Impact of adoption in Ghana of an improved fish processing technology on household income, health and nutrition

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Abstract

Surveys were conducted in three fishing communities in Ghana, where an improved fish smoking technology (the Chorkor smoker) had been introduced previously, to assess the impact of adopting the improved technology on household income, health and nutritional status. Fifty-one fish processors (all women), who had adopted the improved fish processing technology, were selected for the study, in which the participatory rural appraisal (PRA) technique, nutritional survey methods and structured questionnaires were used to obtain both qualitative and quantitative data. The results revealed that there was an improvement in economic activities. This resulted in a positive impact on household income and food consumption patterns of the processors. Improvement in household income resulted from increases in the quality and quantity of output, price per unit output and profits. Improvement in food consumption pattern was mostly in respect of quality and quantity of food intake, but the types of food consumed remained the same. The nutrient intake of the respondents was good on average, with a majority exceeding the recommended daily allowance (RDA) of protein, vitamin B1 and calcium. The average body mass index (BMI) of the processors was also within the ideal range of 20–25. Adoption of the new technology also improved the health status of the respondents. Lessening of eye problems and headaches as a result of reduced exposure to smoke and heat was reported by 52% of the women. However, preschool children were undernourished as a result of poor child feeding practices. In any technology transfer process, apparently unrelated nutritional factors need to be considered.

Keywords Fish processing technology, household income, health, nutrition.

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Introduction

Fish constitute the major source of animal protein intake in Ghana, with marine fish accounting for nearly 80% of the fish production.[1] The large quantities of different species of fish landed during the high season are preserved by one of several traditional processing techniques to avoid excessive wastage.[2–4] Smoking and drying are the most widely used techniques for fish preservation in Ghana. To improve the quality and availability of fish and to enhance socio-economic well-being and, hence, the family nutritional status of fishing communities, improved versions of traditional fish smoking techniques have been developed. This has been assisted by the Ghana/Netherlands Artisanal Fish Processing and Applied Research Project (AFPP).

The main objectives of the AFPP were to contribute to increased availability of, and access to, quality fish products for the rural population through improved fish preservation, and also to reduce post-harvest losses, in order to enhance the economic position of those involved in artisanal fishery activities.[5] The major components of the project include an applied training programme aimed at achieving these objectives through the development, dissemination and adoption of improved fish preservation methods and techniques. Under the project, improved processing and preservation technologies were disseminated in 14 fishing communities in Ghana. Training programmes were held under AFPP for several extension workers throughout Africa for the dissemination of the improved technologies as well as research findings.

Traditionally, fish processing is undertaken in round mud ovens with a single platform above the combustion chamber, onto which a single layer of fish is loaded ready for smoking. The improved version of the traditional oven consist of a 65-cm-high rectangular combustion chamber made of burnt bricks with stock holes leading to fire pits and a set of framed wire mesh trays

(usually 10). The rectangular trays make up the smoking unit when stacked up on the oven, each loaded with one layer of fish. The perceived advantages of the improved technology over the traditional one include an increased smoking capacity, full economy and a better quality product.[2]

Results of baseline socio-economic studies conducted in the fishing villages before the introduction of the improved technology indicated very poor general living conditions in all the villages.[6–8] Specifically, the studies identified poor health of the people, low levels of income and consequent poverty, inefficient processing operations and poor quality of diets as the main problems in the fishing villages. It was against this background that the improved fish processing technologies were disseminated to the villages to enhance production, efficiency and improve the socio-economic and nutritional status of the people.

Although a high rate of adoption of the improved technologies has been reported, post-adoption impact studies have not been undertaken. Not much information is therefore available on the effectiveness and usefulness of the technologies in improving the socio-economic, health and nutritional status of the people. Such evaluation information is necessary to enhance strategies for the dissemination of the effectiveness of such technology. This study was therefore planned to assess the implications of the extended technologies and their adoption on the socio-economic, health and nutritional status of the village people.

Research design and methodology

Survey area and sample

Three pilot fishing communities, where the improved fish smoking technology had been introduced over 5 years ago, were selected for the adoption and impact assessment studies. The villages include Tema Manhean, Lekpongunor and Akplabanya, all in the Greater Accra region of Ghana. The sample included fish processors who have adopted the improved technology. In all, 51 fish processors (all women) were interviewed. Fish processing in Ghana is done almost exclusively by women.

