

CROP POST HARVEST PROGRAMME

Developing food safety strategies and procedures through reduction of food hazards in street-vended foods to improve food security for consumers, street food vendors and input suppliers

R8270 (ZB0339)

PROJECT FINAL REPORT

1 February 2003 – 31 December 2004

Core Partners: **Ghana:** Food Research Institute (FRI) Food and Drugs Board (FDB) University of Ghana (UG); Kwame Nkrumah University of Science & Technology (KNUST); Noguchi Memorial Institute for Medical Research (NMIMR); Accra Metropolitan Assembly (AMA); Kumasi Metropolitan Assembly (KMA); Ghana Traditional Caterers Association (GTCA). **UK:** Natural Resources Institute (NRI)

Managing Partners: Mr Keith Tomlins and Dr Paa-Nii Johnson

Managing Partners' Institutes: Natural Resources Institute, UK and Food Research Institute, Ghana

Project Final Report

Cover page – please use the template given at the end of this document

Section A Executive Summary

The project, through an enabling process, sought to improve the livelihoods of vendors and health of consumers. This was achieved through a successful coalition partnership approach comprising street food vendor NGO's, local authorities, food standards authorities, research institutions and food laboratories. They explored the wider framework in which the policies, institutional linkages and food laws associated with street vending were carried out and by determining the sources and extent of food safety hazards that could jeopardise livelihoods and consumer health. The coalition approach began during an earlier CPHP project (R7493) and was successfully formalised during this project; new partners joined the coalition and some stakeholders/agencies substantially enhanced this project. It is anticipated that the coalition will sustainably address future food safety issues in Ghana. However, at the inception of this project, there were uncertainties by the CPHP over the role of international organisations such as NRI (and manager of the earlier project) and were initially excluded from the project until this was successfully resolved. The CPHP also appointed a coalition partner to provide strategic research into heavy metals. While the organisation played a constructive role in the coalition, equipment failure led to substantial delays and by using an incorrect approach the results could have potentially had serious implications for the livelihoods of those in the street food sector. A UK backstopping laboratory successfully complemented this organisation to overcome these concerns.

The research partnership developed strategies that could be used to control identified food safety hazards in an economical and socially-acceptable manner. A food safety baseline study indicated variations between markets and vendors selling different food types. Microbiological studies indicated that *fufu* was more at risk than others. Analysis of heavy metal residues indicated that concentrations of the heavy metal lead in street foods were generally low. However, cooking pots produced by informal manufacturers contained high concentrations (419mg/kg) that could leach into foods at levels slightly above the maximum permitted level (WHO/FAO). Promotion materials on food safety to educate both consumers and vendors were developed. These included four TV documentaries and billboards by the FDB (with UNIDO funding), four posters and training manuals for Environmental Health Officers and street vendor NGOs. Nearly 300 vendors were trained but falls substantially short of the estimated 60000 vendors in Accra. A survey of 265 street food vendors highlighted that many had limited understanding of their business finances and this hindered the benefits of training. A survey of 530 consumers indicated that most consumers did not associate unsafe food with food borne illnesses. New male dominated street food vending businesses, known as 'check-check food vendors' have recently arisen but the food safety issues are similar and need to be addressed.

The project successfully contributed to developing new knowledge on food safety issues, how information is managed and issues relating to how street vendors take up this new knowledge. It has also illustrated new challenges if this new knowledge is to be adapted successfully and in a sustainable way to improve livelihoods of the vendors and the health of consumers.

Section B Background

B.1 Administrative data

NRIL Contract Number: ZB0339	Managing Partner(s)/Institution(s): Natural Resources Institute, UK & Food Research Institute, Ghana
DFID Contract Number: R8270	Partner institution(s) Ghana: Food Research Institute (FRI) Food and Drugs Board (FDB) University of Ghana (UG); Kwame Nkrumah University of Science & Technology (KNUST); Noguchi Memorial Institute for Medical Research (NMIMR); Accra Metropolitan Assembly (AMA); Kumasi Metropolitan Assembly (KMA); Ghana Traditional Caterers Association (GTCA). UK: Natural Resources Institute (NRI)
Project Title: Developing food safety strategies and procedures through reduction of food hazards in street-vended foods to improve food security for consumers, street food vendors and input suppliers	Target Institution(s) Food Research Institute (FRI) Food and Drugs Board (FDB) University of Ghana (UG); Kwame Nkrumah University of Science & Technology (KNUST); Noguchi Memorial Institute for Medical Research (NMIMR); Accra Metropolitan Assembly (AMA); Kumasi Metropolitan Assembly (KMA); Ghana Traditional Caterers Association (GTCA).
Research Programme: Crop Post-Harvest	Start Date: 01/02/03 End Date: 31/12/04
Thematic area: Food Safety	Budget (i.e. Total Cost): £195,000

Section C Identification and design stage (3 pages)

Poverty focus

How did the project aim to contribute to poverty reduction? Was it enabling, inclusive or focussed (see definitions below¹)? What aspects of poverty were targeted, and for which groups?

Please describe the importance of the livelihood constraint(s) that the project sought to address and specify how and why this was identified.

How and to what extent did the project understand and work with different groups of end users? Describe the design for adoption of project outputs by the user partners?

The project sought to contribute to poverty reduction through an enabling and inclusive process. The aspects of poverty targeted were as follows:

- Improved livelihoods for those employed (mainly low income and resource-poor females) in the street food sector (enabling process);
- Improved health of consumers (all income groups) of street vended foods through reduced incidence of food borne illness (inclusive process).

The livelihood constraints that this project sought to address were identified in a previous CPHP project (R7493) which established that the street-vended food sector significantly contributes to the economy of Accra, with an annual turnover of over US\$100 million and annual profit of US\$24 million, employs around 60000 people (mostly female with minimal education) and that microbiological and heavy metal residue hazards were potentially a hazard in certain popular

¹ **Enabling:** addresses an issue that under-pins pro-poor economic growth or other policies for poverty reduction which leads to social, environmental and economic benefits for poor people

Inclusive: addresses an issue that affects both rich and poor, but from which the poor will benefit equally

Focussed: addresses an issue that directly affects the rights, interests and needs of poor people primarily

foods sold on the streets of Accra. This had been identified by a survey of 48 street food vendors and analysis of 96 street food samples for microbiological and heavy metal contaminants. This situation was confirmed in this project where a further 256 street food vendors were interviewed regarding livelihood constraints and opportunities.

This project sought to improve livelihoods of those working in the street food sector and the health of consumers through the coalition partnership approach. The groups of end users requiring the project knowledge and expertise included:

- Street food vendor associations (Ghana Traditional Caterers Association). This organisation represents and works with the street food vendors in Ghana. The Association provided points of contact through which street food vendors could be approached for participation in these project activities. The Association also actively participated in the quarterly coalition project meetings and responded to training needs and requirements.
- Local authorities (Accra Metropolitan Assembly and Kumasi Metropolitan Assembly). The organisations are responsible for provision of utility services (electricity, water, electricity, gas, sanitation and refuse disposal) in the Accra and Kumasi metropolis, consumer awareness and inspection of food businesses.
- Food regulatory and standards authorities (Food and Drugs Board),
- Laboratory services (Noguchi Memorial Institute for Medical Research, Food Research Institute of Ghana and University of Greenwich.
- Research and Development (Food Research Institute of Ghana, University of Ghana and Natural Resources Institute)

Among the coalition project team were four organisations who were direct users of the project findings. These were the Food and Drugs Board (FDB), the Accra Metropolitan Assembly (AMA), Kumasi Metropolitan Assembly (KMA) and the Ghana Traditional Caterers' Association (GTCA).

Under a legal instrument number 305 passed by the Parliament of the Republic of Ghana, in 1992, the FDB was established to enforce the Ghana Food Law and therefore advise the Ministry of Health of Ghana on measures for protecting the consumers on matters of food safety. The Board has therefore oversight responsibility on all matters related to food safety in Ghana; either from the formal food companies or from the informal sector like the street food sector. On the latter, the FDB has been enforcing the Ghana Food Law through its collaboration with the Ministry of Local Government and Rural Development and its implementing agencies in the cities and districts in Ghana. The FDB is therefore expected to set broad policy guidelines and help coordinate food regulation and inspection of the street food sector. The project findings were therefore immediately implemented by the FDB and other user agencies in the production of documentaries, billboards to sensitize the consuming public on current issues on food safety identified through the project as well as in the development of appropriate training material and the participation of the training programmes by the project.

Project outputs formed the basis for the development of four documentaries and billboards on food safety produced by the FDB during the course of the project.

Training programmes were held for 229 street food vendors (70% from the GTCA) and 40 environmental health officers from the AMA.

Institutional design

Describe the process of forming the coalition partnership from the design stage and its evolution during the project?

The idea of forming a coalition project team to examine issues confronting the street food vending sector in Ghana was at the initiation of a DFID/CPHP-sponsored thematic workshop on Street Food Vending in Ghana in July 2002. During this workshop, a number of key

institutions, agencies and individuals connected with the control of street food vending in Ghana were invited to review previous works which have been carried out on the sector since 1992. Prior to this workshop, the last 1 year DFID/CPHP-sponsored street food project, R7493, had organized a workshop, in September 2000, for stakeholders, policy makers and regulators of street food vending in Accra to present findings of the year-long activities as well as agree on additional knowledge required to assist the sector. It was actually at this workshop that the idea of close working relation between research teams and target groups and/or end-users of research findings on the street food sector was first mooted. A street food Working Group was therefore initiated through the help of the Chief Director of the Ministry of Science and Environment. So by the time the idea of the forming a coalition came up, the partners for the present Street Food Coalition Project Team had been identified and already started working together. Thus the coalition partnership development began in the earlier project, R7493, and became formalised in this project.

A number of issues concerning institutional development arose early on in the development of the coalition formed during this project:

- Issues concerning the interpretation of the coalition development process by the CPHP Programme led to uncertainties regarding the role of international organisations such as NRI in the coalition process. This led to the temporary exclusion of one of the managing partners, Mr Keith Tomlins, NRI (and manager of the earlier project R7493) when attending the DFID/CPHP-sponsored thematic workshop on Street Food Vending in Ghana in July 2002. This was later successfully resolved by having a joint management approach to this project. Mr Tomlins is now the international coordinator of the recent new proposal to CPHP which if funded will span five countries in the West Africa, Southern Africa and South Asia regions.
- One coalition member (NMIMR) was recommended for providing facilities for heavy metal analysis of street foods by the CPHP Programme. The programme had funded a consultant to explore the analytical capability of institutions in Ghana and recommend institutions that had the capability for this type of work. While this institution was able to play a constructive role as a coalition member it was not able to provide reliable results because of equipment failure and because suitable reference materials were not used.

The project coalition has been developing through a number of routes.

- Development of the PMF
- Project Inception Meeting
- Participation in project activities.
- Preparation and of reports
- Coalition Quarterly Meetings: In all there have been six such meetings in the life of the present project.

In the course of the present project, though no new partner was added to the main coalition team, close collaborations were established with other groups working in the sector. These included:

- Food Component Project of the Integrated Programme for Ghana by the United Nations Industrial Development Organisation (UNIDO)
- School of Sciences of the University of Greenwich (UoG)
- Centre for Informal Activities and Development (representative of StreetNet)
- Maggi Fast Foods Association of Ghana (known locally in Ghana as the “Check Check” Group)
- Environmental Health Division of the Tema Municipal Assembly.

UNIDO assisted one the key coalition member, the FDB, to develop documentaries and billboards on food safety using knowledge acquired through the project. The School of

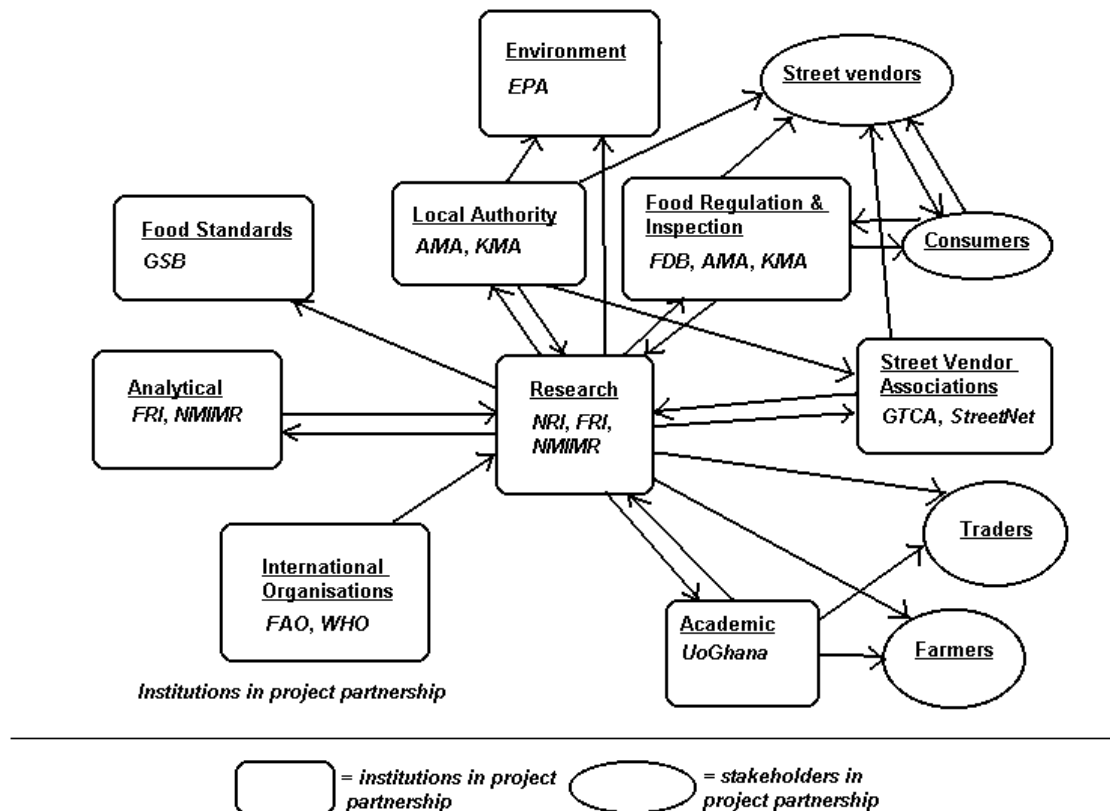
Sciences of UoG became the backstopping institution which offered laboratory facilities which analyzed heavy metals residues in street food samples when the Noguchi Memorial Institute for Medical Research, the coalition partner responsible for this, had problems with the equipment for the carrying out the analysis. The rest took part in the development of training materials (posters and training manual) as well as the actual training programmes organized by the coalition.

Is there an explicit institutional hypothesis? If yes, is it trying to attack a failure or inadequacy in a mechanism? What other institutional factors were seen as being important?

There was no institutional hypothesis as such that was implicitly a part of the project. This is because this project pre-dates the national innovation systems approach. However activity 3.1 of output 3 of the project explored the present policy and institutional issues with the view to making recommendations that would assist better adoption and use of the research findings of this project. Other institutional factors were that some of the institutions were still in the infancy and therefore considered higher risk with respect to longer term sustainability.

The institutional linkages are given in figure 1.

Figure 1: Linkages between coalition partners and stakeholders



Section D Implementation process (5 pages)

How was participation maintained among the different stakeholders (the Managing Partner(s) and the Core other Partners and, where relevant, user communities) in the research process?

Participation among the different stakeholders was maintained in the research process by a number of processes including:

- Demands of stakeholders: For example, the FDB mandate was to improve food safety in Ghana at a national level and this organisation has, with funding from UNIDO organised 2 national food safety weeks, (in June 2003 in Accra and in July 2004 in Kumasi). It has also produced food safety bill boards and videos. The FRI is a member of the national food safety committee, the National Codex Committee of Ghana and improving street foods is contributing to this.
- Day-to-day contact: Managing partners liaised with coalition partners and stakeholders regarding coordination of project activities and resolving conflicts.
- Development of the project PMF: Stakeholders were involved in the development of the project concept note and project memorandum. However, issues concerning the interpretation of the coalition development process by the Programme led to uncertainties regarding the role of international organisations such as NRI in the coalition process. This led to the temporary exclusion of one of the managing partners, Mr Keith Tomlins, NRI (and manager of the earlier project R7493), until this was successfully resolved.
- Project inception meetings: This was important for bring all partners together
- coalition meeting: This enabled the project partners to discuss issues concerning the partnership and project activities.
- Participation in project activities.

What were the major changes that took place during the implementation period. For each one, explain why they came about and how well did the project manage them?

The major changes that occurred during the implementation period were:

- Improvements in linkages between coalition partners and stakeholders
- Improved knowledge about each partner

What were the strengths and weaknesses of your monitoring system? How did you use the Information provided by your monitoring system?

This project did not have a specific monitoring system apart from good project management practice whereby budgets and activities were monitored for the sake of good order. There were some changes in the coalition during the project. These were:

- The possibility of including the Centre for Informal Activities and Development (formerly called StreetNet), an NGO representing street vendors was discussed at the January 2004 coalition meeting. However, the organisation was not added because it was a new organisation to Ghana and there were concerns regarding its sustainability.
- The School of Science, University of Greenwich, UK was included in the project to provide backstopping support to the NMIMR for the analysis of heavy metals. The NMIMR had equipment failure with prevented them from participating fully as a coalition member. In addition, the analytical approach they used did not include reference standards to verify the accuracy of the method. It was vital that accurate information about the concentration of heavy metals be obtained since this had the potential for serious impact on the livelihoods of certain street food vendors and the manufacturers of the informal cooking pots used by many vendors if incorrect information was used. The School of Science at the University of Greenwich provided a backstopping role by carrying out the heavy metal analysis for the project at a lower cost than that charged by NMIMR. The University of Greenwich fees included all costs whereas the project had to provide NMIMR with a certified reference material costing in the region of £250 in addition to their standard fees. The analytical approach used by the School of Science,

University of Greenwich had the advantage of using a microwave digester that avoided losses of volatile heavy metals such as arsenic and mercury during extraction. Detection was by inductively coupled plasma emission spectroscopy (ICP).

What organisations were involved at the end of the project? Were there changes to the coalition (joining/leaving) during the project? If yes, why? Include a complete list of organisations involved, directly or indirectly, in the project and describe their relationships and contributions.

Organisations involved in the project, relationships and contributions is illustrated in table 1. Changes to the coalition have already been described.

Table 1: List of organisations involved, directly or indirectly, in the project, their relationships and contributions.

Coalition Member / Stakeholder	Relationships and roles in the Project	Justification of Role	Relationship to project and responsibilities
Food Research Institute	Joint Managing Partner Coalition partner Research Food Analysis Food Safety	Research Profile Facilities and equipment	Monitoring specific activities assigned to each coalition member
Natural Resources Institute	Joint Managing Partner Coalition partner Research Food Safety Gender analysis	Research Profile Facilities and expertise	Monitoring specific activities assigned to each coalition member
Noguchi Memorial Institute for Medical Research	Coalition partner Food Analysis	Facilities and expertise	Quarterly meetings to review progress and prepare reports
Accra Metropolitan Assembly	Coalition partner Implementation and links with street food vendors	Urban planning, food law, food regulation, food inspection	Quarterly meetings to review progress and prepare reports
Kumasi Metropolitan Assembly	Coalition partner Implementation and links with street food vendors	Urban planning, food law, food regulation, food inspection	Quarterly meetings to review progress and prepare reports
Food and Drugs Board	Coalition partner Implementation and food safety	Food regulation and training	Quarterly meetings to review progress and prepare reports
Ghana Traditional Caterers Association	Coalition partner Implementation as vendors representatives	Facilitators	Quarterly meetings to review progress and prepare reports
University of Ghana	Coalition partner Socio-economics	Social and economic justification	Quarterly meetings to review progress and prepare reports
Kwame Nkrumah University of Science & Technology (KNUST), Kumasi	Coalition partner Implementation and food safety links with KMA	Expertise	Quarterly Meetings to review progress and prepare reports
School of Science, University of Greenwich	Backstopping role for food Analysis	Facilities and expertise	Quarterly meetings to review progress
Centre for Informal Activities and Development (StreetNet)	Stakeholder Implementation as vendors representatives	Social and economic justification	Informed at quarterly meetings
Ghana Standards Board	Stakeholder Food standards	Facilitator	Informed at quarterly meetings
MOFA, PO Box M161, Accra	Stakeholder Food policy Extension	Facilitator	Informed at quarterly meetings
Metro Education Office	Stakeholder Education	Facilitator	Informed at quarterly meetings
Check-Check vendors association	Stakeholder Implementation as vendors representatives	Social and economic justification	Informed at quarterly meetings
UNIDO	Stakeholder	Facilitator	Informed at quarterly meetings
FAO	Stakeholder International organisation	Facilitator	Informed at quarterly meetings
WHO	Stakeholder International organisation	Facilitator	Informed at quarterly meetings

How will(have) project outputs affect(ed) the institutional setting? How will the technical outputs of the project (if successful and if adopted) change the organisations and the relationships between them and in what way? Refer to the project's technical hypothesis.

