likely at this step.

Steps 8, 9, 10,11, 12, 13 and 14. Drying and storage at primary market by primary trader.
Aflatoxin surveys showed that maize frequently became more contaminated with aflatoxin at these steps (Nagler *et al* 1988). Again, aflatoxin levels of shelled maize can rise rapidly if the

'safe' moisture content (14%) is not attained quickly. It is important for the producer, or the primary trader to attain this moisture level at the primary market, before long-term storage is attempted.

Steps 15, 16, 17 and 18. Drying and storage at secondary and tertiary markets by secondary (or higher) traders.
Prior to delivery to secondary and tertiary markets, maize may be stored for long periods of time (1-3 years). During periods of low prices, maize will be stored until prices again rise. During periods of low prices, batches may be traded between many middlemen. Maize under long term storage must have moisture levels of 12% or lower. It is important for the producer, or the primary trader to attain this moisture level at the primary market, before long-term storage is attempted.

Task 7. Determination of CCP's – Where (Principle 2).
Utilising the HACCP decision tree (Figure 6) processing steps 3, 6, 8, 13 and 15 were identified as CCP's.

Step 3. On-farm drying.
Mature maize, in the field, can have moisture levels of 25-30%. It would be desirable to reduce this moisture level prior to harvesting. In semi-arid regions, field drying can easily accomplish this, but in more humid areas cobs are commonly harvested with moisture levels substantially above 16%. Under these circumstances drying of the cobs must be accomplished before storage is attempted.

Step 6. On-farm Storage
Aflatoxin levels of freshly shelled maize rise very rapidly if the 'safe' moisture content is not attained within 48 hours. Surveys during the rainy season confirmed that aflatoxin contamination is extremely likely at this step.

Step 8. On-farm Drying
Prior to shipping of bagged maize to primary markets, maize must not exceed safe moisture content levels. During the wet season, when maize is plentiful and drying is difficult, wet maize can often be shipped to primary markets. High moisture levels can easily result in rapid mould growth.

Step 13. Primary Market Drying
Where on-farm drying has not been carried out, wet maize shipped to primary markets must have its moisture levels reduced to safe levels. This is especially important during the wet season.

Step 15. Secondary Market Drying
During periods of low prices, maize may be stored for time periods in excess of one year, in anticipation of higher prices. Under these circumstances, moisture levels should be reduced further to eliminate possible mould growth.

Task 8.Establish tolerances – What (principle 3).
Utilising Figure 7 tolerances were defined for each CCP.

Step 3. On-farm drying.
Where circumstances do not permit proper field drying, the moisture content of the cobs must be reduced to ≤16%.

Step 6. On-farm Storage
When on-farm storage of maize kernels exceeds 48 hours, the moisture content must be reduced to ≤14%.

Step 8. On-farm Drying
Bagged maize entering the primary markets must not exceed 14% moisture content.

Step 13. Primary Market Drying
Bagged maize entering the primary markets must not exceed 14% moisture content.

Step 15. Secondary Market Drying
Bagged maize to be stored for periods exceeding one year should have moisture levels no greater than 12%.

Task 9.Establish monitoring requirements – How (principle 4).
Utilising Figure 7 monitoring requirements were defined for each CCP.

Step 3. On-farm drying.
Under ideal conditions, physical measurement of moisture content using appropriate instruments would be best. On a practical basis, however, on-farm measurement of moisture content using sensory testing must be used. Farmers, use to their products, are able to accurately determine the moisture content of their crop by judging the colour and texture of the kernels.

Step 6. On-farm Storage
Practical means of moisture measurement, on-farm, relies upon judging the colour and texture of the kernels.

Step 8. On-farm Drying
Practical means of moisture measurement, on-farm, relies upon judging the colour and texture of the kernels.

Step 13. Primary Market Drying
Practical means of moisture measurement, at the primary market level, again relies upon judging the colour and texture of the kernels. In situations where mechanical drying is possible, drying plant personnel should have available simple moisture measuring equipment.

Step 15. Secondary Market Drying
Bagged maize to be stored for periods exceeding one year should have moisture levels no greater than 12%.

Task 10. Establish corrective action - (principle 5).
Utilising Figure 7 corrective actions were defined for each CCP.

Step 3. On-farm drying.
Where it has been determined that stored cobs have exceeded 16% moisture content, the cobs should be taken out of storage and examined. Those cobs displaying obvious signs of mould growth should be discarded. Sound cobs should have their moisture contents reduced to proper levels before being placed back into storage.