Survey methodologies

Methods used in the determination of the impact of adoption of the improved technology on household income, food consumption patterns, quality of family diet, family health and nutrition involved interviews using structured questionnaires, anthropometry (weight, height) and nutritional evaluation of foods. In addition, formal and informal interviews were conducted with a total of nine key informants selected from the survey areas.

Determination of impact of adoption on nutritional status

A 24-h dietary recall method was used to collect information on food intake of the respondents. This information was converted into quantitative data using Ghana Food Composition Tables.[9] Nutritional anthropometry was used to assess the nutritional status of the respondents as well as preschoolers in the household. Additionally, the data on household food consumption patterns and the dietary quality analysis were used to determine whether individual recommended daily allowances (RDAs) were being satisfied. Some nutritional indicators used include weight-for-age and weight-for-height to classify the nutritional status of preschool children. Weight-for-age (W/A) was based on the WHO recommendation.[10] Children falling below 80% of the standard were considered as being malnourished or 'at risk'. Weight-for-height (W/H) was based on the Waterlow *et al.*[11] classification, and children falling below 80% of the standard were considered malnourished. BMI was used to determine adult nutritional status. Using the Dugdale[12] classification, women with a BMI below 20 were considered as underweight, 20–25 as normal, 26–27 as overweight and above 27 as obese. All the quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) program, version 8.0.

Results and discussion

Background information on respondents

The ages of the respondents ranged between 30 and 70 years. Almost half (47%) were above 50 years of age,

with an average age of 46 years. The implication is that fish processors in Ghana tend to be old. There is therefore a need to make improved fish processing technologies more attractive to the younger women for the sustainability of the village fish processing industry.

With regard to education, a large proportion of the respondents were illiterate. Only 10% had had formal education up to primary school. The rest had no formal education. However, it was observed that the educational level of the processors did not influence the technology adoption. The improved fish processing technology is not complex and, therefore, the level of education is not likely to play much role in the adoption process, although it would be an advantage in terms of management and record keeping.

Of the sample interviewed, 86% were married, 12% widowed and 2% single, with the number of surviving children ranging between one and 10. The average number of children per parent was six. In terms of social obligations in a typical Ghanaian household, men were found to be responsible for the provision of income to support the family, whereas women are home-makers in charge of food preparation, child care and other domestic activities such as cleaning, washing, sweeping, etc. Although men are generally the heads of the families, some of the respondents were household heads and the main contributors to household income. These women take their own decisions and perform the functions of both men and women.

The primary source of income of the respondents was fish processing. Secondary income sources included farming, petty trading and food preparation for sale. About 47% of the respondents were found to depend on petty trading and food vending during the off fishing season for their livelihood, while 12% engaged in farming. Forty-one per cent depended solely on fish processing for their income throughout the year, by purchasing frozen fish from cold stores in the cities during the off season to process.

Conceptual framework used for analysis of results

The following concept for the process of growth of household members forms the framework for discussing the impact of the adoption of improved fish preservation technology on the nutrition and health of household members (Fig. 1). It is assumed that new technology resulting in improved economic activity will have a positive impact upon the household. A positive impact is expressed as an upward trend in household incomes, either continued increases or fluctuations in certain economic indicators. A negative impact is depicted by the absence of change or decreases in these indicators. Selected indicators of household income are quantity and quality of output accruing from economic activity, price per unit of output, income generated, profits and fluctuations.

Positive changes resulting from adopting the improved technology are depicted as increased quantity and quality of output, increased incomes and rising profits. Positive changes in these factors are expected to have an effect upon household expenditure. This is because households will increase their expenditure on food as increased returns from economic activity enable them to afford food items of better quality and quantity. There should therefore be increased expenditure on food and improvements in the nutritional status of the household. The increased expenditure on food will be revealed in improvement in the types of food consumed, number of meals per day and both quality and quantity of food.

Improvement in nutritional status should bring about better health conditions for household members, which will be reflected in their physical growth. In this manner, the adoption of the improved technology will impact upon the health and growth of the household. A more direct benefit, in which the use of the improved technology has an immediate effect upon the health of the users, is achieved through the reduction of health hazards and strenuous procedure involved in the economic activity.