The relationship between the institutions, organisations and stakeholders is illustrated in Figure 1. Figure 1 illustrates the complexity of the partnership linkages and highlights the need for institutional linkages and the organisational personnel to be fully effective to ensure the success of the project. This project has developed an institutional coalition and framework through these linkages. Through this network, strategies and procedures and uptake mechanisms required to bring about improvements in the safety of foods vended in the street food sector have been developed. The partnership contains policy, regulatory and enforcement agencies that will assist the project in both the development and uptake of policy and technical outputs. Although this project only addresses food safety issues related to heavy metal and microbial contamination, it is anticipated that the coalition will constitute a forum that will continue to address other food safety concerns beyond the duration of this project.

All the user agencies consider the outcome of the project outputs to be positive. In particular, the GTCA consider the approach for developing composite posters used in the training programme to be particularly useful in assisting the vendors. They were equally keen with the practical session which enabled vendors to better appreciate the problems with microbiological contaminations during the street food preparation and sale.

Table 2 illustrates the roles and linkages between the organisations involved in this project. An issue that may arise, particularly with respect to policy, are conflicts in responsibility that some organisations may encounter. For example, more than one organisation in Ghana is concerned with inspection of food establishments (FDB, AMA and Ghana Tourist Board) and development of food standards (FDB and Ghana Standards Board). While these factors are out of the remit of this project, they may have an impact on the institutional context and how recommendations arising from this project are taken up.

Table 2: List of coalition members and stakeholders to show roles and relationships

Coalition Member / Stakeholder	Role	Linkages
Food Research Institute	Joint Managing Partner. Delivery of strategic research outputs and acting as an impartial and independent mediator within the coalition. FRI also supplies analytical capacity.	<ul style="list-style-type: none"> Links to all members of the coalition as a managing partner and provider of research outcomes
Natural Resources Institute	Joint Managing Partner. Delivery of strategic research outputs and acting as an impartial and independent mediator within the coalition.	<ul style="list-style-type: none"> Links to all members of the coalition as a managing partner and provider of research outcomes
Noguchi Memorial Institute for Medical Research	Strategic research into heavy metals and their function in the safety of food.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
Accra Metropolitan Assembly and Kumasi Metropolitan Assembly	These assemblies are responsible for the overall development of the Accra and Kumasi Metropolis. This includes the preparation of development and budgetary plans for the city, initiation of programmes for the development of basic infrastructure, the development, improvement and management of human settlements and the environment and ensuring secured and sound conditions for development.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners Links to food standards and regulatory organisations Links to street food vendors Links to consumers Links to traders Links to environmental organisations
Food and Drugs	Responsible for regulation and inspection of food quality and	<ul style="list-style-type: none"> Links to FRI and

Board	safety in Ghana at the local and national level.	<ul style="list-style-type: none"> NRI as managing partners Links to local authorities (AMA, KMA) Links to street food vendors Links to consumers Links to traders
Ghana Traditional Caterers Association	The Ghana Traditional Food Caterers Association (GTFCA) is an NGO. Its mission is to encourage traditional foods in Ghana and to represent the catering sector. GTFCA works closely with the AMA and KMA.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners Links to local authorities (AMA, KMA) Links to consumers
University of Ghana	Provider of strategic socio-economic research inputs.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
KNUST	Strategic research into heavy metal and food safety	<ul style="list-style-type: none"> Links to KMA & FDB
School of Science, University of Greenwich, UK	Strategic research into heavy metals and their function in the safety of food.	<ul style="list-style-type: none"> Links to FRI & NRI
<i>StreetNet</i>	StreetNet is an international NGO with affiliations with the International Labour Organisation. They represent street vendors.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners Links to street vendors and consumers
<i>Environmental Protection Agency</i>	Government body in Ghana concerned with regulation and policy regarding environmental issues.	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
<i>Ghana Standards Board</i>	Stakeholder Food standards	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners Links to AMA and FDB
<i>MOFA, PO Box M161, Accra</i>	Stakeholder Food policy Extension	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
<i>Metro Education Office</i>	Stakeholder Education	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
<i>MLGERD</i>	Stakeholder	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners
<i>FAO</i>	Stakeholder International organisation	<ul style="list-style-type: none"> Links to FRI and NRI as managing partners Links to FDB and GSB
<i>WHO</i>	Stakeholder International organisation	<ul style="list-style-type: none"> Links to FRI & NRI

Note: Organisations in **bold** are coalition members, and those in *italics* are stakeholders

Section E Research Activities (15-20 pages)

This section should include a description of all the research activities (research studies, surveys etc.) conducted to achieve the outputs of the project analysed against the milestones set for the implementation period.

Information on any facilities, expertise and special resources used to implement the project should also be included.

The research activities are listed by project outputs.

PROJECT OUTPUT 1. EXTENT OF HAZARDS FROM HEAVY METALS AND MICROBIOLOGICAL CONTAMINATION IN SELECTED STREET FOODS IN ACCRA EVALUATED.

Initially, a literature review of the street food situation was carried out to keep the project coalition up to date with developments by other researchers (ANNEX 7). Furthermore, Mr Tomlins (Joint Project Manger) successfully passed exams in Advanced certificate in applied HACCP principles (RIPH) and the project chosen was 'Development of appropriate food safety management systems for improving the safety of informal food systems in developing countries'.

Selection of street vended foods and vendors investigated during this project

The street foods in the survey were selected on the basis of prior knowledge from an earlier CPHP project (R7493) and perceived risk. Fufu and waakye were chosen because these were studied in an earlier project and preliminary investigations suggested both microbiological and heavy metal health hazards to consumers. *Kenkey* was added because it was widely sold by street vendors.

These street foods are sold to the consumer for immediate consumption or are taken home to be eaten later. The consumers of these foods come from all segments of society with respect to age, gender and social and income status.

The street foods are described below:

- *Kenkey*: This is prepared from fermented wholemeal maize dough. To prepare kenkey, the fermented maize dough is divided into two halves. One half is partially cooked into a thick paste called "aflata" and the remaining half of fresh dough added and mixed thoroughly. The cooked and uncooked blend is moulded into balls of different sizes and covered with cornhusks. The wrapped balls are boiled in water until cooked. Ga kenkey that was the focus of this study is salted during preparation. The kenkey is usually served with fried fish and hot pepper or with all kinds of soup depending on one's taste. This is high moisture and low pH food and is usually served when hot or warm.
- *Fufu*: This is a sticky paste prepared by pounding cooked cassava only, cassava and either plantain or cocoyam, or yam only in a wooden mortar. During pounding, water is added intermittently to lubricate the pistil and also soften the paste. At a particular consistency and elasticity depending on preference, the paste is moulded into balls and served with soup. The soup can be light, groundnuts or palm nut soup. This is a high moisture neutral pH food that is usually served luke warm with some warming from the hot soup that is added when served.
- *Waakye*: This is a cooked mixture of rice and beans (cowpea) coloured with the stock of dry millet leaves. The millet leave is soaked and boiled to release the brown colour. The cowpea is then boiled separately to near cooked point. The rice is also boiled separately to a point and the almost cooked cowpea added to steam to cooked point of the mixture. The cooked waakye is brownish in colour and is eaten with stew prepared with fish, meat or both.

Waakye is made from beans (cowpeas), rice and dried sorghum stalks (red colouring). It is a high moisture food, of near neutral pH and usually kept and served at ambient temperature or above.

Example photographs of these dishes (kenkey, waakye and fufu) are shown in Figure2

Figure 2: Street food dishes



The markets in Accra where street food vendors participated were at the following locations: Accra Timber, Accra Kinbu, Kaneshie, Odorkor and Accra Post Office

Evaluation of street vendor prerequisite practices with respect to basic food safety

A total of 90 street food vendors serving either fufu, waakye or kenkey at five different markets (Accra Timber, Accra Kinbu, Kaneshie, Odorkor and Accra Post Office) Accra participated in a survey of basic food hygiene practices. Most vendors were visited on three occasions although this was not always possible.

Flow diagrams for the production and vending of *kenkey*, *waakye* and *fufu* are shown in figures 3 to 5. A knowledge of the method of producing these street vended foods was necessary when carrying out an evaluation of prerequisite food safety practices during the survey. It also provided an opportunity for the team to assess possible deviations from this methods.

Figure 3: Process flow chart for the production and vending of *kenkey*.

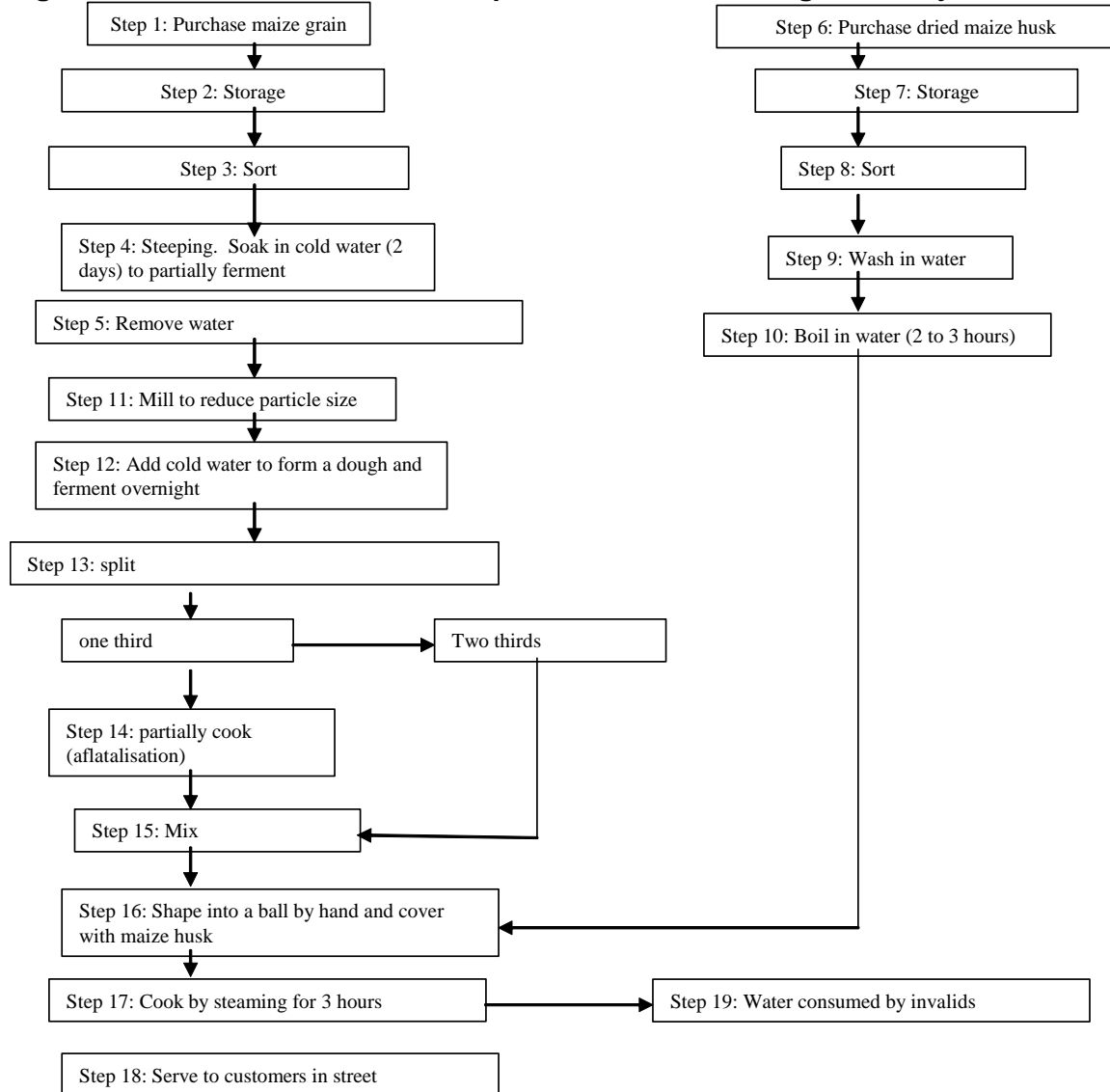


Figure 4: Process flow chart for the production and vending of waakye.

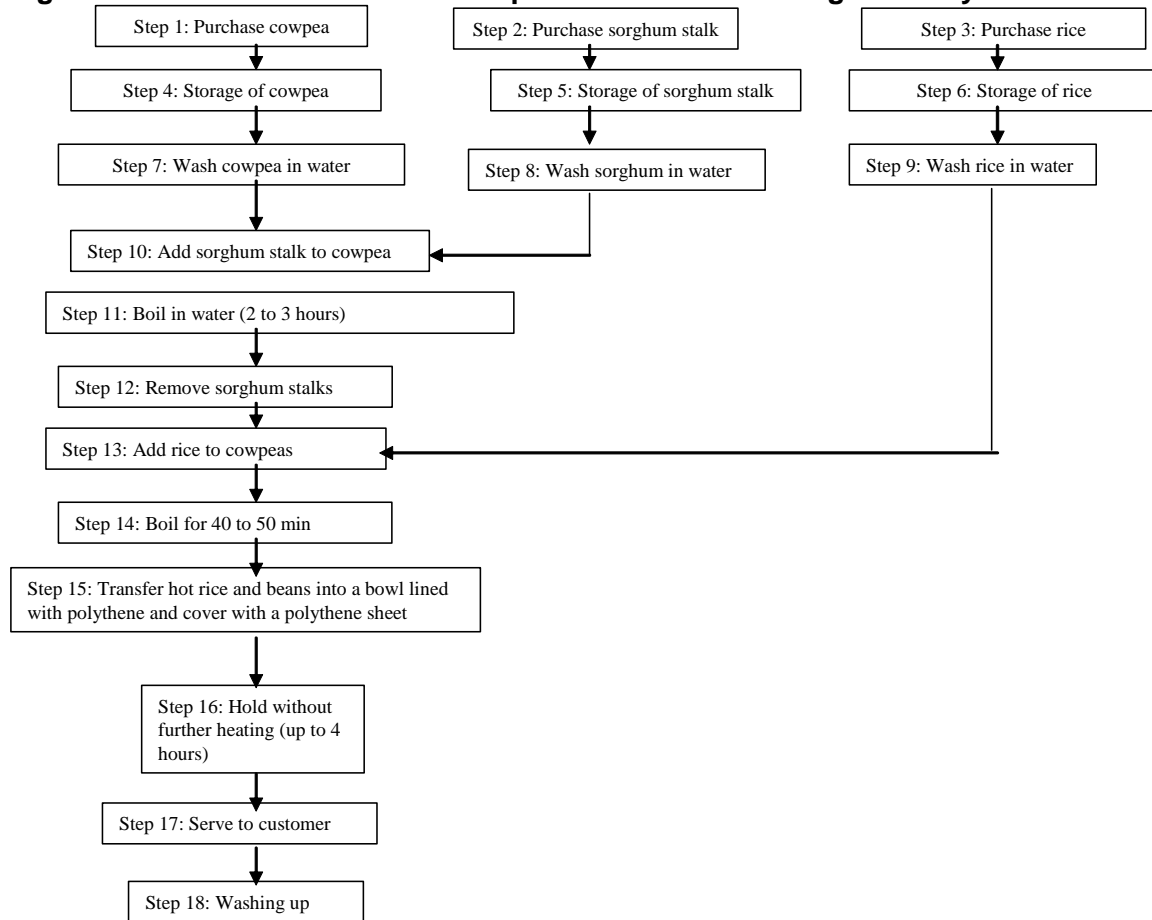
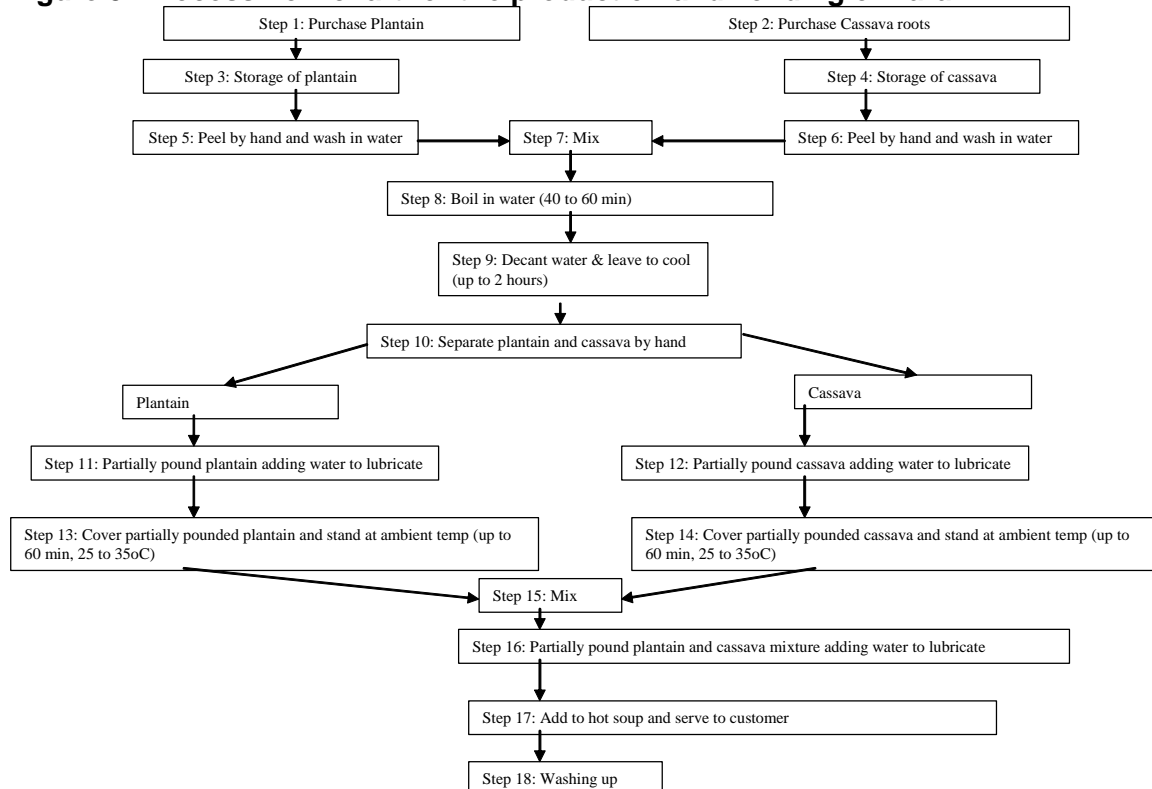


Figure 5: Process flow chart for the production and vending of Fufu



A total of 90 street food vendors serving either fufu, waakye or kenkey at five different markets (Accra Timber, Accra Kinbu, Kaneshie, Odorkor and Accra Post Office) Accra participated in a survey of basic food hygiene practices. Most vendors were visited on three occasions although this was not always possible. Of the vendors interviewed, 48 sold fufu, 24 kenkey and 18 waakye. Of the markets, 26 vended in Accra Kinbu, 17 in Accra Post Office, 10 in Accra Timber, 11 in Kaneshie and 26 in Odorkor (table 3). The scoring system for assessing the environment and food safety practices is shown in table 4.