Step 6. On-farm Storage
Where it has been determined that maize kernels, in excess of 14%, will be stored for 48 hours or more, the kernels should have their moisture contents reduced to proper levels before storage begins. Maize showing visible signs of mould growth should be discarded.

Step 8. On-farm Drying
Before shelled maize is shipped to primary markets, maize kernels must not have moisture levels in excess of 14%. Drying must be dried prior to bagging. Maize showing visible signs of mould growth should be discarded.

Step 13. Primary Market Drying
Bagged maize entering the primary markets must not exceed 14% moisture content. Solar or mechanical drying must be carried out.

Step 15. Secondary Market Drying
Bagged maize to be stored for periods exceeding one year should have moisture levels no greater than 12%. Where long term storage of maize is carried out, mechanical drying and simple moisture measuring equipment should be available.

Task 11. Establish verification procedures - (principle 6).
Utilising Figure 7 verification procedures were defined for each CCP.

Verification of the HACCP procedures must be carried out during development of the HACCP plan. Before plan implementation, the HACCP team must verify that all the hazards identified during maize production are eliminated at the critical control points identified. Careful measurement of moisture levels during each step of the production chain is necessary to verify the plan's efficacy. Subsequent to HACCP plan implementation, occasional monitoring of moisture levels, by Ministry of Agriculture extension officers, will verify that the HACCP plan is operating as intended.

Task 12. Establish record keeping/documentation - (principle 7).
The principle of record keeping is perhaps the key to successful implementation of a HACCP plan. The establishment of an effective recording keeping program is required to document information from the following areas:

Producers.
1. Keep general records regarding planting and harvesting dates cropping areas and general crop descriptions.
2. Storage and distribution records. Information should include data on quantities stored and quantities shipped. Additional information on the general condition of maize should also be recorded.
3. Packaging (bagging) records.

4. Deviation record. Date, time and description of problems encountered. Record of corrective action taken. The deviation record should include data on the eventual disposition of the maize.
5. Modification file. If a modification to the product flow chart has been made, it should be documented here.

Traders.

1. Keep dated records of maize receipt, storage conditions and storage times.
2. Keep packaging (bagging) records.
4. Storage and distribution records. How much was stored, how much was shipped. Information should include general condition of maize.
4. Deviation record. Date, time and description of problems encountered. Record of corrective action taken. The deviation record should include data on the eventual disposition of the maize.
5. Modification file. If a modification to the product flow chart has been made, it should be documented here.

The Ghanaian government has recently (Anonymous, 1997) proposed a new initiative, *Guide on Farm Household Record Keeping and Accounting*. The purpose of the guide is to help the agricultural production stakeholders, better manage their businesses.

Better record keeping will allow the farmers to identify potential problems associated with maize production and post-harvest processing. It would also allow traders and post-harvest processors to better evaluate shipments of maize coming into their possession. For the Department of Agricultural extension services (DAES), improved recording keeping will allow them to better encourage and implement technological developments. Finally, better record keeping will allow the DAES front line staff to better assess the impact that technological programs, such as HACCP plan implementation, have on the farmer's livelihood.