Impact on household income

The focus of the study was on the changes in household income, which were directly attributable to the adoption of the new technology. Positive impact was expressed in terms of increases and fluctuations in income, and negative impact in terms of lack of change and/or decrease in income. Indicators of household income were output quantity, output quality, price per unit of fish, income, profit and expenditure. It was observed that a majority

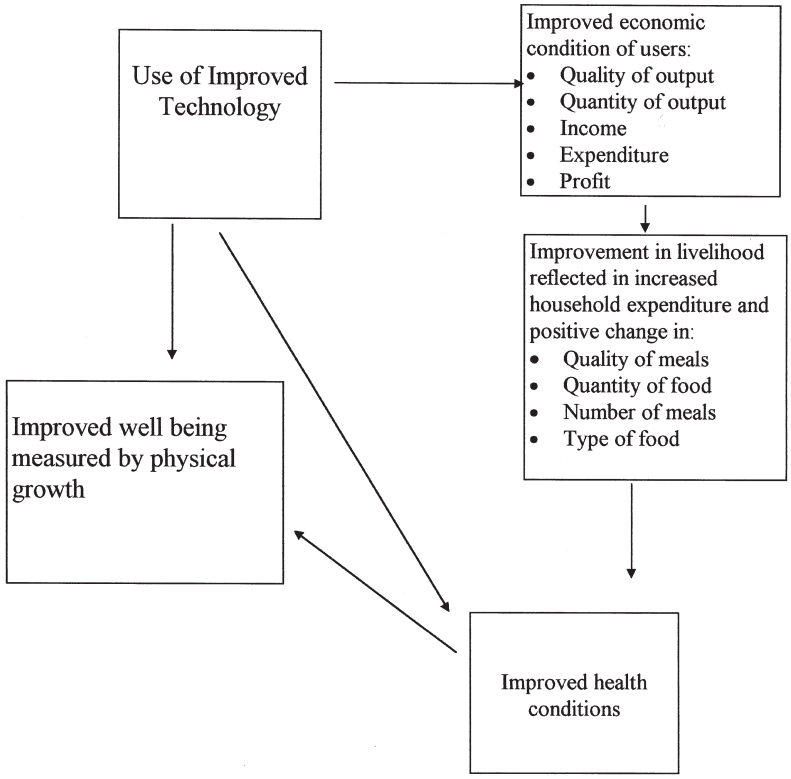

Figure 1 A model of the impact of adoption of the Chorkor smoker, an improved fish processing technology, on household economy, health and nutrition.

of the women are now economically empowered by the adoption of the improved technology. Some of the women own properties such as buildings, boats and fishing nets. They also performed most of the responsibilities of men, namely supporting the family financially and paying the children's school fees.

As shown in Table 1, all the respondents reported a positive impact on output quality. Again, almost all reported a similar impact on output quantity. Roughly 80%, 92% and 67% indicated a positive impact on price per unit, income and profit respectively. Similarly, over 90% reported increased expenditure after the adoption of the technology. Reasons assigned to the increase in output quantity were reduction in smoking period and the relatively larger oven capacity of the improved technology. The approximately 75% increase in the unit selling price of smoked fish resulted from the fact that better quality fish processed attracted higher prices on the market. These factors contributed significantly to the improvement in income levels of the processors as well as to better standards of living. Few respondents complained of the erosion of profits associated with the improved technology, as a result of high input and maintenance costs or seasonal trends in volumes of fish leading to fluctuation in prices.

Impact on food consumption patterns and quality of food at household level

The main staple foods in the survey areas were corn, cassava and plantain. Fermented corn dough porridge with bread was the popular breakfast meal. Fish, which was the main source of protein in the area, was consumed in the smoked form or freshly boiled. Increased household expenditure was expected to be reflected in economic activity as well as in the pattern of food consumption. Indications of the extent to which increased expenditure was reflected in food consumption

Table 1 Impact of technology on household income

	% Respondents indicating			
	Decreased	Same	Increased	Remarks
Output (quality)	–	–	100	Better quality fish
Output (quantity)	–	2.1	97.9	Increase of about10-fold in processing capacity
Price/unit output	–	18.75	81.25	Attract higher prices (75% increase) as a result of better quality fish
Income	–	8.33	91.67	Increase in price per unit output and quantity of fish processed
Expenditure	2.1	2.1	95.8	High cost of inputs and maintenance
Profit	10.42	22.92	66.67	Increase in price