Table 3. Number of street food vendors interviewed with respect to food sold and market where they operated.

Market	Street food type			Total score by market
	Fufu	Kenkey	Waakye	
AK (Accra Kinbu)	17	4	5	26
AP (Accra Post-Office Area)	7	6	4	17
AT (Accra Timber Market Area)	2	5	3	10
KN (Kaneshie)	7	1	3	11
OS (Odorkor Sukura)	15	8	3	26
Total score by street food type	48	24	18	90

Table 4: Scoring system for prerequisites for basic food safety used by the project food safety team

	Aspect of vendor operation	NSF	NSL	Present	Satisfactory	Good
1	Location					
2	Proximity to road					
3	Structure and condition of Vendor's stall					
4	Storage facilities (raw and cooked foods)					
5	Water supply					
6	Drainage and waste disposal					
7	Raw material handling					
8	Cooking equipment and utensils					
9	Facilities for personnel					
10	Personal hygiene					
11	Cleaning					
12	Pest control					
13	Process control					
14	Vendor training					

Where:

NSF = Not satisfactory = score of 0

NSL = Not satisfactory but has limited facilities = score of 1

Partially satisfactory = score of 2

Satisfactory = score of 3

Good = score of 4

Total score can vary between 0 and 56

The mean total scores for each market and by street food type is given in Table 5. Analysis of variance (ANOVA) showed significant differences in total scores between the markets ($P = 0.002$) and between the street food types ($P = 0.012$). There was no interaction between ($P = 0.602$) them indicating that the pattern was the same for each market. Considering the markets, Accra Kinbu, Kaneshie and Odorkor had similar total scores and were in the higher category. Accra Post Office and Accra Timber had the lowest total scores for basic food safety prerequisites. Vendors at Accra Kinbu were situated furthest from the road side, had access to cleaner facilities, pest control, process control and training. The training, in particular, seems to be related to the higher scores. Vendors in Kaneshie had higher scores for the condition of their stalls, water supply and toilet facilities.

Considering the vendors selling different food types, the fufu vendors received the higher scores overall. These vendors tended to vend further away from the road avoiding dust and pollution, have stalls in better and cleaner condition and control the catering process more effectively. These vendors also tended to have higher incomes than the other types of vendor. The waakye vendors tended to have cleaner equipment and better storage facilities.

Table 5: Mean total scores for basic food safety prerequisites for vendors markets and food types.

Market	food			Grand Total
	fufu	Waakye	kenkey	
AK	19	17	17	18
KN	17	17	18	17
OS	18	15	14	16
AP	16	16	12	14
AT	16	13	12	13
Grand Total	18	16	14	16

Where total score of 0 = not satisfactory; 14 = not satisfactory but has limited facilities, 28 = partially satisfactory, 42 = satisfactory and 56 = good

The differences between the markets with respect to basic food safety are illustrated in a principal component plot in figure 6. The F1 axis relates to the overall score for basic food safety while the F2 axis relates to access to clean water and toilet facilities. Examples of the facilities and vending environment are given in figure 7.

Figure 6: Principal component plot showing the relationship of the vendors markets to basic food safety prerequisites.

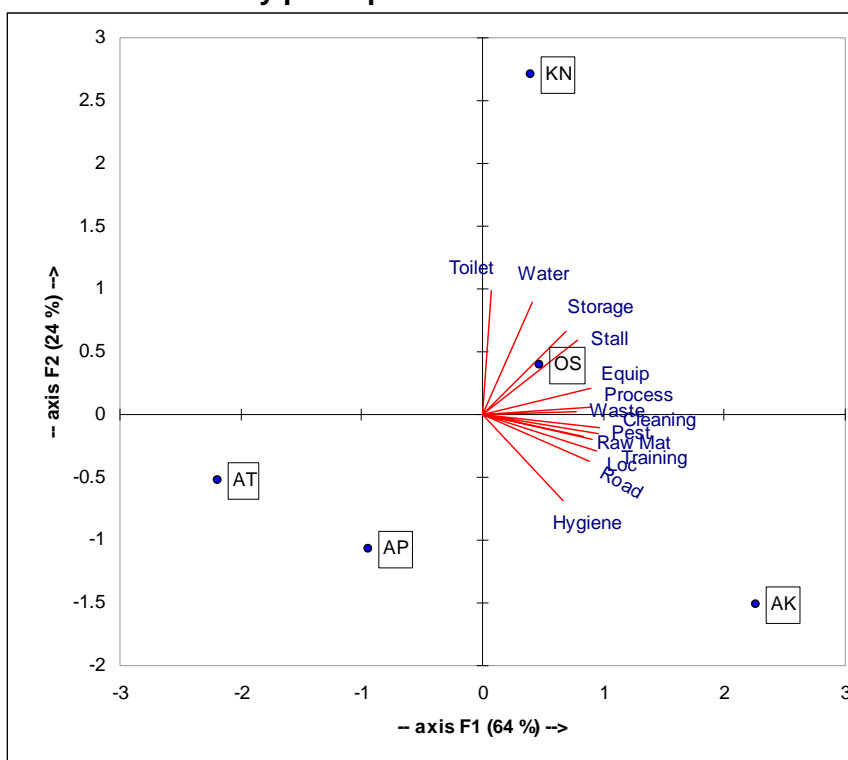


Figure 7: Street vendors in Accra – situation and activities

Vendor cleaning equipment and utensils in dirty recycled water



Water supply at Tema market. Vendors collect from here and transport the water in buckets. The tank is for storing water when the main supply is not operating.



Vendor at Tema market. *Note the earth floor, lack of drainage and water supply.*



General view of Tema market



General comments arising from the survey were:

- Location where vendors operated their businesses: Many vendors operated close to open drains and discarded refuse. The survey revealed that most vendors appear to be more concerned with how to sell food and not where to sell. Only a few are located in well-structured stalls. Most kenkey and waakye sellers operate in the open tabletops while most fufu vendors have shelter and eating-places.
- Proximity to road of the vendors business: Many vendors operated close to the road side exposing the food to contamination from dust and pollution from motor vehicles
- Structure and condition of Vendor's stall: Many vendors' stalls were very basic. The provision of plastic, wipeable table cloths may be a low cost way of improving hygiene.
- Storage facilities (raw and cooked foods): No vendors had access to a fridge for storing perishable produce although most stored their products on wooden shelves above ground level.
- Water supply: In general most vendors used potable treated water from the Ghana Water Company for their food preparation. However, in the last few years, there has

recurring shortage of water supply in some parts of Accra. It is therefore common practice to find vendors purchased their water locally which is transported (between 10 and 50m) and stored in plastic containers with lids. The containers were not always clean or covered and could be a source of contamination. Most scooped water from the containers using a plastic jug. Few used buckets with a tap at the base to prevent water becoming contaminated. No vendor in the survey had a supply of piped potato water directly into their stall.

- Drainage and waste disposal: Drainage of water from cooking and cleaning was usually into open drains close to the vendors business. Waste disposal was generally poor. This can be attributed partly to the general laxity in the disposal of refuse in Accra by the Accra Metropolitan Assembly. It is common to find uncollected refuse in several parts of the city. Most vendors do not have bins to store waste before they are finally collected. Where there are bins, they are not usually covered. Generally, liquid wastes are disposed into nearest main gutter.
- Raw material handling: No vendor had access to a fridge for storing perishable produce although most stored their products on wooden shelves above ground level. Most vendors knew the importance of keeping raw and cooked food separate although this was not always easy to tell during the inspection. All the vendors buy raw materials from the market; some buy on their own while others depended on middlemen for their supplies. Most vendors buy just enough for the day's use but in some situations there were leftovers. It was observed that leftover foods are stored, heated and sold the next day.
- Cooking equipment and utensils: Cooking equipment and utensils were generally in good condition. However, because water was expensive and had to be constantly carried in plastic containers, the vendors reused water such that they were often washing equipment and utensils in very contaminated water.
- Facilities for personnel: Hand washing facilities were limited because water was expensive and therefore in short supply. Toilet facilities were variable and running water was not always available. Most vendors during sale use the public toilets provided AMA, which invariably are not in the best of conditions. No vendors wore uniforms and clothing that was specific for work although some wore aprons.
- Personal hygiene: Hand washing was difficult and the cleanliness of clothing was variable. Generally vendors use the same dress for preparing foods and for serving. Only a few vendors wear aprons. Use of bare hands to fetch food is also common among vendors.
- Cleaning: The stalls and surfaces were made of wood which is difficult to clean and sanitize. Surfaces of work surfaces and tables used by customers could be improved by covering with appropriate plastic table cloths. The floors were usually earth instead of concrete making it difficult to clean. Where vendors had solid walls, painting with high gloss paint will improve the ability to keep clean.
- Pest control: With the exception of very few vendors, practices to control pests are woefully inadequate. A few vendors, especially waakye and kenkey sellers had stalls/kiosk covered with mosquito netting to serve as barrier to the entry of houseflies, although some were torn and dust-laden. Additionally, waakye sellers have the tendency of placing beside the food mosquito coils to drive away the houseflies. This practice may have the potential to contaminate the food with chemical hazard. Fufu vendors use lace cloth to cover boiled cassava, the partially pounded product and the pounded fufu.
- Process control: The project team were not always able to inspect the process because some vendors prepared their product at home (for example waakye sellers). Process control was by use of the senses and judgement (for example, few vendors appeared to have a watch/clock or access to a thermometer). Process control in fufu production caused concern because contaminated water was used in the pounding process when there was no subsequent heating step in the process to remove this

hazard. Vendors of Waakye and Kenkey cover food with transparent thick polyethylene bags to retain heat in the food and keep off flies.

- Vendor training: Most vendors received their training from family of other vendors. Few had received formal training in basic hygiene and catering.

The overall conclusion is that the scores for basic food safety for the vendors were low compared to a desirable score approaching the maximum of 56. Basic food safety improvements need to be made in the way that vendors operate. Many of these improvements must be made in partnership with local authorities. For example provision of clean potable water, refuse disposal and safe places to operate must be some of top priority services that AMA should provide for the vendors. Other aspects of the business are more under the control of the vendors if they receive training and understand how their businesses will benefit. These include better process control, improved condition of the stalls and improved personal hygiene through wearing of uniforms and plastic gloves when handling food.

Identification of potential food safety hazards

To assist the vendors in improving livelihoods and to contribute to improved consumer health, the project sought to identify potential hazards to consumer health. This complemented the prerequisite food safety survey and will be used later in the report when determining the hazards at each step in the production chain and in identifying critical control points and control measures. The hazards investigated were microbiological and heavy metal.

Microbiological survey of selected street food vendors.

During the survey of prerequisite food safety practices of street food vendors, selected vendors provided food samples for microbiological analysis. These were purchased from 14 kenkey, 14 waakye and 17 fufu vendors. The microorganisms monitored were:

- *E. coli* (NMKL method 125; 1996)
- Aerobic plate count (NMKL method 86; 1999)
- Coliforms, (NMKL method 44; 1995)
- *S. aureus* (NMKL method 66; 2003)
- *Salmonella spp* (NMKL method 71; 1999)
- *B. cereus*. (NMKL method 67; 1997)

The results of the microbiological analysis and mean temperatures and pH of vended foods are given in tables 6 and 7.

Table 6. Microbial analysis of selected street foods purchased from vendors in Accra.

Kenkey

No.	<i>E. coli</i> (cfu/g)	Aerobic Plate count at 30 °C (cfu/g)	Coliform count (cfu/g)	<i>S. aureus</i> count (cfu/g)	<i>Salmonella</i> (spp./25g)	<i>B. cereus</i> count (cfu/g)
1	<10	<10	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
2	<10	3.0 x 10 ¹	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
3	<10	3.0 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
4	<10	7.0 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
5	<10	3.6 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
6	<10	5.0 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
7	<10	1.2 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
8	<10	4.3 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
9	<10	3.7 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
10	<10	1.6 x 10 ⁴	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
11	<10	9.1 x 10 ²	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
12	<10	2.7 x 10 ⁴	8.6 x 10 ²	<1.0 x 10 ²	ND	<1.0 x 10 ²
13	<10	1.9 x 10 ⁵	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
14	<10	9.7 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²

Waakye

No.	<i>E. coli</i> (cfu/g)	Aerobic Plate count at 30 °C (cfu/g)	Coliform count (cfu/g)	<i>S. aureus</i> count (cfu/g)	<i>Salmonella</i> (spp./25g)	<i>B. cereus</i> count (cfu/g)
1	<10	5.2 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
2	<10	3.3 x 10 ³	9.0 x 10 ¹	<1.0 x 10 ²	ND	<1.0 x 10 ²
3	<10	2.6 x 10 ⁴	1.1 x 10 ²	<1.0 x 10 ²	ND	<1.0 x 10 ²
4	<10	7.2 x 10 ³	6.0 x 10 ¹	<1.0 x 10 ²	ND	<1.0 x 10 ²
5	<10	3.4 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
6	<10	3.3 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
7	<10	3.1 x 10 ³	8.0 x 10 ¹	<1.0 x 10 ²	ND	<1.0 x 10 ²
8	<10	9.3 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
9	<10	7.9 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
10	2.4 x 10 ²	1.7 x 10 ⁵	4.9 x 10 ³	<1.0 x 10 ²	ND	<1.0 x 10 ²
11	<10	3.3 x 10 ³	<10	<1.0 x 10 ²	ND	<1.0 x 10 ²
12	<10	8.0 x 10 ⁴	1.0 x 10 ¹	<1.0 x 10 ²	ND	<1.0 x 10 ²
13	<10	9.8 x 10 ⁶	5.0 x 10 ¹	<1.0 x 10 ²	ND	<1.0 x 10 ²
14	7.0 x 10 ²	4.0 x 10 ⁴	3.9 x 10 ³	<1.0 x 10 ²	ND	<1.0 x 10 ²

Fufu

No.	<i>E. coli</i> (cfu/g)	Aerobic Plate count at 30 °C (cfu/g)	Coliform count (cfu/g)	<i>S. aureus</i> count (cfu/g)	<i>Salmonella</i> (spp./25g)	<i>B. cereus</i> count (cfu/g)
1	6.3 x 10 ³	5.8 x 10 ⁵	1.3 x 10 ⁵	<1.0 x 10 ²	ND	<1.0 x 10 ²
2	<10	4.6 x 10 ⁶	1.6 x 10 ⁴	<1.0 x 10 ²	ND	<1.0 x 10 ²
3	4.2 x 10 ³	2.1 x 10 ⁷	9.0 x 10 ⁴	1.6 x 10 ³	ND	<1.0 x 10 ²
4	1.7 x 10 ²	2.1 x 10 ⁵	6.0 x 10 ⁴	3.3 x 10 ³	ND	1.0 x 10 ²
5	3.0 x 10 ³	6.4 x 10 ⁸	1.1 x 10 ⁵	3.0 x 10 ²	ND	<1.0 x 10 ²
6	1.1 x 10 ³	2.1 x 10 ⁸	1.2 x 10 ⁵	<1.0 x 10 ²	ND	<1.0 x 10 ²
7	1.7 x 10 ³	1.5 x 10 ⁸	1.7 x 10 ⁵	3.9 x 10 ³	ND	<1.0 x 10 ²
8	6.9 x 10 ³	2.2 x 10 ⁸	9.7 x 10 ⁴	1.8 x 10 ³	ND	2.0 x 10 ²
9	3.1 x 10 ³	1.7 x 10 ⁸	7.0 x 10 ⁴	<1.0 x 10 ²	ND	1.0 x 10 ²
10	1.0 x 10 ²	1.2 x 10 ⁸	4.1 x 10 ⁴	1.0 x 10 ²	ND	3.8 x 10 ³
11	5.0 x 10 ⁴	3.6 x 10 ⁷	6.2 x 10 ⁵	3.8 x 10 ³	ND	2.5 x 10 ³
12	<10	1.0 x 10 ⁸	1.3 x 10 ⁵	2.5 x 10 ³	ND	<1.0 x 10 ²
13	<10	1.0 x 10 ⁷	3.3 x 10 ⁵	<1.0 x 10 ²	ND	<1.0 x 10 ²
14	<10	1.2 x 10 ⁷	5.1 x 10 ⁴	1.8 x 10 ³	ND	3.0 x 10 ²
15	7.0 x 10 ³	4.7 x 10 ⁷	4.6 x 10 ³	<1.0 x 10 ²	ND	2.0 x 10 ²
16	6.0 x 10 ³	9.5 x 10 ⁷	9.0 x 10 ³	<1.0 x 10 ²	ND	1.9 x 10 ³
17	2.3 x 10 ³	5.6 x 10 ⁷	5.4 x 10 ⁵	2.2 x 10 ³	ND	7.0 x 10 ²

Where ND = not detected

Table 7. Holding temperature and pH of kenkey, waakye and fufu

Street food											
Kenkey				Waakye				Fufu			
No.	Vendor Code	Temperature (°C)	pH	No.	Vendor Code	Temperature (°C)	pH	No.	Vendor Code	Temperature (°C)	pH
1	OL	40	3.8	1	AT	36	9.1	1	AA	33	4.7
2	AM	36	3.8	2	AM	35	9.2	2	SL	33	5.5
3	FJ	35	3.6	3	AY	35	7.1	3	VA	37	4.9
4	SA	36	3.4	4	FL	35	7.9	4	ME	34	5.8
5	LP	37	3.4	5	AD	34	8.0	5	DB	33	4.9
6	VN	40	3.5	6	AJ	35	9.1	6	MY	32	4.9
7	Aa	40	3.6	7	RM	37	8.4	7	AH	34	4.9
8	Rb	37	3.6	8	BO	36	8.7	8	MT	34	4.8
9	DN	39	3.5	9	DA	34	6.6	9	MA	33	4.8
10	ZN	32	3.6	10	ZN	33	5.1	10	AJ	33	4.7
11	BY	41	3.6	11	DD	34	7.7	11	EN	33	5.6
12	OA	40	3.6	12	FT	35	6.8	12	CA	33	5.1
13	DA	38	3.7	13	AZ	33	6.0	13	AD	32	5.4
14	CL	40	3.6	14	AM ₁	33	8.8	14	CD	33	6.1

Of the microorganisms monitored *E. coli* is considered to be a reliable indicator of poor basic food hygiene practices because it is associated with faecal contamination. If this organism is present it can be inferred that other food borne illness organisms may also be present.

The results show large differences between the street food types. Kenkey samples considered safe. None had *E. coli* present and other organisms were either not present or at low levels. Kenkey was considered low risk because the food had a low pH (between 3.4 and 3.8). Therefore, even though some kenkey vendors work in unsanitary conditions (see photograph of vendor by open sewer and kenkey sample) and received the lowest total scores in the basic food safety survey, the product itself is safe with respect to microorganisms.

Waakye samples were generally safe apart from 2 samples that were contaminated with *E. coli*. Waakye is usually served warm (33 to 37°C). *E. coli* may have occurred in this

product because it is moist and had a near neutral pH. It was held at an unsafe temperature (between 8°C and 63°C). Usually leftover food from the previous days sales are not refrigerated. Considering the baseline survey, waakye vendors had higher total scores than kenkey but lower than those vending fufu.

Of the fufu samples analysed, the majority (13 out of 17) had detectable *E. coli* suggesting poor food hygiene practices and poor process control. Other organisms detected that present a food safety hazard included *S. aureus* (detected in 10 out of 17 samples). In the survey of food safety prerequisites the fufu vendors received the highest score. However, this score, along with all the other food vendors were very low.

Figure 8 shows pictures of vendors producing and selling each of the street vended products.

Figure 8: Vendors producing and selling street vended products selected by this project.

General view of vendors stalls in Kaneshie market



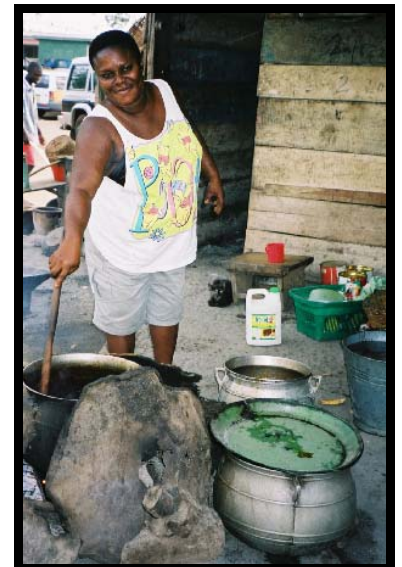
Vendor pounding fufu.
Note the blue bucket filled with dirty water and a sponge that is used to lubricate and rinse the wooden bowl.