HACCP DECISION TREE HAZARDS ANALYSIS AND USE OF CODEX ALIMENTARIUS LOGIC SEQUENCE FOR CCP'S DETERMINATION						
PROCESS STEP	HAZARD CATEGORY (DESCRIPTION)	Q1. COULD A PREVENTIVE MEASURE(S) EXIST? *IF NO = NOT CCP +IDENTIFICATION ON HOW THIS HAZARD WILL BE CONTROLLED AFTER THE PROCESS + PROCEED TO THE NEXT PROCESS STEP *IF YES = DESCRIPTION + NEXT QUESTION	Q2. IS THIS PROCESS STEP SPECIFICALLY DESIGNED TO ELIMINATE / REDUCE THE LIKELY OCCURRENCE OF HAZARDS TO ACCEPTABLE LEVEL? *IF NO = NEXT QUESTION *IF YES = CCP + GO TO LAST COLUMN	Q3. IS IT LIKELY THAT CONTAMINATION WITH IDENTIFIED HAZARD (S) COULD OCCUR IN EXCESS OF ACCEPTABLE LEVEL (S) OR COULD INCREASE TO UNACCEPTABLE LEVEL? *IF NO = NOT CCP + PROCEED TO THE NEXT PROCESS STEP *IF YES = NEXT QUESTION	Q4. WILL A SUBSEQUENT STEP ELIMINATE IDENTIFIED HAZARD(S) OR REDUCE LIKELY OCCURRENCE TO AN ACCEPTABLE LEVEL? *IF NO = CCP + GO TO LAST COLUMN *IF YES = NOT CCP + IDENTIFY SUBSEQUENT STEP (#/CCP + PROCEED TO NEXT PROCESS STEP	CCP NUMBER *PROCEED TO NEXT STEP
1. Growing	No Hazard					
2. Harvesting	No Hazard					
3. On- farm drying 16%	Biological Mould Growth MC >16%	Yes	Yes	Yes	No	CCP 1
4. Cob Storage	Biological Mould Growth MC >16%	Yes	No	No		
5. Shelling	No Hazard					
6. On Farm Storage	Biological Mould Growth Time period >48 hours At MC >14%	Yes	No	Yes	No	CCP 2
7. On-farm bagging	No Hazard					
8. On-farm drying 14%	Biological Mould Growth MC >14%	Yes	Yes	Yes	No	CCP 3
9. Primary Market	Biological Mould Growth MC >14%	Yes	No	Yes	Yes Step 13	
10. Primary Market	Biological Mould Growth MC >14%	Yes	No	Yes	Yes Step 13	

Figure 6. HACCP decision tree.

HACCP DECISION TREE HAZARDS ANALYSIS AND USE OF CODEX ALIMENTARIUS LOGIC SEQUENCE FOR CCP'S DETERMINATION						
PROCESS STEP	HAZARD CATEGORY (DESCRIPTION)	Q1. COULD A PREVENTIVE MEASURE(S) EXIST? *IF NO = NOT CCP +IDENTIFICATION ON HOW THIS HAZARD WILL BE CONTROLLED AFTER THE PROCESS + PROCEED TO THE NEXT PROCESS STEP *IF YES = DESCRIPTION + NEXT QUESTION	Q2. IS THIS PROCESS STEP SPECIFICALLY DESIGNED TO ELIMINATE / REDUCE THE LIKELY OCCURRENCE OF HAZARDS TO ACCEPTABLE LEVEL? *IF NO = NEXT QUESTION *IF YES = CCP + GO TO LAST COLUMN	Q3. IS IT LIKELY THAT CONTAMINATION WITH IDENTIFIED HAZARD (S) COULD OCCUR IN EXCESS OF ACCEPTABLE LEVEL (S) OR COULD INCREASE TO UNACCEPTABLE LEVEL? *IF NO = NOT CCP + PROCEED TO THE NEXT PROCESS STEP *IF YES = NEXT QUESTION	Q4. WILL A SUBSEQUENT STEP ELIMINATE IDENTIFIED HAZARD(S) OR REDUCE LIKELY OCCURRENCE TO AN ACCEPTABLE LEVEL? *IF NO = CCP + GO TO LAST COLUMN *IF YES = NOT CCP + IDENTIFY SUBSEQUENT STEP (#/CCP + PROCEED TO NEXT PROCESS STEP	CCP NUMBER *PROCEED TO NEXT STEP
11. Itinerant Trader #1	No Hazard					
12. Itinerant Trader #1	No Hazard					
13. Itinerant Trader #1 Drying 14%	Biological Mould Growth MC >14%	Yes	Yes	Yes	No	CCP 4
14. Storage	No Hazard					
15. Itinerant Trader #1 Drying 12%	Biological Mould Growth MC >12%	Yes	Yes	Yes	No	CCP 5
16. Secondary Market	No Hazard					
17. Itinerant Trader #X	No Hazard					
18. Accra	No Hazard					