Table 2 Changes in quality, quantity and type of food consumed as well as frequency of consumption

Parameter	Frequency	% indicating
Type of food consumed		
Change	7	14.0
No change	44	86.0
Meal size and quality of food		
Larger size, better quality	30	59.0
Same size, better quality	21	41.0
No change	–	–
Frequency of consumption		
Improved frequency	40	78.4
No change	11	21.6

Table 3 Average daily nutrient intake of respondents in survey areas

	Survey area			
Nutrient/ energy	Study area 1 (n = 12)	Study area 2 (n = 21)	Study area 3 (n = 18)	Overall (n = 51)
Calories				
Respondent	1441.47	2058.22	1870.90	1855.26
% RDA	72.07	102.91	93.54	92.76
Protein (g)				
Respondent	70.90	118.97	102.63	101.83
% RDA	161.15	270.40	233.26	231.43
Vitamin B1 (mg)				
Respondent	1.01	1.05	1.17	1.09
% RDA	101.05	105.41	117.06	108.78
Vitamin B2 (mg)				
Respondent	0.65	1.07	0.86	0.89
% RDA	54.11	89.05	71.70	74.54
Calcium (mg)				
Respondent	1293.09	1871.87	1256.48	1508.46
% RDA	161.64	233.98	157.06	188.55
Iron (mg)				
Respondent	13.52	17.41	12.85	14.81
% RDA	75.14	96.76	71.41	82.30

patterns and food quality are shown in Tables 2 and 3 respectively.

With regard to changes in the types of food consumed, 86% of the respondents reported no change in the type of staple foods and eating habits. The reason given was that they enjoyed their traditional foods. Although there was no change in the types of food consumed, 59% reported larger meal sizes and better quality of meals. For the remaining 41% of the respondents, although meal sizes remained the same, the quality of the meals improved. In terms of frequency of consumption, 78% indicated an improvement in the frequency of consumption of meals. They could now afford three main meals a day, instead of two meals. Thus, where there were positive changes in food consumption, these were mostly with respect to the quality and quantity of the meals consumed as well as the frequency of meal consumption.

Analysis of the 24-h recall of the respondents revealed that the RDA of most nutrients was being met (Table 3). The percentage RDA (% RDA) showed that protein, vitamin B1 and calcium requirements were exceeded by respondents in all the survey areas. Protein intake, for example, was more than 200% of the RDA. This is obviously because of access to and high intake of fish by the respondents. Because of the abundant availability, fish is consumed in more than adequate

quantities in at least two main meals. The dietary recall also revealed that even those who did not cook most of the main meals themselves always had a lot of fish with food bought from vendors. Calcium intake was found to be high because small species of fish are abundant in these areas and these are consumed whole. Although respondents did not fully meet the average daily requirement for energy, vitamin B2 and iron, the percentage RDA for these showed that their meals were not very deficient in them. On average, 93% of the energy requirement was being met, whereas vitamin B2 and iron requirements were being met at 75% and 82% respectively.

Impact on nutritional status

The BMI results of respondents are presented in Table 4. Sixty-five per cent of the respondents had normal body weight with reference to height. The overall average BMI of the survey areas as well as the overall average BMI of the respective areas were within the normal range of 20–25, indicating that most of the women have good nutritional status. However, 35% of the women were at risk. Twelve per cent of the women were overweight, and 6% were obese, whereas 17% were underweight, with a BMI below 20.

In spite of the improved food consumption and nutritional status of adults in the survey areas as a result of the adoption of the improved technology, weaning-age children were found to be undernourished. The weight-for-age (W/A) curves of the children (both boys and girls) deviated drastically when compared with the WHO reference, indicating malnutrition and being underweight (Fig. 2A and B). In both cases, the deviation was about 20% from the WHO reference. Although the weights of the boys began to improve around 11 months of age, those of the girls consistently remained at 80% of the reference. Weaning foods given to children in the villages were normally starchy foods low in food nutrients. A drop in weight observed in both groups around the age of 3 months resulted from the fact that most mothers in Ghana introduce weaning foods around 3–4 months. The initial 'nutritional shock' from the relatively poor quality weaning foods was responsible for the decrease in weight observed. There was, however, an immediate recovery from the age of 5 months. Although there is abundant fish in the villages, the form in which it is given may not be easily assimilated by young children. Secondly, feeding these