Vendor cooking kenkey.
Note the close proximity to an open drain.



Vendor cooking rice.



Consumers eating fufu with fish stew.



Vendor selling kenkey.
Note that food is covered to protect from flies and dust.



Vendor selling waakye.
Note the use of the fly screen and covering of food.



Heavy metals in selected street foods and cooking pots.

An earlier CPHP funded project (R7493) on the safety of street vended foods had indicated the possibility of heavy metal contamination (lead and cadmium) in street vended foods sold in Accra. This was based on preliminary analysis by a laboratory in Ghana (Ghana Standards Board) and observations when the project team visited informal foundries that manufacture these pots.

Figure 9 shows examples of informal and formal cooking pots sold by merchants in Accra. The informal pots use a traditional design while the formal pots use a design similar to those in formal catering businesses.

Figure 9: Examples of informal and formal cooking pots sold by merchants in Accra.

Cooking pots produced by informal manufacturers



Cooking pots produced by formal manufacturers



Figure 10 shows the type of scrap metal used by informal foundries, how the metal is heated and the method of casting each pot. The scrap metal comprised of metal from various sources including old engine components and also another foundry has been observed to add lead to the aluminium. The metal was heated in a charcoal furnace with air forced in using a blower made from a car fan-heater. The molten metal was poured into sand casts which after cooling were broken down to remove the pot which was then cleaned up with a metal file to round sharp edges.

Figure 10: Cooking pots being manufactured by informal a foundry



A number of issues arose from this study. These were:

- Capability of a coalition partner in Ghana (NMIMR) in analysing heavy metals;
- Comparison of analysis of heavy metals by NMIMR and University of Greenwich, UK;
- Survey of heavy metals in selected street vended foods (University of Greenwich laboratory);
- Survey of heavy metals in informal and formally manufactured cooking pots (University of Greenwich laboratory);
- Leaching test to determine if heavy metals from pots manufactured by informal vendors could leach into certain street vended foods (University of Greenwich laboratory).

Capability of NMIMR for analysis of heavy metals.

The NMIMR was recommended for this activity after a consultant, at the request of the CPHP programme, had identified this institution and confirmed that it had the capability for this type of work. However, continued equipment failure at NMIMR led to delays. A further problem also identified was that NMIMR could only analyse for the heavy metal lead and did not have the capability for analysis of volatile heavy metals such as mercury and arsenic. Therefore, a backstopping organisation in the UK (School of Science, University of Greenwich) was identified mid-way in the project to provide support.

Comparison of analysis of heavy metals by NMIMR and University of Greenwich, UK

So that the results from the two laboratories were consistent the laboratory at the University of Greenwich analysed the 52 street food samples previously analysed by NMIMR.

The comparison table is shown in table 8. Of the 52 samples, the laboratories gave similar results for 42 samples where both laboratories agreed that the street food samples had low levels of lead. However for 10 samples, while the laboratory at the University of Greenwich continues to find only low levels of lead, the laboratory at NMIMR was finding levels as high as 24.38 mg/kg which is well above the maximum levels set by the WHO of 0.2 mg/kg.

Discussions with the University of Greenwich and NMIMR identified that whereas the University of Greenwich included certified standards of known heavy metal concentration in their analysis, the NMIMR did not. This meant that the NMIMR could not verify their results. The project has since provided NMIMR with a certified reference material but they were unable to carry out any further analyses to confirm that they were now able to achieve results comparable to the UK laboratory.

A further factor was that the UK laboratory were able to carry out the analysis at a cost less than NMIMR and this included the cost of the reference material (costing in the region of £250) while the project had to supply the reference material to NMIMR at extra cost.

If the project had relied on the results from NMIMR without cross-checking, this could have led to serious consequences for the livelihoods of the street food vendors because their foods would have been considered unsafe, especially for children since lead contamination can result in learning difficulties and behaviour problems.

Table 8. Comparison of laboratories in Ghana and UK for the analysis of lead in street vended foods.

No.	Street food	Laboratory	
		Lead concentration (Pb; mg/kg)	
		University of Greenwich	NMIMR
1	Waakye	0.184	24.38
2	Waakye	0.129	7.51
3	Fufu	0.183	3.75
4	Fufu	0.134	3.75
5	Waakye	0.069	3.75
6	Kenkey	nd	1.88
7	Waakye	nd	1.88
8	Fufu	0.248	1.88
9	Waakye	0.121	1.88
10	Fufu	nd	1.43
11	Fufu	nd	nd
12	Kenkey	nd	nd
13	Kenkey	nd	nd
14	Kenkey	nd	nd
15	Kenkey	nd	nd
16	Kenkey	nd	nd
17	Kenkey	nd	nd
18	Kenkey	nd	nd
19	Kenkey	nd	nd
20	Kenkey	nd	nd
21	Kenkey	nd	nd
22	Waakye	nd	nd
23	Waakye	nd	nd
24	Waakye	nd	nd
25	Waakye	nd	nd
26	Waakye	nd	nd
27	Waakye	nd	nd
28	Waakye	nd	nd
29	Waakye	nd	nd
30	Fufu	0.338	nd
31	Kenkey	0.248	nd
32	Kenkey	0.233	nd
33	Waakye	0.232	nd
34	Waakye	0.194	nd
35	Fufu	0.181	nd
36	Waakye	0.178	nd
37	Fufu	0.166	nd
38	Fufu	0.128	nd
39	Fufu	0.115	nd
40	Fufu	0.113	nd

41	Waakye	0.113	nd
42	Kenkey	0.106	nd
43	Fufu	0.099	nd
44	Waakye	0.098	nd
45	Waakye	0.091	nd
46	Kenkey	0.075	nd
47	Waakye	0.068	nd
48	Waakye	0.066	nd
49	Kenkey	nd	nd
50	Kenkey	nd	nd
51	Kenkey	nd	nd
52	Waakye	nd	nd
53	Fufu	0.353	nd
54	Fufu	0.252	nd

Where nd = not detected; lowest detectable limit for analytical method at NMIMR was 0.180 mg/kg and for University of Greenwich 0.065 mg/kg.

A survey of heavy metals in selected street vended foods (University of Greenwich laboratory)

A total of 145 samples were analysed for heavy metals at the University of Greenwich laboratory. This included 115 street food samples and 30 check samples for comparison. The results are given in Table 9. The Mean and median concentrations for all metals analysed (copper, arsenic, cadmium, lead and mercury) in the check samples and street food sample were below the maximum limits specified by the European Union. The median concentrations were included because in many cases the concentrations were below the detectable limit of the analytical method used at the University of Greenwich. Therefore, these products are unlikely to present a food safety hazard with respect to these samples.

However, for lead, some samples of waakye (6%), fufu (22%) and kenkey (5%) were at the maximum limit or slightly above. Additionally some rice samples (20%) were also slightly above the limit.

Table 9: Survey of heavy metals (lead, copper, arsenic, cadmium and mercury) in street vended foods (fufu, kenkey and waakye) and check samples (rice, maize flour and commercial fufu flour)

Sample	Statistic	Concentration (mg/kg)				
		Copper (Cu)	Arsenic (As)	Cadmium (Cd)	Mercury (Hg)	Lead (Pb)
	<i>Maximum limit specified by EU</i>	<i>20 mg/kg (not specified)</i>	<i>1.0 mg/kg (other products)</i>	<i>0.1 mg/kg (cereals)</i>	<i>1.0 mg/kg (not specified)</i>	<i>0.2 mg/kg (cereals)</i>
Rice	mean	2.363	0.316	0.039	0.006	0.158
	median	2.355	0.325	0.017	0.006	0.154
	max	2.709	0.343	0.182	0.010	0.327
	min	2.219	0.265	0.015	nd	0.072
Maize flour	mean	0.095	0.045	0.005	0.005	0.076
	median	nd	nd	nd	nd	nd
	max	3.043	0.122	0.007	nd	0.113
	min	nd	nd	nd	nd	0.058
fufu flour	mean	2.579	0.055	0.005	0.006	0.096
	median	2.539	nd	nd	nd	0.080
	max	3.043	0.122	0.007	0.007	0.207
	min	2.464	nd	nd	nd	0.063
Waakye	mean	1.380	0.053	0.010	0.005	0.097

	median	1.372	nd	0.007	nd	nd
	max	2.504	0.087	0.025	0.012	0.365
	min	0.769	nd	nd	nd	nd
Kenkey	mean	0.936	0.051	0.005	0.005	0.077
	median	0.861	nd	nd	nd	nd
	max	2.283	0.143	<0.005	0.009	0.248
	min	0.523	nd	nd	nd	nd
fufu	mean	0.674	0.045	0.005	0.005	0.159
	median	0.712	nd	nd	nd	0.143
	max	0.950	0.051	0.008	0.011	0.353
	min	0.358	nd	nd	nd	nd

Where nd = not detected; maximum limits specified by the European Union are for Pb, Cd, As, Hg and Cu are 0.2 mg/kg (cereals), 0.1 mg/kg (cereals), 1.0 mg/kg (other products), 1.0 mg/kg (not specified) and 20 mg/kg (not specified) respectively.

Survey of heavy metals in informal and formally manufactured cooking pots (University of Greenwich laboratory).

An earlier CPHP funded project (R7493) had visited informal foundries in Accra that manufactured metal cooking pots used by many street vendors. The visits indicated that some of these foundries were not aware of the potential food safety hazards resulting from using scrap metal that was potentially contaminated with heavy metals. For example, engine components were used along with parts of lead-acid batteries etc. An analysis of a single cooking pot by the University of Greenwich identified the heavy metal lead at a concentration of 100 mg/kg.

A total of 20 cooking pots were purchased from merchants in Accra. These were five pots each from merchants selling informal cooking pots at December, Kaneshie and Madina markets and five pots from a merchant selling formal cooking pots that were locally manufactured.

The results of analysis are given in Table 10. The results suggested that the heavy metal concentration in the cooking pots that was manufactured by a formal vendor was low (mean of 9mg/kg varying between 8 and 17). However the concentrations of lead in the informally manufactured pots varied widely. The highest was in pots purchased from a merchant in Kaneshie (mean of 360 mg/kg varying between 311 and 419) and the lowest was from ones in Madina market (mean of 27 mg/kg varying between 8 and 78). It should be noted that because of the way that informal vendors produce the pots, the heavy metal content is expected to vary widely from batch to batch and from foundry to foundry.

Table 10: Concentrations of the heavy metal lead in informal and formal cooking pots purchased from markets in Accra

Market were purchased	Class of manufacture	Statistic	Lead (Pb) mg/kg
31 st December Market	Informal	Mean	130
		Min	8
		Max	380
Kaneshie	Informal	Mean	360
		Min	311
		Max	419
Madina	Informal	Mean	27
		Min	8
		Max	78
31 st December Market	Formal	Mean	9
		Min	8
		Max	17

Leaching test to determine if heavy metals from pots manufactured by informal vendors could leach into certain street vended foods (University of Greenwich laboratory).

The potentially high levels of lead (419mg/kg) found in some of the informally manufactured cooking pots led to the need to assess the possibility of this metal leaching into food and hence causing a food safety hazard. This was evaluated using kenkey. Kenkey was chosen for two reasons. Firstly it has a low pH (i.e., acidic) which accelerated leaching of heavy metals and it is often cooked for a long period of time. Because the pots were new, the cooking process was repeated several times to simulate an aging affect. The results are given in Table 11.

The results show that kenkey (dough and water) cooked in pots produced by a formal manufacturer (mean lead concentration of 9 mg/kg) did not have any detectable lead (<0.065 mg/kg). However, kenkey (dough and water) cooked in pots produced by an informal manufacturer (mean lead concentration of 360 mg/kg) had levels of lead at or above the maximum permitted concentrations recommended by WHO of 0.2 mg/kg. When cooking brand new pots, the concentration of lead was highest at between 0.619 and 0.757 mg/kg and this declined to between 0.203 and 0.225 mg/kg after the cooking pots had been aged by using at least three times. This is based on a survey of informal cooking pots purchased from three merchants and the concentrations of lead varied. This was because of variations in practice from one informal foundry to another and also upon the type of scrap metal that they purchase at any given time.

Although the concentrations of lead leached into the food samples were at the maximum level or slightly above it the risk to consumer health is probably small. However, any amount of lead in food is a food safety risk and it because can accumulate in the body over time, the following is suggested:

- Ways should be found for informal manufacturers to implement 'Good Manufacturing Practice' so that the heavy metal content can be brought down to levels similar to those produced by formal manufacturers;
- Vendors and consumers should be advised to consider purchasing cooking pots that have a lower lead content;
- Vendors and consumers using informally manufactured cooking pots should discard the first portions of food when cooking in brand new pots;
- Carefully clean informally manufactured cooking pots to avoid exposing bare metal.

Table 11: Mean concentrations of the heavy metal lead in samples of kenkey dough and water after cooking in cooking pots manufactured by informal and informal manufacturers.

Class of cooking pot manufacturer	Type of food product tested	New or aged pot	Concentration (mg/kg)
Formal	Dough	Aged	nd
Formal	Dough	New	nd
Formal	Water	Aged	nd
Formal	Water	New	nd
Informal	Dough	Aged	0.203
Informal	Dough	New	0.757
Informal	Water	Aged	0.225
Informal	Water	New	0.619

Where nd = not detected; limit of detection = 0.065 mg/kg; mean concentration of lead (Pb) in formal and informal cooking pots was 9 and 360 mg/kg respectively.

Identify potential hazards, Conduct hazard analysis Specify control measures

The process flow diagrams for the street vended foods are given in Figures 3 to 5. While it is not practical to apply HACCP to the street vended situation, the approach can be used to

highlight the critical steps in the food process that contribute to improved food safety. This can be used to target training of street food vendors and EHO's.

Considering the hazards, these can be considered as "A biological, chemical or physical property, or condition of, food with the potential to cause an adverse health effect" (Codex 1997). In this study, two types of hazard are considered by microbiological (*E. coli*, *S. aureus* and *B. cereus*) and chemical (the heavy metal lead). To assess the nature of each hazard, the way that each hazard is manifested was considered. These are:

- Presence – Is the hazard present?
- Introduction/Contamination – how does the hazard contaminate the food product?
- Growth – can the severity of the hazard increase during food production, processing and serving?
- Survival – can the hazard survive in the food product or the processing steps?

Table 12 and 13 show the hazard analysis sheets and decision tree record sheets when determining the hazards and critical control points using the HACCP (CODEX) approach.

With respect to the chemical hazard (heavy metal), this could not be reduced by processing and as such the HACCP principles do not directly apply. This can only be avoided by ensuring effective prerequisites, upon which HACCP is based, are in place. It is recommended that vendors either purchase cooking pots made by formal manufacturers or from informal foundries who apply GMP to avoid introducing contaminated scrap metal into the process.

With respect to the biological hazards the following critical points and target limits in the catering process were identified:

Fufu

- Step 1: Purchase Plantain - Plantain is clean and free of pest and disease;
- Step 2: Purchase Cassava roots - Cassava is clean and free of pest and disease;
- Step 8: Boil in water - Boil the roots for at least 40 to 60 minutes;
- Step 10: Separate plantain and cassava by hand - Clean hands with soap and water;
- Step 11: Partially pound plantain adding water to lubricate - Clean hands with soap and water, use fresh tap water and use clean equipment;
- Step 12: Partially pound cassava adding water to lubricate - - Clean hands with soap and water, use fresh tap water and use clean equipment;
- Step 13: Cover partially pounded plantain and stand at ambient temp (up to 60 min, 25 to 35oC) - Use clean material to cover partially pounded cassava, do not store for too long;
- 14: Cover partially pounded cassava and stand at ambient temp (up to 60 min, 25 to 35oC) - Use clean material to cover partially pounded cassava, do not store for too long;
- 15: Mix - - clean hands with soap and water, clean equipment;
- 16: Partially pound plantain and cassava mixture adding water to lubricate - Clean hands with soap and water, use fresh tap water, clean equipment;
- 17: Add to hot soup and serve to customer - discard fufu mixture if not served after 4 hours from time of cooking;
- Step 18: Washing up - Ensure all equipment is cleaned thoroughly.

Kenkey

- Step 1: Purchase maize grain - Maize is clean and free of pest and disease
- Step 4: Steeping - pH 4.5 or lower
- Step 6: Purchase dried maize husk - Maize husk is clean and free of pest and disease

- Step 10: Boil in water - Boil the husks for at least 10 min
- Step 14: Aflatalisation - Cook for at least 30 min
- Step 17: Cook - Steam for at least 30 min

Waakye

- Step 1: Purchase cowpea - Cowpea is clean and free of pest and disease;
- Step 2: Purchase sorghum stalk - Sorghum stalk is clean and free of pest and disease;
- Step 3: Purchase rice - Rice is clean and free of pest and disease;
- Step 10: Boil in water - Boil for at least 40 to 60 minutes;
- Step 13: Boil in water Boil for at least 40 to 60 minutes;
- Step 14: Transfer hot rice and beans into a bowl lined with polythene and cover with a polythene sheet - Clean hands with soap and water, use clean covering, use clean equipment;
- Step 15: Hold without further heating (up to 4 hours) - keep covered, discard if not sold within 4 hours after cooking;
- Step 16: Serve to customer - keep covered, use clean utensils to serve to customer, discard if not sold within 4 hours after cooking;
- Step 17: Washing up - Ensure all equipment is cleaned thoroughly.

Kenkey had the least number of critical steps in the catering process because this product has a low pH which will inhibit the growth of biological hazards. Fufu has the most number of critical steps because this product is processed and handled after the final cooking step.