HACCP MODEL							
PRODUCT NAME Maize							
Process Steps	CCP/Hazard Number	CCP Description	Monitoring Procedures	Tolerances	Corrective Action	HACCP System Verification	HACCP Records
3. On-farm drying 16%	CCP 1	Biological Mould Growth	Monitor moisture content (Sensory / Physical testing)	Moisture content ≤16%	Do not store until moisture content ≤ 16%.	Check on-farm records. Analytical measurement of moisture content.	On-farm records
6. On-farm storage for time periods >48 hours	CCP 2	Biological Mould Growth	Monitor moisture content (Sensory / Physical testing)	Moisture content ≤14%	Do not store until moisture content ≤14%.	Check on-farm records. Analytical measurement of moisture content.	On-farm records
8. On-farm drying	CCP 3	Biological Mould Growth	Monitor moisture content (Sensory / Physical testing)	Moisture content ≤14%	Reduce moisture content ≤14%.	Check on-farm records. Analytical measurement of moisture content.	On-farm records
13. Itinerant Trader #1 Drying	CCP 4	Biological Mould Growth	Monitor moisture content (Sensory / Physical testing)	Moisture content ≤14%	Reduce moisture content ≤14%.	Check itinerant trader #1 records. Analytical measurement of moisture content.	Itinerant trader #1 records.
15. Itinerant trader #X Drying prior to long-term storage	CCP 5	Biological Mould Growth		Moisture content ≤12%	Reduce moisture content ≤12%.	Check itinerant trader #X records. Analytical measurement of moisture content.	Itinerant trader #X records.

Figure 7. Critical control point monitoring, corrective actions and verifications.

2.1. and 2.2: Disseminate study outcomes to key stakeholders and Organise workshop for key stakeholders

Recommendations made at the workshop were as follows:

Recommendations to improve the food safety and quality of street foods by these stakeholders without further research were:

- Improvements to infrastructure to provide adequate clean water, sanitation and refuse disposal;
- Regulatory framework needed to be enhanced to ensure enforcement of bye-laws and issuing of licenses along with the need for the local council (AMA) to co-ordinate with supplier of utility services (water, electricity);
- Education of street food vendors, school children and consumers in hygiene and sanitation and farmers on the use of agrochemicals;
- Dissemination of Information on food handling and safety through the media, consumers associations, NGO's, street vendors associations;
- Provision of credit facilities and financial assistance to street food vendors;

Recommendation on areas where new knowledge is required to ensure impact on livelihoods of target beneficiaries was identified by the workshop were:

- Identify of the sources of heavy metal and pesticide contamination of street vended foods and heavy metals and methods for reducing the hazard;
- Socio-economic appraisal of improved vending facilities on a case-study basis and consumer perception on street-food vending;
- How to relay information on research findings to street food vendors, traders and farmers;
- Appropriate implementation of HACCP in raw materials used in street vended foods.

Television, radio and newspapers

The workshop (25 to 26 September 2000) was the top story on both Ghanaian television channels, on the front page of the national newspapers the Chronicle, Ghanaian Times and Daily Graphic and on national radio (GBC, Joy FM, Universe, Choice FM, Vibe, Top Radio, Peace FM and Radio Gold.

Governmental working group involving stakeholders in the street food sector

As a result of this workshop, a high level working group comprising Ministry of Environment Science and Technology, Accra Metropolitan Assembly, Ghana Education Service, Ministry of Health and the Food Research Institute will be chaired by Mr Barnes, Chief Director (Ministry of Environment Science and Technology). Its purpose will be to implement improvements in the working conditions for street food vendors and to develop its tourism potential. A priority will

be to establish a pilot study to improve access to water, sanitation and refuse disposal for street food vendors at the Osu area, Accra.

The workshop proceedings will document and record the presentations and outcomes of the workshop.

Contribution of Outputs

The project goal is 'Strategies developed which improve food security of poor households through increased availability and improved quality of horticultural foods and better access to markets'.

The outputs of the project have been achieved. The contribution to the research goal 'Poor people benefit from new knowledge applied to food commodity systems in peri-urban interface areas' has been the identification of new contaminants (heavy metals, pesticides and aflatoxins) in addition to the microbiological hazards identified by earlier research. The socio economic study has demonstrated that this sector contributes over US$100 million to the economy of Accra annually and that the sector employs over 60,000 people, 94% of whom are women of either no or minimal education.

A high level-working group was formed as a result of the workshop comprising the Ministry of Environment Science and Technology, Accra Metropolitan Assembly, Ghana Education Service, Ministry of Health and the Food Research Institute. It will implement improvements in the working conditions for street food vendors and to develop its tourism potential. A priority will be to establish a pilot study to improve access to water, sanitation and refuse disposal for street food vendors at the Osu area, Accra

At the workshop (25 to 26 September 2000) a priority for research was to investigate the cause and source of heavy metal and pesticide contamination of street vended foods along with methods for eliminating them from the street food system. A concept note has been submitted to DFID entitled 'Improving the safety of street-vended foods in Ghana by identifying sources of heavy metal contamination and determining methods for removing the risk' in November 2000. It is proposed that it be led by NRI with the Food Research Institute and University of Ghana as collaborators.