Table 12: Hazard Analysis Sheets for Kenkey, Waakye and Fufu street vended foods

Kenkey

No	Process Step	Hazard and source	Control measure
1	Purchase of maize grain	Biological Hazard (B.H). from poor food handling	GHP (good hygiene practice), SQA (supplier quality assurance)
2	Storage of maize grain	B.H. growth of spores	GHP, GMP (good manufacturing practice), keep cool and dry
3	Sort	B.H. from poor food handling	GHP, GMP
4	Steeping	B.H. growth of pathogens	GHP, GMP
5	Remove water		
6	Purchase of dried maize husk	B.H. from poor food handling	GHP, SQA
7	Storage of dried maize husk	B.H. growth of spores	GHP, GMP, keep cool and dry
8	Sort	B.H. from poor food handling	GHP, GMP
9	Wash in water	B.H. from poor water	GHP, cover water, use clean container with tap at base
10	Boil maize husk in water (2-3 hrs)	Chemical Hazard (C.H) (lead) from cooking put	GMP
11	Milling	B.H. for poorly cleaned mill	GHP, GMP
12	Add water	B.H. from poor water	GHP
13	Split		
14	Aflatalisation	C.H. (lead) from cooking put	GMP
15	Mix		
16	Shaping	B.H. from hands	GHP
17	Cook	C.H. (lead) from cooking put	GMP
18	Serve to customers	B.H. from poorly cleaned plates and utensils	
19	Water for invalids	C.H. (lead) from cooking put	GMP

Waakye

No	Process Step	Hazard and source	Control measure
1	Purchase of cowpea	B.H. from poor food handling	GHP, SQA
2	Purchase of sorghum stalk	B.H. from poor food handling	GHP, SQA
3	Purchase of rice	B.H. from poor food handling	GHP, SQA
4	Storage of cowpea	B.H. growth of spores	GHP, GMP, keep cool and dry
5	Storage of sorghum stalk	B.H. growth of spores	GHP, GMP, keep cool and dry
6	Storage of rice	B.H. growth of spores	GHP, GMP, keep cool and dry
7	Wash in water	B.H. from poor water	GHP, cover water, use clean container with tap at base
8	Wash in water	B.H. from poor water	GHP, cover water, use clean container with tap at base
9	Wash in water	B.H. from poor water	GHP, cover water, use clean container with tap at base
10	Add sorghum stalk to cowpea		
11	Boil in water	C.H. (lead) from cooking put	GMP
12	Remove sorghum stalk	B.H. from equipment	GHP, GMP
13	Add rice to cowpeas	B.H. from equipment	GHP, GMP
14	Boil in water	C.H. (lead) from cooking put	GMP
15	Transfer to bowl	B.H. from equipment and handling	GHP, GMP
16	Holding until serving	B.H. growth of spores	GHP, GMP
17	Serving	B.H. from poorly cleaned plates and utensils	GHP
18	Washing up	B.H. from poor water	GHP, cover water, use clean container with tap at base, change water frequently

Fufu

No	Process Step	Hazard and source	Control measure
1	Purchase of plantain	B.H. from poor food handling	GHP, SQA
2	Purchase of cassava	B.H. from poor food handling	GHP, SQA
3	Storage of plantain	B.H. growth of spores	GHP, GMP, keep cool and dry
4	Storage of cassava	B.H. growth of spores	GHP, GMP, keep cool and dry
5	Peel & wash plantain	B.H. from poor food handling	GHP, GMP
6	Peel & wash cassava	B.H. from poor food handling	GHP, GMP
7	Mix		
8	Boil		
9	Decant water & cool		
10	Separate cooked cassava and plantain by hand	B.H. from poor food handling	GHP, GMP
11	Partially pound plantain	B.H. from handling & equipment	GHP, GMP
12	Partially pound cassava	B.H. from handling & equipment	GHP, GMP

13	Cover cassava and leave to stand	B.H. growth of spores	GHP, GMP, keep hot
14	Cover plantain and leave to stand	B.H. growth of spores	GHP, GMP, keep hot
15	Mix	B.H. from handling & equipment	GHP, GMP
16	Partially pound cassava & plantain mixture	B.H. from handling & equipment	GHP, GMP
17	Add hot soup and serve		
18	Washing up	B.H. from poor water	GHP, cover water, use clean container with tap at base, change water frequently

Table 13: Decision tree record sheets for fufu, kenkey and waakye

Fufu

Step in process	Q1	Q2	Q3	Q4	Is this step a CCP?	Target Limits` (only if a CCP)
Step 1: Purchase Plantain	Yes	Yes			Yes	Plantain is clean and free of pest and disease
Step 2: Purchase Cassava roots	Yes	Yes			Yes	Cassava is clean and free of pest and disease
Step 3: Storage of plantain	Yes	No	Yes	Yes	No	
Step 4: Storage of cassava	Yes	No	Yes	Yes	No	
Step 5: Peel by hand and wash in water	Yes	No	Yes	Yes	No	
Step 6: Peel by hand and wash in water	Yes	No	Yes	Yes	No	
Step 7: Mix	Yes	No	Yes	Yes	No	
Step 8: Boil in water (40 to 60 min)	Yes	Yes			Yes	Boil the roots for at least 40 to 60 minutes
Step 9: Decant water & leave to cool (up to 2 hours)	Yes	No	No	No	No	
Step 10: Separate plantain and cassava by hand	Yes	No	Yes	No	Yes	Clean hands with soap and water
Step 11: Partially pound plantain adding water to lubricate	Yes	No	Yes	No	Yes	- Clean hands with soap and water - use fresh tap water - clean equipment
Step 12: Partially pound cassava adding water to lubricate	Yes	No	Yes	No	Yes	- Clean hands with soap and water - use fresh tap water - clean equipment
Step 13: Cover partially pounded plantain and stand at ambient temp (up to 60 min, 25 to 35oC)	Yes	No	Yes	No	Yes	- Use clean material to cover partially pounded cassava - do not store for too long
Step 14: Cover partially pounded cassava and stand at ambient temp (up to 60 min, 25 to 35oC)	Yes	No	Yes	No	Yes	- Use clean material to cover partially pounded cassava - do not store for too long
Step 15: Mix	Yes	No	Yes	No	Yes	- clean hands with soap and water - clean equipment
Step 16: Partially pound plantain and cassava mixture adding water to lubricate	Yes	No	Yes	No	Yes	- Clean hands with soap and water - use fresh tap water - clean equipment
Step 17: Add to hot soup and serve to customer	Yes	No	Yes	No	Yes	- discard fufu mixture if not served after 4 hours from time of cooking
Step 18: Washing up	Yes	No	Yes	No	Yes	Ensure all equipment is cleaned thoroughly

Kenkey

Step in process	Q1	Q2	Q3	Q4	Is this step a CCP?	Target Limits` (only if a CCP)
Step 1: Purchase maize grain	Yes	Yes			Yes	Maize is clean and free of pest and disease
Step 2: Storage of plantain	Yes	No	Yes	Yes	No	
Step 3: Sort	Yes	No	Yes	Yes	No	
Step 4: Steeping	Yes	Yes				pH 4.5 or lower
Step 5: Remove water						
Step 6: Purchase dried maize husk	Yes	Yes			Yes	Maize husk is clean and free of pest and disease
Step 7: Storage of dried maize husk	Yes	No	Yes	Yes	No	
Step 8: Sort	Yes	No	Yes	Yes	No	
Step 9: Wash in water	Yes	No	Yes	Yes	No	
Step 10: Boil in water	Yes	Yes			Yes	Boil the husks for at least 10 min
Step 11: Milling						
Step 12: Add water	Yes	No	Yes	Yes		
Step 13: Split						
Step 14: Aflatalisation	Yes	Yes				Cook for at least 30 min
Step 15: Mix	Yes	No	Yes	Yes	No	
Step 16: Shaping	Yes	No	Yes	Yes	No	
Step 17: Cook	Yes	Yes				Steam for at least 30 min
Step 18: Serve to customers	Yes	No	Yes	Yes	No	
Step 19: Water for invalids	Yes	No	Yes	No	No	

Waakye

Step in process	Q1	Q2	Q3	Q4	Is this step a CCP?	Target Limits` (only if a CCP)
Step 1: Purchase cowpea	Yes	Yes			Yes	Cowpea is clean and free of pest and disease
Step 2: Purchase sorghum stalk	Yes	Yes			Yes	Sorghum stalk is clean and free of pest and disease
Step 3: Purchase rice	Yes	Yes			Yes	Rice is clean and free of pest and disease
Step 4: Storage of cowpea	Yes	No	Yes	No	No	
Step 5: Storage of sorghum stalk	Yes	No	Yes	No	No	
Step 6: Storage of rice	Yes	No	Yes	No	No	
Step 7: Wash cowpea in water	Yes	No	Yes	No	No	
Step 7: Wash sorghum in water	Yes	No	Yes	No	No	
Step 8: Wash rice in water	Yes	No	Yes	No	No	
Step 9: Add sorghum stalk to cowpea	Yes	No	Yes	No	No	
Step 10: Boil in water (2 to 3 hours)	Yes	Yes			Yes	Boil for at least 40 to 60 minutes
Step 11: Remove sorghum stalks	Yes	No	Yes	No	No	
Step 12: Add rice to cowpeas	Yes	No	Yes	No	No	
Step 13: Boil for 40 to 50 min	Yes	Yes			Yes	Boil for at least 40 to 60 minutes
Step 14: Transfer hot rice and beans	Yes	Yes			Yes	- Clean hands with

into a bowl lined with polythene and cover with a polythene sheet						soap and water - use clean covering - use clean equipment
Step 15: Hold without further heating (up to 4 hours)	Yes	Yes			Yes	- keep covered - discard if not sold within 4 hours after cooking
Step 16: Serve to customer	Yes	Yes			Yes	- keep covered - use clean utensils to serve to customer - discard if not sold within 4 hours after cooking
Step 17: Washing up	Yes	Yes			Yes	Ensure all equipment is cleaned thoroughly

Where Q1 = Do control measures exist?; Q2 = Is the step specifically designed to eliminate or reduce the likely occurrence of the hazard to acceptable levels?; Q3 = Could contamination with identified hazard(s) occur in excess of acceptable level(s) or increase to unacceptable levels?; Q4 = Will a subsequent step eliminate the identified hazard(s) or reduce their likely occurrence to an acceptable level?

B.H. = biological hazards (*E. coli*, *S. aureus*, or *B. cereus*), C.H. = chemical hazard (heavy metal lead; Pb).

Establishing monitoring systems for food safety

Monitoring is the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a critical control point (CCP) is under control.

Monitoring procedures must be able to detect loss of control at the CCP. Ideally monitoring should provide this information in time for corrective actions to be taken to regain control of the operation before there is a need to reject product. Characteristics that can be measured quickly, easily and with low cost are most suitable for monitoring by street vendors.

Examples include assessments of temperature (where vendor has equipment), time and sensory parameters such as visual and texture, for example "meat juices running clear" or "boiling of liquids" often indicate thorough cooking, raw material inspection, employee practices, examining cleanliness of equipment, off-odours and colours, feeling for abnormal textures etc.

In addition to identifying the most appropriate monitoring system the coalition will address the following issues:

- Who is to act? Generally this will be the street-food vendor. After receiving training, the vendor must be told how to ensure that critical limits are observed and the corrective action to take if the critical limits are exceeded.
- When they are to act? The frequency of monitoring must be sufficient to guarantee that control is being exercised at the CCP.
- How they are to act? The details should be relevant to the type of monitoring being carried out. This requirement means that the vendors must be trained to properly carry out their monitoring functions.

Establish corrective action plan

A corrective action is any action to be taken when the results of monitoring at the CCP indicates a loss of control. This will be carried out by the vendor and EHO's can assist the vendors during routine inspections.

These can include:

- Adjusting the process to maintain or regain control;
- Dealing with the cause of non-compliance;
- Determining the cause of non-compliance;

- Product reworking or product disposal;
- Short term and long term planning: e.g., a quick fix or need for new equipment.

It is anticipated that the monitoring procedures and corrective actions outlined above will form the basis of the education and training requirements for the street-food vendors by the FDB and the AMA.

Verification and review

Verification is the application of methods, procedure, tests and other evaluations, in addition to monitoring, to determine compliance with the HACCP plan. Validation is obtaining evidence that the elements of the plan are effective.

Because vendors have minimal education and resources, it is expected that the verification and validation will be carried out by FDB and AMA food inspectors (EHO's) and health personnel who are experienced in HACCP and knowledgeable about preparing the foods of concern. This will be in collaboration with the street vendor association. Food and health inspectors need to verify appropriateness of control measures and CCPs and the extent and effectiveness of the monitoring. During verification inspectors will be trained to:

- observe operations at CCPs and interview vendor about how they monitor them;
- confirm accuracy of the vendor's monitoring;
- test calibration of monitoring instruments if used;
- collect samples;
- review any available logs or records, if appropriate.

Validation may involve the collection of samples for testing, temperature monitoring and analysis of customer complaints and health records if they are kept by the vendor.

Establish documentation and records

HACCP systems call for maintenance of a log or record forms in which to put results of monitoring. Such record keeping will not be easy for street vending operations but it is anticipated that the authorities in collaboration with the street vendors association will have records of the HACCP plan, policy statement, procedures and work instructions and food and health inspector's reports, recommendations and actions taken.

Conclusions

Appropriate application of HACCP to the street food sector will require a multi-institutional approach where ownership of the plan will be jointly shared between the street vendor association and the authorities that have the resources and expertise in food safety. Consumer awareness will also contribute to improving food safety. The HACCP approach will assist the authorities in prioritising those street foods that are most at risk to the consumer and in focusing training programmes in food hygiene for the vendors. It is expected that changes in the local food bye-laws may be required to assist the partnership. The approach suggested will enable authorities and street vendor associations to steadily contribute to improving food safety in Ghana while protecting livelihoods in the sector and meeting cultural demands for street foods by the consumer.

PROJECT OUTPUT 2. SOURCES OF HEAVY METAL AND MICROBIOLOGICAL CONTAMINATIONS IDENTIFIED AND ECONOMICALLY VIABLE AND SOCIALLY ACCEPTABLE CONTROL MEASURES FOR REDUCING THE HAZARDS TO ACCEPTABLE LEVELS DETERMINED AND VERIFIED.

In output 1 it was established that none of the street food vendors participating in this project were able to apply basic food safety prerequisites effectively and few had received any formal education. The main issues centred on the high cost of water leading to ineffective cleaning of equipment and facilities and poor personal hygiene, lack of suitable clothing for

personnel and poor sanitation and refuse disposal. This means that their products sold are high risk with respect to food safety and hence will have an impact on consumer health. These issues will need to be addressed before substantial improvements in food safety and consumer health can be achieved.

This appeared to be closely related to the nature of the food product and the way that the product was handled and processed. *Kenkey* has the lowest risk with respect to biological hazards because it had a low pH which inhibited the growth and survival of microorganisms and was also well cooked which eliminated the biological hazards. Therefore, although the vendors could not control the basic food hygiene situation, microbiological analysis of this product found no occurrences of food borne pathogens. Microbiological analysis of *waakye* showed a slightly higher occurrence of food borne pathogens and this product is higher risk because of the high moisture content and neutral pH. While many vendors sell this product immediately after preparation delays of some hours may occur if the vendor has few customers. In this study, samples of waakye were close to ambient temperature suggesting that some may have experienced delays in selling. Training may be necessary so that waakye vendors understand the importance of selling immediately or holding the food hot until served. *Fufu* analysis showed that the majority of samples have evidence of faecal contamination (*E. coli*) from poor hygiene and food handling. This is because the product is pounded and severely handled after cooking with out a subsequent step to eliminate this.

Considering the analysis of heavy metals, the survey of street foods suggested that a small proportion of the samples (between 5 and 22%) could be slightly above the maximum recommended levels by the WHO of 0.2 mg/kg. Analysis of cooking puts manufactured by informal foundries in Accra indicated levels of lead as high at 419 mg/kg. Subsequent leaching testing using kenkey (acidic products are prone to leach more from non-acidic ones) confirmed that lead can leach from informal cooking pots and at levels similar to those found in the survey. However, cooking pots that had been used (aged) leached less lead than brand new ones. It is therefore suggested that vendors only use cooking pots when the lead levels are low.

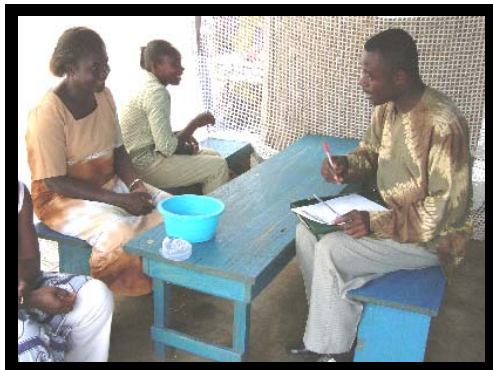
To assist the sector, ways were explored to identify control measures for reducing the hazards to acceptable levels. It should be noted that this was not possible for the heavy metal lead because the delays mentioned in output 1 meant that there was insufficient time for the coalition to act. Considering the microbiological hazards, this was explored by carrying out a socio-economic survey of street food vendors in order to determine their attitude to food safety and their ability to adapt their businesses so that food safety improvements could be incorporated. This was supported by a survey of consumers of street food vendors to assess their willingness to respond to food safety improvements and the cost of achieving this. Finally, training materials were developed. These were detailed training materials for use by environmental health offices and simple food safety messages developed with the collaboration and participation of street food vendors.

Socio-economic survey of street food vendors to assess ability to apply improved food safety practices

The socio-economic survey (ANNEX 8) suggested that the street vended foods sector provides employment for a large number of the urban population, convenient, cheap and affordable food for the poor, which include people working outside the home, school children, commuters and travellers to urban areas, and serve as an important market for raw materials (foodstuffs) producers and traders. Photographs of the project team interviewing street food vendors and consumers are shown in figure 11.

Figure 11. Project team working with street food vendors and consumers.

Project coalition member interviewing a consumer of street foods



Project coalition team interviewing street food vendors



The majority of street food vending were women (96 %). The majority of the vendors were married, aged between 20 and 50 years, were mostly Christians (79%), and had low levels of education. By food group, fufu vendors had more schooling than the kenkey and waakye sellers. Thus, it may require more effort and innovative measures to get the health and food safety message across to vendors.

The three main channels vendors would like to receive health and food safety information were radio, TV and the AMA in descending order of importance. These are the most important channels because they have easy access to these communication items and the AMA. The results indicate high vendor's knowledge level on health and food safety, though no individual case was absolute and some areas can be graded only fair. There is the need for training workshops using talks, demonstrations and role-plays as training methods. Results from the food groups revealed that among the kenkey vendors there was no subject area where all vendors had knowledge. Currently only 10% of the vendors had had any training in hygiene and food safety and the AMA had provided majority of the trainings. This show there is a strong formal linkage between the vendors and AMA. There is, however, the need to intensify the training and to make it permanent, and also involving other stakeholders.

The main source of street vendor's income is the services they provided in the form of preparing and selling food. The secondary source is most from traditional processing, i.e. charcoal and local beer. On the other hand, the main income source for members of vendors family were trading in primary commodities. For most activities involving women, pay is usually in cash.

The survey indicated that many of the more successful vendors had incomes above the Ghanaian poverty line of ₵900,000 poverty line. This was considered a positive factor since it illustrates the potential benefit for many vendors if they can successfully implement food safety improvements. The majority of the vendors owned radio and television but only a few vendors owned refrigerators. This illustrates that the radio is a suitable avenue for receiving health and food safety information. Majority of the vendors do not pay rent because they lived in their own houses or that of their relations. Vendors who paid rent, paid amounts ranging between ₵20,000 and ₵200,000 per month. A total of 37 % own their accommodation, 28 % are registered in the name of women and 10 % registered in the name of both men and women. This a major shift in the socio-cultural practices in the family system in Ghana. Vendors usually sell in locations close to their houses and therefore walk to their selling points. The rest use public transport except a few who own cars. For the surveyed vendors, the highest proportion of household expenditure was on education followed in importance by economic activities. The least household expenditure item was

on health. However, there are significant differences within each food group. For example, while waakye sellers spent 25.8 % of household expenditure on economic activities, fufu and kenkey vendors respectively spent 13.6 % and 12.2 % on economic activities.

Only a small percentage of the vendors belong to any vendor association. Of those who did, there were more fufu vendors in associations than the other food groups. The benefits derived by those in association include cash and advice on business management.

Food prepared by the vendors per day range from one to ten batches for fufu vendors, one to three batches for waakye vendors and up to two batches for kenkey vendors. The frequency of preparation is somewhat related to the keeping qualities of the food in question. Fufu is the least storable food and must be consumed within a few minutes after preparation. Kenkey and waakye have a longer storable time when they are well packaged. The estimated turnover per annum of the vendors surveyed amounted to ₵ 51.84 billion (\$5.67 million)

The benefit-cost result shows on average all three foods; kenkey, fufu, and waakye were profitable operations. The food vendors do not operate on business lines and therefore do not pay themselves. On average, the food vendors operate a six-day week and 52 week year. Therefore a kenkey vendor makes an annual profit of ₵32 million (\$3,500), a fufu vendor makes on average an annual profit of ₵144 million (\$12,482), and a waakye vendor on average makes an annual profit of ₵ 44 million (\$4,840). Thus the most profitable street vending business covered in this study is fufu. This means the vendors can financially support improvement that will improve hygiene and food safety. However, almost all the vendors do not keep any records on their operation and do not estimate their profit levels on monthly or even daily basis. There is need to train these vendors in basic business management – costing, pricing, profit estimation, and fixing of salaries for themselves.

Changes in food price follow two main strategies, increases in food price and reduction in food quantity. Almost all the vendors accept that by improving food hygiene the number of all categories of customers will increase. In addition, most consumers are willing to pay more for food when vendor improve on their hygiene and food safety practices. The main constraints facing vendors are associated with the technologies employed in food preparation, which are mostly traditional, risky and tedious. The employment of modern gadgets and processes will eliminate the problems but require some investment capital. From the profit estimates, the vendors can meet these financial needs from their own resources or can service any loans they contract for the investment. The vendors, however, need training in the management of their business finances.

The problems related to selling food are low patronage and customer relations. Improvements addressed by this project can help to improve livelihoods. Support from city planners should assist them in establishing their businesses in a more organised approach.

Socio-economic survey of street food vendors to assess ability to apply improved food safety practices

The consumer survey (ANNEX 8) suggests that most consumers were male and varied with respect to marital status, religion, age and educational achievement. The frequency of purchase indicated a high dependence on street foods by the Accra population. This high dependence suggests changes in policy are required by city managers to project the welfare of consumers and the livelihoods of the vendors.

It was observed from the analysis that most consumes do not buy from a permanent vendors. The reason adduced was the generally unhygienic conditions surrounding the places of preparing and selling food. No particular factor is dominant in dictating the purchasing behaviour of consumers though 26 % buy from the same vendor based on the

quality of the food. Improvements requested by consumers mostly relate to hygiene and food safety and were willing to pay more for the food if that is done. This provides livelihoods opportunities for those vendors who can improve the presentation of their stalls, staff appearance and food hygiene.

Promotion to street vendors, Environmental Health Officers and consumers

Promotion to Street Vendors on ways to prepare and sell safer street foods

The first promotion workshop for 40 Environmental Health Officers (EHOs) was held on the 27th of May 2004. Thirty-two of these EHOs were from the 8 sub-metro stations of the Accra Metropolitan Assembly and the rest from the Tema Municipal Assembly. The training programme was from 9 am to 4.30 in the evening, with an hour break for lunch. This particular training programme served dual purpose. The first was for the EHOs to assist the coalition to finalise the draft training materials (composite posters and training manual) that have been prepared by the street food coalition team. The second was to inform as well as train the EHOs on new food safety issues as have been identified by the project. The EHOs were also taken through the basics of good manufacturing practices (GMPs) and good hygienic practice (GHPs). In particular, the programme explained and helped the EHOs to appreciate the possibilities of using the HACCP principles as embodied in one of the composite posters titled "Street Food Catering- Critical Control Points". During the latter part of the training, the EHOs were divided into syndicate groups to further discuss and agree on what topics could be considered as most urgent for training of the street food vendors.

Five training workshops were conducted for 225 street food vendors in Accra between the 10th of August and the 17th of November. Each training programme began with participants watching the two of the four documentaries developed by the coalition through funding from UNIDO. This was to set the scene as well as sensitise the participants. Next was the session on GMPs and GHPs. It is at this stage that the four posters, (*Five keys to Safer food*, "*Street Catering-Critical Control Points*", "*Wash your hands I*" and "*Wash your hands II*") as well as the training manual were extensively used (figure 12). It must be emphasised that these posters proved very useful given the low education levels of most of the SFVs. According to the coalition partners, this was probably the first time such dissemination material had been used in training vendors in Ghana. This session was very interactive and SFVs were given the chance to make contribution as to what they could better to produce safer street foods (figure 13).

After break the participants were then taken to the Microbiological laboratories at the Food Research Institute where an attempt was made to help the SFVs better appreciate the menace/dangers of the micro-organisms. This was achieved using an innovative technique in which vendors used a special hand indicator dye to illustrate how easily food poisoning bacteria can spread and the importance of thorough hand washing. There were also shown bacteria through a microscope. This was to help them understand the importance of bacteria in food hygiene. The SFVS also participated in general discussions on financially managing their vending businesses to enable them to apply improved food safety practices in their livelihoods. After the practical session at the laboratory, participants regrouped to discuss what they have learnt. The training programme was from 9.30 to 2.00 pm

Figure 12: Training posters developed by the coalition for promotion of food safety to street food vendors



Figure 13: Development and delivery of basic food safety training to contribute to improving the livelihoods of street food vendors

Syndicate groups developing training material for improving food safety for street vendors at a workshop in Ghana on 27th May 04.



Street food vendor viewing 'germs' under a microscope



Training of street food vendors in basic food hygiene



ii. Development of Training Manual: “Instituting elements of good manufacturing and hygienic practices for street Food Vendors in Ghana- A Trainer’s Manual Module One (edited by P-T.N Johnson, M. Ottah Atikpo and K.I. Tomlins)”

iii. 10 min radio interview given project co-leader Dr Paa-Nii Johnson with WRENmedia titled “*Making Street Food Safe*” in April 2004. This can be found on website www.agfax.net

Promotion to Consumers and Vendors on the need to eat safe food

In the course of the project implementation, one of the key coalition partners organised a number of subsidiary activities to educate consumers and vendors on emerging issues on food safety as well as eating safe food. These activities were made possible through funding from UNIDO. They include:

- Four T.V documentaries on food safety on the promotion of hygienic practices from the farm to the consumer were developed. The documentaries were targeted at food producers as well as consumers. It was to help them understand the relationship between disease and consumption of unsafe foods as well as

sensitize them on their role in ensuring a safe food production and delivery in Ghana. The titles of the documentaries produced were: “*From to Farm to Market to the Table*, (duration 15 min), *Food Safety Issues in Ghana- Relationship between diseases and unsafe foods*”, 15 min, “*Improving the competitiveness of Food Manufacturing Companies in Ghana*”, 15 min. and “*Ensuring a Safe Food Supply- What the Consumer Should Know*”, 12 min. •

Since March 2004, these documentaries are shown periodically on TV3 Television, one of the main national television stations in Ghana.

- The UNIDO sponsored billboards for the FDB (Figure 14)

Figure 14: Publicity billboards in Accra to promote consumer awareness of food safety



- In June 2003, the Food and Drugs Board organized the first ever National Food Safety Week in Ghana (NFSWG). The theme of the Week was “*Safe Food for Good Health, a Responsibility of All*”. Activities carried out during the course of the NFSWG included an official launching of the programme by the Vice-President of Ghana, a consumers’ awareness float through the principal streets in Accra, a food safety quiz competition among Senior Secondary School (SSS) students in Ghana, a cleaning competition among street-food vendors in Accra and consumers’ forum. Subsequently, an essay and radio competitions on Food Safety Competition were organized among the SSS students. The radio competition was broadcast live on the national radio, Ghana Broadcasting Corporation. This event was repeated in July 2004 in Kumasi.

PROJECT OUTPUT 3. RECOMMENDATIONS AND CONSULTATIVE DOCUMENTS TO IMPROVE THE SAFETY OF FOODS IN THE STREET FOOD SECTOR DELIVERED TO POLICY, REGULATORY AND ENFORCEMENT AGENCIES AND A STRATEGY FOR DISSEMINATION TO THE SECTOR DEVELOPED AND IMPLEMENTED.

At the inception meeting of the project coalition and the stakeholders at ERATA Hotel, Accra on the 4 and 5th of March 2003, the coalition decided to form two committees, one in Accra and the other in Kumasi, for the purposes of producing a consultative document containing recommendations to improve the street food sector to policy and enforcement agencies. In both Accra and Kumasi, the composition of the committees was made of coalition members as well as key stakeholders who offered to assist. The focus of both committees was developing recommendation that would result in policies which will be more practical, educational as well as create consumer awareness on issues of food safety.

The Accra committee had some initial delays, partly because at the time the committee wanted to start work, it was informed that the Ministry of Local Government and Rural Development that it was in the process of putting together a team to review the present

byelaws for the Accra Metropolitan Assembly. Thus in November 2003, the committee members joined other government officials from the Ministry of Local Government and Rural Development for a workshop in Dodowa to discuss the present byelaws on in Accra which included those on sale of street foods during which the present. It was expected that there will be subsequent meetings to review and finalise the report of the special committee put together at the Dodowa workshop. There have been further delays.

The Kumasi group started quite early and had a series of meetings culminating in a stakeholders meeting at which representatives of the following attended by from the following groups and organizations: Health Education Unit, KMA., Vegetable Sellers Association, Processed Water Producers Association, Butchers/Kebab Sellers Association, Fast Food operators association, Traditional Caterers Association, Ghana Tourist Board (GTB), Food and Drugs Board (FDB) and the Environmental Protection Agency (EPA)

Issues discussed at this stakeholder meeting were the present weaknesses with bye-laws regulating the sale of food in Kumasi. The stakeholders all agreed on the following as being the most important issues to be tackled in the set of recommendations to be submitted:

Lack of awareness on food hygiene practices, excessive handling of food, non-adherence, and bye-laws are not adhered to. People break them with impunity, Fines for breaking these food laws are not deterrent enough (¢200,000 maximum, Act 426), lack of coordination among regulatory agencies with respect to collaboration and consultation, lack of coordination results in duplication of functions thus creating gaps, Lack of institutional capacity for enforcing regulations, Inadequate consumer education, food vendors do not belong to associations hampering information dissemination,

Some issues extensively highlighted during discussions on policy framework were;

The definition of Street food, Categorization of Street food within the context of Kumasi Location/Selling environment/Sitting., Licensing regulations, Mandatory provisions Nature of operational structure, Fines, Food handling and adulteration, Labour/workers Personal hygiene and behaviour, Services – water supply, Waste disposal – solid and liquid waste, Pest control.

Some of recommendation made include:

i. *Location/Selling environment/Siting*

This was discussed taking into consideration already established street food locations. Food should generally be kept from sources of contamination e.g. Solid and liquid wastes, pests, etc. Thus;

- Food shall not be prepared, handled, offered or exhibited for sale at a distance not less than 5 metres from an open or close earth or concrete drain so as to avoid any possible contamination of the food.
- Preparation, handling and sale of food shall not be carried out at a distance of not less than 100 metres from a cemetery, sanitary sites and infrastructure (refuse dump (10 metres), public latrine (10 metres), sewage treatment or oxidation ponds, animal habitats (10 metres) or abattoir (50 metres)).
- Food vending shall not obstruct or impede the free movement of vehicular or pedestrian traffic.
- An occupier of a space or selling site shall be responsible for maintaining the cleanliness of the space or selling site.
- No occupier of any space or selling site shall offer for sale any food (bread, prepared grain food or any other articles of food) unless it is placed on a table or support raised at least 2.0 metres from the ground.

ii. Licensing regulations

- Any vendor, helper or food handler shall be required to undergo medical examination or the requisite medical investigation by the relevant authority (the medical officer of Health Department, Ministry of Local Government and Rural Development (MLGRD), GTB and FDB). This should be before the issuance of a licence and at any other time deemed necessary by the relevant authority.
- Any vendor, helper or food handler whether suspected of suffering from a communicable disease or not but has the potential to transmit disease is prohibited from handling food until he/she furnishes a certificate from a medical practitioner that he/she is healthy.
- Every vendor, helper or food handler shall be required to undergo basic training in food hygiene, personal hygiene, food handling and storage and food laws prior to licensing. Training is to be conducted by the relevant authority or other institutions recognised or approved by the relevant authorities.
- No person shall operate as a food vendor unless he/she obtains a licensing from the relevant authorities.
- A license issued shall expire on the 31st December of the year in which it is issued.

iii. Mandatory provisions

This was discussed on the basis that every vendor should satisfy these conditions.

The provisions are essential for ensuring that food is safe for public consumption.

- Adequate and wholesome water supply.
- Proper and efficient waste disposal systems and place(s) of convenience.
- Adequate ventilation and lighting or illumination.
- Pests and pets control.
- Proper storage facilities.
- Good personal hygiene.

iv. Structure

Vendors of selected food types e.g. Fast foods, kenkey, pastries, etc. in selected sites of the metropolis (central business area, first class residential areas of metropolitan and municipal assemblies) shall prepare, handle and sell food in a structure approved by the relevant authority.

v. Protection of food

No article or food offered for sale or likely to be used for human consumption shall be exposed either to flies, dust, fumes, microorganisms etc

Section F Project effectiveness

This section of the evaluation report uses the rating criteria for the purpose and your outputs previously used in your annual reports.

	Rating
Project Goal: National and international crop-post harvest innovation systems respond more effectively to the needs of the poor.	X
Project Purpose Strategies developed which improve food security of poor households through increased availability and improved safety and quality of foods	2
Project Output 1. Extent of hazards from heavy metals and microbiological contamination in selected street foods in Accra evaluated.	2
Project Output 2. Sources of heavy metal and microbiological contaminations identified and economically viable and socially acceptable control measures for reducing the hazards to acceptable levels determined and verified.	2
Project Output 3. Recommendations and consultative documents to improve the safety of foods in the street food sector delivered to policy, regulatory and enforcement agencies and a strategy for dissemination to the sector developed.	3

1= *completely achieved*

2= *largely achieved*

3= *partially achieved*

4= *achieved only to a very limited extent*

X= *too early to judge the extent of achievement (avoid using this rating for purpose and outputs)*

Outputs (5 pages)

What were the research outputs achieved by the project as defined by the value of their respective OVIs? Were all the anticipated outputs achieved and if not what were the reasons? Your assessment of outputs should be presented as tables or graphs rather than lengthy writing, and provided in as quantitative a form as far as is possible.

Project Output	OVI	Achievement of OVI	Reasons why not achieved if not fully achieved.
1. Extent of hazards from heavy metals and microbiological contamination in selected street foods in Accra evaluated.	1.1 Levels of heavy metals and microbiological contamination determined in representative areas in Accra by Nov 2003.	Report. Tomlins et al., 2004. Atikpo et al., 2004. Tomlins 2004.	Completed
2. Sources of heavy metal and microbiological contaminations identified and economically viable and socially acceptable control measures for reducing the hazards to acceptable levels determined and verified.	2.1. Sources of heavy metal and microbiological contaminations within the food chain identified in Accra by Mar 2004.	Report. Tomlins et al., 2004. Atikpo et al., 2004.	Completed
	2.2. Strategies and control measures to reduce identified hazards in the food chain developed (by Dec. 2004).	Report. Tomlins et al., 2004.	Partially completed. Delays in analysis led to delays in training vendors in improved food safety. Therefore, there was insufficient time to complete verification of improvements in food safety.
3. Recommendations and consultative documents to improve the safety of foods in the street food sector delivered to policy, regulatory and enforcement agencies and a strategy for dissemination to the sector developed.	3.1. Production of documentation identifying current weaknesses with procedures and policies affecting the street food sector (by Dec. 2003).	Awudza et al., 2004	Partially completed. Conflicts between responsibilities for food safety management in Ghana delayed the production of a report for Accra.
	3.2. Delivery of draft consultative document detailing key recommendations and guidelines to lawmakers / regulatory bodies, enforcement agencies, NGOs and other appropriate ministries (by Aug 2004).	Awudza et al., 2004	Partially completed. Conflicts between responsibilities for food safety management in Ghana delayed the production of a report for Accra.
	3.3. Food inspectors (20) and vendors (500) will have been trained in Accra. (by Dec 2004).	Posters developed for training street food vendors. A total of 300 vendors trained in basic food safety. Billboards for dissemination to consumers. Training materials for EHO's developed and 40 EHO's training. Johnson et al., 2004, Tomlins et al., 2004b.	Completed

	3.4 Dissemination and consultative strategies developed and delivered to the national street food coalition team (by Dec 2004).	Delivered throughout project coalitions to FDB, AMA and FRI.	Completed
--	---	--	-----------

Purpose (2 pages)

Based on the values of your purpose level OVIs, to what extent was the purpose achieved? In other words, to what degree have partners/other users adopted the research outputs or have the results of the research been validated as potentially effective at farmer/processor/trader level?

The purpose level OVI was ‘Appropriate strategies developed for ensuring safe street food through determination and control of hazards as well as developing policy recommendations (by Dec 04)’.

The project outputs were achieved. Food safety and quality management systems have been developed by the coalition partnership and adapted so that street food vendors can improve food safety and potentially increase the incomes of low income vendors and other participants in the street food sector. This will also potentially contribute to improved health of consumers of street vended foods, particularly vulnerable groups such as infants, children, pregnant women, the elderly and immuno-suppressed. A number of dissemination outputs have been produced including billboards a workshop for key stakeholders in April 2002 and a dissemination leaflet. Further scientific publications will be submitted from the work, but these have not yet been completed.

It is anticipated that the partnership could address other food safety issues affecting not only street food vendors but other groups as well.

A number of constraints, however will have to be overcome which are largely beyond the scope of this project. These are:

- The need to support laboratory facilities and training of staff in good laboratory practice so that reliable analytical facilities can be provided locally
- While street food vendors will be able to make improvements in food safety, full compliance will only be feasible if the services (water supply, sanitation, refuse disposal, electricity, gas) is also improved. Food law and food safety protocols need to be adapted to meet these demands.

Goal (1 page)

What is the expected contribution of outputs to Project Goal?

The project was contributing to the goal ‘National and international crop-post harvest innovation systems respond more effectively to the needs of the poor’. This has contributed by establishing institutional arrangements that effectively and it is anticipated sustainably, improve access to knowledge in the area of food safety and quality management. It is anticipated that this will stimulate further innovation that benefits the livelihoods of those working in the street vended foods and other sectors.

Section G – Uptake and Impact (2 pages)

Organisational Uptake (max 100 words)

What do you know about the uptake of research outputs by other intermediary institutions or projects (local, national, regional or international)? What uptake by which institutions/projects where? Give details and information sources (Who?What?Howmany?Where?)

Uptake of research outputs by other intermediary institutions or projects is as follows:

- FAO – Dr Paa-Nii Johnson is a committee member of the national Codex committee for food safety in Ghana. He has advised the committee of project progress on a regular basis during this project;
- UNIDO – UNIDO sponsored billboards promoting improved food safety and this project contributed to this;
- Dissemination to other CPHP projects – The project shared information with the CPHP project in Zambia and Zimbabwe 'R8272 - Improving Food Safety of Informally Vended Foods in Southern Africa'. A presentation of the project progress was given at the quarterly meeting in June 2004 by Mr K Tomlins, NRI.
- India – Professor Joyashree Roy, Jadavpur University, Kolkata, India was keen to learn more about the street food work in Ghana and the coalition approach.
- The project website (<http://www.nri.org/streetfoods/index.htm>) led to several enquiries from organisations and individuals in Senegal, Burkina Faso, USA, India, Philippines. South Africa. Many were interested in the coalition approach but difficulties in obtaining funding have delayed uptake to date.

Presentation at FoodAfrica symposium

End user uptake (max 100 words)

What do you know about the uptake of research outputs by end-users? Which end-users, how many and where? Give details and information sources

Uptake of project outputs include:

- Ghana Traditional Caterers Association – a total of 300 vendors have been training in basic food safety;
- Check-check vendors – a group of five attended the project workshop on basic food safety;
- Research institutions (NRI, FRI, University of Ghana) have used the new food safety knowledge management approach to develop improved impact in research carried out by these organisations;
- Food and Drugs Board have used the research outputs to contribute to the policy for national food safety in Ghana;
- Accra Metropolitan Assembly have used the outputs to improve their understanding of the issues, particularly food inspection, that contribute to improved food safety of street vendors.

Knowledge (max 100 words)

What do you know about the impact of the project on the stock of knowledge? What is the new knowledge? How significant is it? What is the evidence for this judgement?

New knowledge acquired regarding:

- Coalition development which will be applied to different food hazards and other food sectors in Ghana
- Improved capability of institutions in Ghana
- New knowledge on extent of microbiological and heavy metal contamination of selected foods in the street food sector
- New knowledge of socio-economic constraints faced by street vendors and ways of overcoming them to improve livelihoods

Institutional (max 100 words)

What do you know about the impact on institutional capacity? What impact on which institutions and where? What change did it make to the organisations (more on intermediate organisations). Give details and information sources.

- Improved linkages between partners in coalition, in particular between the street vendor organisations and AMA, FDB and FRI.
- NMIMR require support to provide capability in heavy metal analysis within Ghana. Project has a duty of care to provide vendors and consumer with accurate information and at present NMIMR are unable to do this without serious risk to either the consumer (analysis wrongly says a food is safe when there is really a hazard) or to the vendor (analysis wrongly says a food is hazardous when it is actually safe).

Policy (max 100 words)

What do you know about any impact on policy, law or regulations? What impact and where? Give details and information sources

- FDB have used outputs to contribute to national food safety programme regarding national and international food law;
- AMA and KMA are currently evaluating local food bye-laws and how EHO's work with and relate to street food vendors;
- Laboratory facilities in Ghana require more support if consumers are to have access to accurate information. If the information is not accurate there is a potential consumer risk (analysis wrongly says a food is safe when there is really a hazard) or producer risk (analysis wrongly says a food is hazardous when it is actually safe).

Poverty and livelihoods (max 100 words)

What do you know about any impact on poverty or poor people and livelihoods? What impact on how many people where? Give details and information sources.

- A total of 300 street food vendors trained in food safety. However, the sector employs at least 60,000 vendors in Accra and this is thought to be well short of a 'critical mass' of sustainable knowledge and expertise among the vendors and vendors organisations;
- Anticipated that improved safety of foods, in particular high risk foods such as fufu, will lead to improved consumer health;
- A survey of 265 street food vendors highlighted that many had limited understanding of their business finances and this hindered the benefits of training.

Environment (max 100 words)

What do you know about any impact on the environment? What impact and where? Give details and information sources.

- Adoption of good manufacturing practice by informal foundries that manufacture cooking pots will lead to reduced heavy metal (lead) pollution.
- Advising consumers and vendors to use and purchase cooking pots that are low in the heavy metal lead with reduce hazards to human health and pollution to the environment
- Pollution will be reduced if the local authorities can will contribute to improved quality of water used by vendors, sanitation and refuse disposal.

Signature	Date	
Core Partners
Managing Partner

ANNEXES

- I Copies of the stakeholder, gender, livelihoods and environmental form included with the concept note.
- II Project Logical Framework
- II Partner (user) organisations workplan for adopting project outputs
- III Copies of diaries, coalition meeting reports etc
- IV Feedback on the process from Partners(s) and users (where appropriate)
- V Tabulated description of disseminated outputs (format from green book) – same as given in the PCSS and should include all published, unpublished and data sets. If any of the reports included in this annex has not been submitted to the programme previously, please include a copy (preferably an electronic copy or if not available a hard copy)

ANNEX 1: Copies of the stakeholder, gender, livelihoods and environmental form included with the concept note.

ENVIRONMENTAL SCREENING SUMMARY NOTE

<p>1. Project Title: <i>Improving the safety of street-vended foods in Ghana by identifying sources of heavy metal contamination and determining methods for removing the risk.</i></p> <p>2. Project Cost: <i>£166,176</i></p> <p>3. Duration: <i>2 years</i></p> <p>4. Country: <i>Ghana</i></p>
<p>5. What are the potential significant environmental impacts (both positive and negative) of the proposed research activities? <i>The research activities will have a neutral impact.</i></p>
<p>6. What are the potentially significant environmental impacts (both positive and negative) of widespread dissemination and application of research findings? <i>Heavy metals in street vended foods will be reduced through widespread dissemination and application of research findings. This will lead to improved health and nutrition of consumers of street vended foods and sustained livelihoods for the farmers, traders and vendors.</i></p>
<p>7. What follow-up action is required to minimise potentially significant negative impacts:</p> <ul style="list-style-type: none"> • Who will be responsible for ensuring this action is taken? <i>Government Ministries (Health and Environment Science and Technology) and food standard and regulatory organisations (Food and Drug Board, Ghana Standards Board, Food Research Institute) in Ghana.</i> • What form of monitoring/objective verification? <i>Random analysis of high risk street vended foods, inspection of farms/traders/vendors where contamination enters the food chain, documentation if a HACCP plan is implemented, improved health and nutrition of consumers (especially children).</i>
<p>8. How can positive impacts be enhanced/extended cost-effectively?</p> <ul style="list-style-type: none"> • Who will be responsible for ensuring this action is taken? <i>Government of Ghana through a working group on the safety of street vended foods. This will act through local authorities (Accra Metropolitan Assembly) and local government.</i> • What form of monitoring/objective verification? <i>Monitoring will be by food and regulatory organisations (Food and Drug Board, Food Research Institute)</i>

and NGO's (Ghana Traditional Caterers Association, Friends of the Earth).

This Note completed by (proposer
of project concept)

name: Mr K Tomlins.....

institution: Natural Resources Institute

date: 20/12/00.....

Endorsed/modified by Programme Manager

.....

date:

ANNEX 2

Revised Logical Framework.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Risks
Goal			
National and international crop-post harvest innovation systems respond more effectively to the needs of the poor.	By 2005, a replicable range of different institutional arrangements which effectively and sustainably improve access to post-harvest knowledge and/or stimulate post-harvest innovation to benefit the poor have been validated in four regions.	Project evaluation reports. Partners' reports. Regional Co-ordinators' Annual Reports. CPHP Annual Reports. CPHP Review 2005.	National and international crop-post harvest systems have the capacity to respond to and integrate an increased range of research outputs during and after programme completion. National and international delivery systems deliver a range of services relevant to poor people in both focus and non-focus countries. Livelihood analysis provides accurate identification of researchable constraints or opportunities that lead to poverty reduction.
Purpose			
Strategies developed which improve food security of poor households through increased availability and improved safety and quality of foods.	Appropriate strategies developed for ensuring safe street food through determination and control of hazards as well as developing policy recommendations (by Dec 04)	Quarterly and annual reports. Final Technical report.	Political stability Regulatory and enforcement agencies are able to act / work in partnership
Outputs			
Note: Activities for Outputs 1 and 3 will be undertaken concurrently and not in a linear fashion			
1. Extent of hazards from heavy metals and microbiological contamination in selected street foods in Accra evaluated.	1.1 Levels of heavy metals and microbiological contamination determined in representative areas in Accra by Nov 2003.	1.1.1 Analytical laboratory and quarterly reports. 1.1.2 Coalition meetings report. 1.1.3 Quarterly and Annual reports	Continued coalition partner support.

<p>2. Sources of heavy metal and microbiological contaminations identified and economically viable and socially acceptable control measures for reducing the hazards to acceptable levels determined and verified.</p> <p>3. Recommendations and consultative documents to improve the safety of foods in the street food sector delivered to policy, regulatory and enforcement agencies and a strategy for dissemination to the sector developed.</p>	<p>2.1. Sources of heavy metal and microbiological contaminations within the food chain identified in Accra by Mar 2004.</p> <p>2.2. Strategies and control measures to reduce identified hazards in the food chain developed (by Dec. 2004).</p> <p>3.1. Production of documentation identifying current weaknesses with procedures and policies affecting the street food sector (by Dec. 2003).</p> <p>3.2. Delivery of draft consultative document detailing key recommendations and guidelines to lawmakers / regulatory bodies, enforcement agencies, NGOs and other appropriate ministries (by Aug 2004).</p> <p>3.3 Food inspectors (20) and vendors (500) will have been trained in Accra. (by Dec 2004).</p> <p>3.4 Dissemination and consultative strategies developed and delivered to the national street food coalition team (by 2004).</p>	<p>2.1.1 Diagnostic report</p> <p>2.1.2 Quarterly and Annual reports.</p> <p>2.2.1 Draft document on control measures and strategies.</p> <p>2.2.2 Quarterly reports. Annual reports</p> <p>3.1. 1 Draft report document on identified weaknesses.</p> <p>3.1.2 Quarterly and Annual Reports</p> <p>3.1.3 Technical Reports</p> <p>3.2.1 Consultative document and quarterly reports.</p> <p>3.2.2 Quarterly and Annual Reports</p> <p>3.2.3 Technical Reports</p> <p>3.3.1 Reports on training workshops.</p> <p>3.3.2 Quarterly and annual reports.</p> <p>3.3.3 Technical Reports</p> <p>3.4.1 Appropriate dissemination materials such as videos, leaflets, posters, and handouts developed and delivered.</p> <p>3.4.2 Guidelines and manuals for end-users, NGOs, enforcement agencies.</p> <p>3.4.3 Documentaries, Media (TV, radio, newspapers). Press releases.</p> <p>3.4.4 Quarterly and Annual Reports.</p>	<p>External stakeholders supportive of project.</p> <p>Identified hazards can be controlled.</p> <p>Policies of national and municipal authorities are favourable for the street food sector</p>
---	---	---	--

Activities			
1.1 Participatory co-ordination meeting of project stakeholders to inform and confirm project activities (by Mar 03)			Lack of institutional support for members of the coalition to function effectively.
1.2 Participatory selection of street foods, location and target groups to supply representative samples (by Mar 03).			Conditions (climatic, social) remain conducive for rural and urban farmers, traders and wholesalers to produce and sell street vended foods.
1.3 Develop a sampling plan representative of the population (by Mar 03).			National policies continue to support street food vending in Ghana.
1.4 Analysis of the samples and identification of the types and level of hazards (by Nov 03).			Media supportive of project outputs.
2.1. Draw up definable steps of the street food raw materials, supply, processing and vending chain (by Mar 04).			Heavy metal risks can be controlled.
2.2. Preliminary identification of the potential hazards at each stage in the chain (by Nov 03).			
2.3. Field surveys to observe and determine presence and location of hazards in the chain (by Nov 03).			
2.4. Identify critical control points to eliminate or reduce the hazard to acceptable levels including and evaluation of the technical, economic and social interventions (by Sept 04).			
2.5. Validation trials to evaluate the effectiveness of the measures (by Oct 04).			
3.1 Development of a consultative document on improving the general guidelines, legislative requirements and byelaws in the management of the street food vendors in Ghana (by Oct 04).			
3.2 Development of dissemination materials and long term dissemination strategy and policy recommendation (by Oct 04).			

ANNEX 3

Partner (user) organisations workplan for adopting project outputs
The coalition partnership used the project logframe as the workplan

ANNEX 4

Copies of diaries, coalition meeting reports etc
This project used the quarterly reports submitted to CPHP as the basis of a diary and coalition meeting reports. In all cases, a coalition meeting was held shortly before the quarterly meetings were due so that these could be developed jointly.

ANNEX 5

Feedback on the process from Partners(s) and users (where appropriate)

Feedback has been positive and was often expressed during quarterly project meetings.

ANNEX 6

Tabulated description of disseminated outputs (format from green book) – same as given in the PCSS and should include all published, unpublished and data sets. If any of the reports included in this annex has not been submitted to the programme previously, please include a copy (preferably an electronic copy or if not available a hard copy)

<i>Website</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2003) Street Foods in Africa. <http://www.nri.org/streetfoods/index.htm>. [Website] [English]</i>
<i>Popular posters, leaflets, fliers</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Safe Street Catering – Critical Control Point, 50 copies. Food Research Institute, Accra, Ghana [Poster] [Field] [English].</i>
<i>Popular posters, leaflets, fliers</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Wash your hands!! Version I, 50 copies. Food Research Institute, Accra, Ghana [Poster] [Field] [English].</i>
<i>Popular posters, leaflets, fliers</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Wash your hands!! Version II, 50 copies. Food Research Institute, Accra, Ghana [Poster] [Field] [English].</i>
<i>Popular posters, leaflets, fliers</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Five Keys to safer food, 50 copies. Food Research Institute, Accra, Ghana [Poster] [Field] [English].</i>
<i>Factsheets, booklets,</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Instituting</i>

<i>information leaflets</i>	<i>elements of Good Manufacturing and Good Hygienic Practices for street food vendors in Ghana; Eds; P. N. T. Johnson., M. Ottah Atikpo and K. I. Tomlins, 100 copies. Food Research Institute, Accra, Ghana [Factsheet] [English].</i>
<i>Dissertation</i>	TOMLINS, K. I. (2004) Development of appropriate food safety management systems for improving the safety of informal food systems in developing countries, project for Advanced certificate in applied HACCP principles (Royal Institute of Public Health), 13pp
<i>Radio</i>	JOHNSON, P. N. T. (2004) Making street foods safe, Wren Media, 4.12 mins, Ghana [Radio interview] [national] [English]
<i>Factsheet</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) STREET-CATERING - Guide to making street food safe; Eds; K. I. Tomlins and P. N. T. Johnson., , 10 copies. Natural Resources Institute, Chatham, Kent, UK. 16pp [Factsheet] [English].</i>
<i>Journal paper</i>	<i>DFID/CPHP STREET FOOD COALITION: FRI (CSIR), NRI, UG, KNUST, FDB, AMA, KMA, NMIMR, GTCA. (2004) Street food in Africa – economic, nutritional, cultural and food safety aspects and their importance in national food policy, Food Control, manuscript in preparation</i>

ANNEX 7: Evaluation of published literature on street food safety in Africa

Street food and informally vended food in Africa – economic, nutritional, cultural and food safety aspects and their importance in national food policy

K. I. Tomlins¹, & other authors as per contributions

¹*Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, United Kingdom.
(E-mail K.I.Tomlins@gre.ac.uk)*

Introduction

The dramatic growth of urban populations in developing countries provides both opportunities and risks for resource-poor groups in urban and peri-urban environments. In 2020, the global population is predicted to reach 7.6 billion, an increase of 31% over the 1996 population of 5.8 billion. Approximately 98% of the projected population growth is anticipated to occur in developing countries where urban populations will double, reaching 3.4 billion. The expected level of urban food consumption is similarly expected to increase. For example, between 2000 and 2010, food consumption is thought to increase from 3030 to 5752 metric tonnes in Yaounde and from 4805 to 7984 metric tonnes in Nairobi (Argenti 2000). This overall increase in population in urban areas poses great challenges to food systems, consumer health and to the livelihoods of those employed in the food sector. Rapid urbanisation has led to urban services to be stretched beyond their limits, resulting in inadequate supplies of portable water, sewage disposal and other necessary services (Orriss 2002).

A feature of the urbanisation process has been the development of informal food supply systems, in particular, street vended or informally vended foods. Street foods are defined by the World Health Organization (WHO) as “foods and beverages prepared and/or sold by vendors in streets and other public places for immediate consumption or consumption at a later time without further processing or preparation”. This definition includes fresh fruits and vegetables which are sold outside authorised market areas for immediate consumption (Anon 1996). A WHO survey in 1993 (Anon 1996) reported that out of 100 countries participating in a survey, 74% reported street vending to be a significant part of the urban food supply. The WHO recognises that street foods have an essential role for maintaining the nutritional status of the urban population.

This paper reviews the information on the safety of street vended foods, its importance to the livelihoods and incomes of those employed in the sector, the effect on the health of the consumer and legislative aspects. A factor this paper seeks to investigate is how changes in the economy influence street foods and the role of national food control systems in managing the sector.

Importance of street vended foods to the urban economy in African countries

The sale of street foods can make a sizeable contribution to the economy. It has been estimated that consumers in urban areas pay up to 30% more for food compared to their rural counterparts and have less time to spend preparing food (Argenti 2000). Hence, the demand for more convenience and processed meals increases. Resource-poor groups have developed livelihood strategies with limited capital assets to meet these opportunities in urban areas (Maxwell *et al.*, 2000). 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. For example, in Accra, Ghana, with a population of over 3 million, 20.2% of females and 0.4% of males were employed in street vending (Maxwell *et al.*, 2000). A survey (Tomlins *et al.*, 2001) of 334 vendors and a mini census indicated that in Accra, Ghana, 16,000 street food vendors, employing about 60,000 people had an estimated annual turnover of over US\$100 million and an annual profit US\$24 million. In Senegal (1979) it was estimated 40,000 to 50,000 people were engaged in street food vending and 100,000 in Lagos (Dawson ?????) where 74% of vendors earned the minimum wage or greater. Street food vending has the potential to facilitate tourism but concerns about poor hygienic conditions Ghana Tourist Board (Anon 2002) warn that good food hygiene will facilitate growth of tourism in Ghana but if the poor hygienic conditions associated with traditional foods were not tackled it could drive tourists away.

Street vending can also increase in response to a declining economy or currency devaluation. For example Zimbabwe (Mbengeranwa 2001), and currency devaluation in Senegal and the Democratic Republic of Congo (Fouere *et al.*, 2000).

Street food vending and consumer health

The WHO (Anon 1996) reported that of 100 countries responding to a survey, that the majority had concerns about the contribution of street food vending to foodborne disease. However, figures quantifying the impact of foodborne disease on consumer health are hard to come by and those that are available are often difficult to interpret. In Accra, Ghana (Arde-Acquah 2000), the incidence of cholera and diarrhoea dramatically increased between 1995 and 1999 by 186% (1,028 to 2,973) and 562% (2,575 to 17,046). The reported occurrences of cholera differed widely within the metropolis suggesting varied social and economic conditions. This increase, however, was mainly associated with the impact of educational campaigns by local authorities and not necessarily to declines in the safety of food and the deterioration in the socio-economic status of the city. A traditional catering association (Arde-Acquah 2000) in Accra reported that 35% of 600 members suffered from typhoid of which some were street food vendors.

Importance of street vended foods to nutrition and food intake

Street food consumers are reported to come from all levels of society. In Accra, low and high income groups spend 40% and 25% of their household budget on street foods respectively (Maxwell *et al.*, 2000); children both purchase and consume a high proportion of street foods. Of the low-income group in Accra, it has been estimated that 30% of their calorie intake comes from street foods. In Kinshasa (Anon, 1997b), 38% of consumers 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). Street foods in Nigeria had acceptable levels of protein, fat and carbohydrate when compared to other foods consumed by urban dwellers (Sanni *et al.* 1999).

Social and cultural aspects of street food vending

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, 1997b, Myhara *et al.*, 2000, Obeng-Asiedu 2001, Tomlins 2001, Tomlins *et al.*, 2001a and b, Tomlins *et al.*, 2002). In Ghana, most female vendors had minimal or no education and the majority (75%) did not belong to vendors associations or pay taxes (Obeng-Asiedu 2001, Tomlins *et al.*, 2001a and b, Tomlins *et al.*, 2002). Levin *et al.*, 1999 reported that half economically active women in Accra, Ghana were engaged in petty trade and the preparation and sale of street vended foods. Men tended to earn more and were employed in skilled and unskilled labour (Ruel 2002). Compared to men, however, women spent more on basic goods and less on luxuries and were more reliant on interhousehold transfers. Ruel recommended that women in street vending be given more access to credit, work in a regulated and taxed environment. They should have more access to education and training and an improved regulatory environment.

Food safety of street vended foods

A WHO survey (Anon 1996) reported that the infrastructure in many of 100 participating countries was limited with restricted access to potable water (47%), toilets (15%), refrigeration (43%) and washing and waste disposal facilities. The majority of countries reported contamination of food and time and temperature abuse to be the major factors contributing to food borne disease. Most countries reported insufficient inspection personal, insufficient application of the HACCP concept and that registration, training and medical examinations were not amongst management strategies.

Street food vendors are frequently unlicensed and untrained in food hygiene or sanitation and work under very crude and unsanitary conditions. In Ghana, raw materials, for example meat (including game), may be obtained from unregulated sources (King *et al.* 2000). Left over food by street vendors in Ghana can pose a health risk to consumers where if not sold, it is mixed with new food the following day (Anon 2001). In Zaria, Nigeria, 26% of street foods sampled were contaminated with *B. cereus*, 15% with *S. aureus* (Umoh and Odoaba 1999). This can cause food poisoning as a consequence of the growth of *Staphylococcus aureus*, *Salmonella* spp., *Escherichia coli* and *Bacillus*

cereus (Bryan, 1995; Bryan et al., 1997; Jermini et al., 1997; Kampen et al., 1998, Tomlins et al 2000). A further risk may occur from the use of foods and raw materials that contain chemical contaminants such as benzoic acid, tetradifon and aflatoxin as reported in a survey of 74 samples of street food sold on the streets of Bangkok (Nednapis-Vatanasuchart, 1994). 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), in street foods in Bangkok (Dawson et al. 1996) and Accra, Ghana (Tomlins et al 2000).

HACCP has been suggested an approach for improving the safety of street foods in Africa (Ekanem 1998). In Ghana, an FAO funded study (Anon 1997) used a HACCP approach and recommended improved raw material handling and storage, thorough cooking, keeping food hot during display or reheating before serving and storing pepper source and dispensed drinks at 40C, keeping food above floor level and avoiding leftover food. Food handlers should be trained in food handling and personal hygiene. Microbiological analysis indicated that cooked and fried street foods were often re-contaminated by the vendors as a result of repeated handling and reintroduction of pathogens from pepper sauce.

Lead linked to male infertility (Anon 2003) but may not be associated with diet.

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.

WHO (Anon 1996) have recommended using the HACCP approach, as recognised by the Codex Alimentarius Commission, for improving the safety of street vended foods. Guidelines are given for setting the scope of a HACCP study. Priority should be given to street foods that are commonly implicated as vehicles for foodborne disease and to the types of vending operations where outbreaks of foodborne disease have been reported. Where information from foodborne disease surveillance programmes is not available, priorities should be based on four risk factors.

- a) Intrinsic properties of the foods involved. This can include raw materials known to be contaminated with microbial pathogens (for example raw meat at the slaughterhouse) and toxic chemicals (pesticides, fertilisers, heavy metals etc). Other factors include the properties (pH, water activity and redox potential) of the food that support the survival and or growth of microorganisms.
- b) Preparation and handling. Food operations that usually contribute to foodborne illness are preparing food in advance, poor storage and inadequate reheating of the food product. Foods that are thoroughly cooked just before consumption, food that has been processed and those that are well packaged may pose little hazard although chemicals and certain toxins would not be affected.
- c) Volume of food prepared. This influences the amount of food prepared in advance of sales and consumption.
- d) Susceptibility of consumers. Infants, children, pregnant women, the hospitalised, immuno-compromised persons and the elderly are more susceptible to foodborne disease than the general population.

Considering the HACCP team, the industry is usually primarily responsible for the application of HACCP. However, because the street food industry is comprised of a large number of individuals who often lack the collective organisation or resources to undertake a HACCP study, governments may initially need to assume this task. The role of the government is to conduct the HACCP in co-operation with street vendors. The team should consist of persons with skills in HACCP, food microbiology and street food vending operations. An anthropologist and a social scientist may be beneficial to understand factors leading to high risk activities with respect to food safety.

Pre-visits to vendors are recommended to gain confidence, co-operation and to observe operations. In the stages of developing a HACCP plan attention should be given to the critical control points which must be flexible and appropriate. Critical limits should be based on factors that can be measured quickly and easily by the street vendor. These can include sensory parameters such as visual and texture, for example, "meat juices running clear" or "boiling of liquids" often indicate thorough cooking.

Similarly appropriate monitoring procedures for street vending might include observations, sensory evaluations and physical measurements (temperature, time, and pH). Monitoring procedures and corrective actions to bring a CCP under control form the basis of the education and training requirements of street vendors. Verification procedures can be carried out by health personnel who are experienced in HACCP. This can be achieved by observations of operations at the CCP, calibration of monitoring instruments, collection of samples, interview street vendor and review documentation. Considering documentation, WHO acknowledge that street vendors are unlikely to keep records and that the understanding of the street vendor of the importance of CCPs, monitoring and corrective actions are more important.

Location, infrastructure and design of construction of street vending units

Street food vendors often trade around offices, factories, schools, markets, construction sites, beaches, lorry stations, commercial sites and along any street where large numbers of people congregate (George ????, Anon 1997, Obeng-Asiedu 2000, Laryea 2000). WHO (Anon 1996) recommend that street vendors should be officially recognised and where possible, be included in urban development programmes. Grouping street vendors together facilitates the provision of common facilities (potable water, electric supplies, waste disposal, drainage, toilets, parking etc). Additionally, common utensils can be centrally supplied and cleaned. The provision of such facilities is expensive and HACCP can be used to target where the installation of these facilities will bring the greatest benefit in protecting consumer health. The provision of such centralised facilities may be more successful where social and cultural factors of the communities are considered. For example, when possible, improved facilities should be kept as close to their current business sites as possible, even though some facilities might not be available. WHO also recommend consideration of the design of vending carts, stalls and markets to improve food safety. These can be changes that reduce the likelihood of cross contamination between raw and cooked food and use of potable water.

Food safety training

WHO (Anon 1996) recommend training in conjunction of licensing of street vendors along with on-going education. The training and education programmes should be based on the food safety hazards presented by the local street food situation. The minimal education of most vendors precludes them from training in HACCP principles. Training should use information gathered during HACCP studies to recommend monitoring procedures and corrective actions for training street food vendors. Furthermore, by identifying the critical practices of specific street food vending operations and by helping to rank operations according to risk, HACCP can be used to target education and training. All vendors of high risk foods should be trained in safe food handling practices and certification may encourage training.

Ghana Tourist Board (Anon 2002) now includes traditional caterers in its annual awards for best chop bar. A similar system has been reported in Kuala Lumpur (George ????). Participation of private sector in training by Unilever?

In Malaysia, Aziz (????) recommended training of food vendors through the mass media as the most cost effective use of resources. Also integrated health education approaches on a "stall to stall" basis were more effective than giving it on a large group basis. Appropriate codes of practice and guidelines on safe food handling should be established and introduced into the school curriculum.

Education of street vendors and consumers of street vended foods

WHO guidelines (Anon 1996) indicate that consumers are often unaware of the relationship between contaminated food and foodborne disease. Therefore, consumers need to be involved in efforts to improve the safety of street vended foods. WHO advises that consumers ensure the food has been thoroughly cooked and is still hot when served. Groups at particular risk in relation to foodborne illness are children and the elderly. Approaches to improve education may be integrated into general school and health education.

The FAO, in collaboration with the Government of South Africa, has created a series of educational products to help vendors, food inspectors and consumers make the sale of street foods safer and more profitable and have initiated a street food improvement programme in Senegal (FAO 2001).

Street vending can also impact on school children (Adum-Atta 2000). The education service is concerned about the lack of control over the quality and safety of food sold by street vendors despite

earlier efforts to work with them. School children can be exposed to insecurity, for example road accidents, when they leave the school to search for street vendors. In addition, juvenile delinquency can be high because once the school children have left the grounds, they may not return. Earlier efforts to have an integrated canteen policy have so far failed because of lack of resources and economic uncertainty. In the Philippines, the successful integration of street vendors into school catering operations were the political will of local authorities, school authorities (health officials, sanitary inspectors) and street food vendors (Guzman et al 1996).

Street foods and National food policy

The WHO (Anon 1996) recommends that policy, regulation, registration and licences should be developed in response to an integrated consultation with authorities (government), vendors and consumers. Up to 75% of countries report some regulation in the street food sector. HACCP is recommended for focusing regulations and inspection resources on the most critical foods and operations thus maximising the benefits to public health from limited resources. WHO recommend that street vendors should be licensed and has many advantages for authorities in raising revenue, identifying vendors and initiating a training policy. However, the WHO also recognises that licensing currently provides few advantages to vendors. Licensing procedures are often complex, require expenditure by the vendor with limited or no return and are perceived as a burden by street vendors. To encourage licensing, the WHO recommend centralising licensing requirements, remove the requirement for an annual medical inspection and make the issuing of a license dependent upon food safety knowledge derived from HACCP. Certificates might be awarded to trained food handlers. Renewal of licenses should be simplified, particularly for those vendors who are implementing proper control measures during food preparation.

In Accra, Ghana, the local authority (Accra Metropolitan Assembly) has the policy of not over-regulation the street food vendors since they recognise their important contribution (Fenteng 2000). However, the existing laws were the minimum required and in some cases only applied to office hours. Enforcement of the laws was difficult because the fines or penalties were very low (the value of the fines had been eroded by currency inflation) and hence did not serve as a deterrent. Other difficulties were the lack of trained staff, unavailability of transport and the uncooperative attitude of vendors and consumers. Licensing of many street vendors was difficult because they were itinerant and not easy to identify. In Malawi (Tenthani 1999), attempts by authorities to move street vendors to designated places have led to clashes with police. The vendors were concerned that being moved to one place would reduce their trade from impulse buyers. To resolve the dispute, the ministry offered to take representatives of the vendors to Lusaka, Zambia so that they could learn from their counterparts who now traded from designated areas.

In countries outside of Africa an integrated approach has been reported. For example, In Malaysia (Aziz ????, George ????), an integrated approach involving the city authority, consumers associations, veterinary department and non-governmental organisations was reported. Improving the infrastructure involved using experts with adequate training and expertise and supportive laboratory services. To achieve a national policy for street foods, national food laws and local authority's by-laws were updated to ensure they were complementary. Licensing was of three types to cater for the different needs of vendors. These were temporary of less than one month (special occasions, festivals etc), for one year or one month (depending on the type of stall) or indefinite periods (George ????). Relocation of street vendor stalls must maintain consumer access and take into account social as well as economic factors. Enforcement of food safety practices must be strengthened through modern food safety concepts such as HACCP and health education. Voluntary compliance must be encouraged but legal action should be carried out judiciously but firmly or as a last resort when other avenues have failed. Consumers must be able to play their role through appropriate associations. Financial support can be in the form of credit facilities to entrepreneurs in the street food sector, business subsidies in terms of maintenance of utilities (water, electricity) and tax exemptions or incentives. Similarly, Jayasuriya 1994, reported that effective regulation of the street vended food sector is possible only through a comprehensive system that considers the industry as a formal and legal activity that needs to fully integrated into the development process. Regulation of street vending must be broadened to include education, training, monitoring and supervision and must be in consultation with vendors and consumers.

In Thailand, a "clean food good taste" project involved a partnership between authorities and street vendors, quality assurance, sustainability and public awareness. It resulted in 5,377 (of 11,7311)

restaurants and 3,045 (of 6,843) vendors being awarded the Clean Food Good Taste logo subject to conformity to 12 practices involving good sanitation practices (Kongchuntuk 2002).

Discussion

This review suggests that in many African countries the sale of street food can play an important role in the urban economy, provide a source of nutrition for urban consumers and support the livelihoods of people employed in the sector.

However, while much has been reported, information is sparse. In many countries, for example, Ghana, Nigeria and Zambia, the importance of street food vending to society is being recognised to an extent. However, in some countries, for example, Zimbabwe, street food vending is a relatively new phenomenon and so vendors receive little support. Considering food safety issues, there are few comprehensive evaluations and surveillance programmes.

An integrated approach to improving food safety, consumer health and livelihoods involving a coalition of partnerships has been tried outside of Africa with some success. Projects funded the Crops Post Harvest Programme of the Department for International Development in Ghana, Zambia and Zimbabwe have been developing coalition partnerships comprising street food vendor organisations, food standards, local authorities, laboratory services and research organisations.

An issue influencing the sustainability of food safety management systems in many African countries is lack of access to reliable analytical resources. This is important for providing data on the extent and nature of the hazards. A further concern is the accuracy and reliability of the data from analytical laboratories. Under estimation of the hazard will lead to a risk to the health of consumers while over estimating will lead to risks for the livelihoods of the producers.

Issues are lack of information on knowledge management. Little knowledge regarding the demands and flows of information by stakeholders in the sector and how this is used. This may contribute to improving linkages, confidence in the approach and highlight new areas of research and knowledge. This will also assist policy makers and donor institutions in assisting and improving the sector.

References

Adum-Atta, M. (2000). Ghana Education Service (GES) position of food sold to school children in Accra. Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, pp 20 – 23.

Anon. (1996). Essential safety requirements for street-vended foods (revised edition), Food Safety Unit, Division of Food and Nutrition, World Health Organization, 35pp.

Anon (1997). Survey on the street food situation in Ghana (SFSIG), FAO report, 190pp.

Anon. (1997). Street foods, Report of an FAO technical meeting on Street foods, Calcutta, India, 6-9 November 1995, 63, 78pp.

Anon (1997a) Street food: small entrepreneurs, big business, FAO News and Highlights, 21 April 1997, 3 pages (www.fao.org/news/1997/).

ANON (1997b) Factfile: Percentage of women street food vendors, FAO, 1 page (www.fao.org/news/factfile/).

Anon. (1999). Ghana Living Standards Survey (GLSS), 1987-88 and 1988-89, World Bank report.

Anon. (2002). Traditional caterers urged to uphold personal hygiene, Ghanaian Chronicle (Accra), November 6, 2002. Published on the web at <http://allafrica.com/200211060576.html>.

Anon. (2003). Lead linked to male infertility, BBC news online, <http://news.bbc.co.uk/1/hi/health/2721669.stm>.

Arde-Acquah, A. (2000). Health related problems with street foods in Accra. Overview of recent cases. Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, pp 28 – 32.

Argenti, O. (2000), Feeding the cities: Food supply and distribution, 2020 Focus 3 (Achieving Urban Food and Nutrition Security in the Developing World), Brief 5 of 10, August 2000, International Food Policy Research Institute, Washington, D. C, USA.

Aziz, H. (?????). Hawkers' food in Malaysia – a reevaluation,

Carney D (ed), 1998, Sustainable Rural Livelihoods: What Contribution can we make?, DFID, July 1998

Dawson, R., Liamrangsi, S. and Boccas, F. (1996) Bangkok's street food project, Food, Nutrition and Agriculture, No 17-18, 38-46.

Dawson, R.J., & Canet, C. (1991). International activities in street foods. Food Control,2, 135-139

Ekanem, E. O. (1998). The street food trade in Africa: safety and socio-environmental issues, Food Control, 9, 211-215.

Ellis F, Trotter B, Magrath P, 1992, Rice Marketing in Indonesia: Methodology, Results and Implications of a Research Study, NRI Marketing Series Vol. 4

FAO (2001). Street foods made safer, FAO, 21 August 2001, <http://www.fao.org/news/2001/010803-e.htm>.

Fenteng, S. (2000). Regulatory control of food vending in Accra. Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, pp 46 – 52.

Fouere, T., Maire, B., Delpeuch, F., Martin-Prevel, Y., Tchibindat, F and Adoua-Oyila, G. (2000). Dietary changes in African urban households in response to currency devaluation: foreseeable risks for health and nutrition, Public-Health-Nutrition, 3, 293-301.

George, J. (1990) Towards more organised street-vending in Kuala Lumpur. Proceedings First Asian Conference on Food Safety. The Challenges of the '90s. Kuala Lumpur. 2-7 September 1990. pp. 135-8.,

Grosh M, Glewwe P, 1995, A Guide to Living Standards Measurement Study Surveys and their Data Sets, LSMS Working Paper No.120, May 5, 1995, World Bank

Golow, A. A. (1993) Some heavy metals accumulate more in the flesh of *Thryonomis swinderianus* (Lem), grasscutter, than in beef of *Bos* species, cow, Bulletin-of-Environmental-Contamination-and-Toxicology; 50, 823-827.

Golow, A. A. and Kwaansa-Ansah, E. E. (1994) Comparison of lead and zinc levels in the hair of pupils from four towns in the Kumasi municipal area of Ghana, Bull. Environ. Contam. Toxicol, 53, 325-331.

Guzman, P, E., Mondala, A. U., Aguinaldo, A. R., Magsaysay, C. G., Cuaderno, F. C., Castillo, E. V., Rosario, C. M., Bumanglag, M. M., Bautista, E. N., Umali, C. C., Aquino, M. T., Gastrock, F. L. and Pararan, E. M. (1996). Modelling the improvement of the quality and safety of street foods in the school, Philippine Journal of Science, 125, 15-36.

Haggblade & Gamser, 1991, A Field Manual for Subsector Practitioners, Gemini Technical Notes, USAID

Holtzmann J, Operational Guidelines for Rapid Rural Appraisal of Agricultural Marketing Systems, 1993, USAID.

Jayasuriya, D. C. (1994). Street food vending in Asia: some policy and legal aspects, *Food Control*, 5, 222-226.

King, L. K., Awumbila, B., Canacoo, E. A. and Oforu-Amaah, S. (2000). An assessment of the safety of street foods in the Ga district of Ghana; implications for the spread of zoonoses, *Acta Tropica*, 76, 39-43.

Kongchuntuk, H. (2002). Thailand's food safety project on restaurants and street vendors: the "clean food good taste" project, FAO/WHO Global Forum of Food Safety Regulators, Marrakech, Morocco, 28-30 January 2002, 4pp.

Laryea, J. (2000). Improvements to street food vending in Accra. Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, 23 – 27.

Levin, C. E., Maxwell, D. G., Armar-Klemesu, M., Tuel, M. T., Morris, S. S. and Ahiadeke, C. (1999). Working women in an urban setting: traders, vendors, and food security in Accra, International Food Policy Research Institute, NY, USA, 33pp.

Maxwell, D., Levin, C. Armar-Klemesu, M., Ruel, M., Morris, S. and Ahiadeke, C. (2000). Urban Livelihoods and Food and Nutrition Security in Greater Accra, Ghana, International Food Policy Research Institute, Washington, USA, 190pp.

Mbengeranwa, O. L. (2001). Report on the City Health Department 2001, City of Harare, Zimbabwe, annual report of the City Health Department 2001, i – vii.

Myhara, M., Tomlins, K. I., Johnson, P. N., Obeng-Asiedu, P. and Greenhalgh, P. (2000). Implementation of quality management systems to control food safety hazards of street-vended foods in Ghana, pp 1. Poster presented at a forum organised by Food Control and Georgetown Center for Food and Nutrition Policy, December 4 – 5, 2000, Georgetown University, Washington DC, USA.

Obeng-Asiedu, P. (2000). Socio-economic survey of street vended foods in Accra, In: Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods, Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, pp 20 – 23.

Oguntona, C.R.B and Kanye, O. (1995) Contribution of street foods to nutrient intakes by Nigerian adolescents. *Nutrition and Health*. 10, 165-171.

Orriss, G. D. (2002). Food Safety Capacity Building, FAO/WHO Global Forum of Food Safety Regulators, Marrakesh, Morocco, 28-30 January 2002

Raja, T. K., Othman, O. C. and Bahemuka, T. E. (1997) Levels of crude proteins and some inorganic elements in selected green vegetables of Dar es Salaam, *Journal of Food Science and Technology*, India, 34, 419-422.

Ruel, M. (2002). Ghana: Accra urban food and nutrition study, International Food Policy Research Institute, Washington, USA.

Sanni, S. A., Oguntona, C. R. and Sanni, L. O. (1999). Chemical and nutritional composition of some common foods in Abeokuta, Nigeria, *Brazilian Archives of Biology and Technology*, 42, 331-337.

Scoones I, 1998, Sustainable Rural Livelihoods: A Framework for Analysis, IDS Working Paper No. 72, June 1998.

Tenthani, R. (1999). Malawi seeks to remove vendors from streets, Panafrican News Agency, August 26, 1999, http://www.africanews.org/south/malawi/stories/19990826_feat1.html.

Tinker, I. (1997). *Street foods: urban food and employment in developing countries*, Oxford University Press, New York.

Tomlins, K. I. (2001). Heavy metals, pesticides and mycotoxins in street-vended foods, In: *Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods*, Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra, 25 – 26 September 2000, Eds, Johnson, P. N. T. and Yawson, R. M, Food Research Institute, Box M20, Accra, Ghana, pp 20 – 23.

Tomlins, K. I., Johnson, P. N., Obeng-Asiedu, P. and Greenhalgh, P. (2001)a *Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods*, Final Technical Report, R No 7493 (ZB0199), NR International, Chatham, UK.

Tomlins, K. I., Johnson, P. N. T. and Myhara, B. (2001)b. Improving street food vending in Accra: Problems and prospects, In: *Food safety in crop post harvest systems*, Proceedings of an international workshop sponsored by the crop post harvest programme of the United Kingdom Department for International Development, Harare, Zimbabwe, 20-21 September 2001, Eds, Sibanda, T. and Hindmarsh, P, 30-33.

Tomlins, K. I., Johnson, P. N., Obeng-Asiedu, P., Myhara, B. and Greenhalgh, P. (2002). *Enhancing product quality: Street food in Ghana: a source of income, but not without its hazards*, PHAction News, 5, (<http://www.iita.org/info/phnews5/content.htm>).

Trotter B, 1992, *Applying Price Analysis to Marketing Systems: Methods and Examples from the Indonesia Rice Market*, NRI Marketing Series Vol. 3

Umoh, V. J. and Odoaba, M. B. (1999). Safety and quality evaluation of street foods sold in Zaria, Nigeria, *Food Control*, 10, 9 – 14.

Wallace, P. A., Marfo, E. K., and Plahar, W. A. (1998) Nutritional quality and antinutritional composition of four non-conventional leafy vegetables, *Food-Chemistry*, 61, 287-291.