Table 4 Average percentage body mass indices (BMIs) of respondents

Body mass index (BMI = WT/H^2)	Percentage respondent			
	Study area 1	Study area 2	Study area 3	Total
<20	3.85	5.77	7.69	17.31
20–22	11.54	21.15	9.62	42.30
23–25	1.92	7.69	13.46	23.08
26–27	1.92	5.77	3.85	11.54
>27	3.85	1.92	0	5.77
Total	23.08	42.30	34.62	100

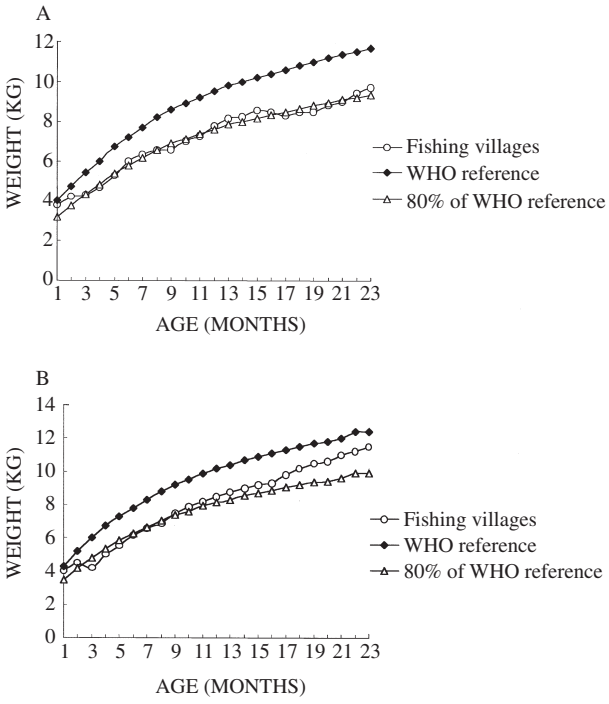

Figure 2 Weight-for-age curves for weaning-age girls (A) and boys (B) in fishing villages compared with the WHO reference.

children was mostly left to older unsupervised children, and this could lead to poor feeding practices. It became obvious that the combined effects of ignorance resulting in poor feeding practices and seemingly high WHO reference values accounted for the poor child nutritional status observed in these areas.

Impact on health status

Improvement in health, as reported by 52% of the respondents, included lessening of eye problems, headaches and fever attacks. The main reason for lessening of eye problems and headaches was traced to reduced exposure to smoke and heat when using the improved technology. Better living conditions might have accounted for the improvement in fever attacks. Twenty per cent of the respondents reported that there had been no change in health status attributable to the adoption of the improved technology, whereas 10% reported bodily pains and fatigue after the adoption of the technology, and 18% complained of chest pains. These physical effects may be attributed to the effort required in lifting the trays while smoking.

Conclusions and recommendations

Based on the results of the study, it was concluded that the adoption of the improved fish preservation technology improved the socio-economic status, household income, dietary quality and nutritional status of the processors. However, lack of knowledge on proper child feeding practices contributed to the poor nutritional status of weaning-age children in the villages. As a number of extension officers in the region have been trained in the improved technology, the wider implications of the results of this study are that poverty reduction and improved nutritional status of fish processing communities in Africa could be greatly enhanced. It is, however, recommended that apparently unrelated factors, such as nutrition education, need to be considered in a technology transfer effort.

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References

1. Plahar, W.A., Nti, C.A. & Steiner-Asiedu, M. (1997) *Fish Consumption Patterns in Ghana and Fish Quality at Household Level.* Proceedings of a workshop organised by AFPP. Food Research Institute, Accra.
2. Okraku-Offei, G.A. (1970) *Processing and Preservation of Fish in Ghana.* FRI Project Report. Food Research Institute, Accra.
3. Nerquaye-Tetteh, G.A. (1979) *The Traditional Post-harvest Fish Processing Technology in Ghana.* FRI Project Report. Food Research Institute, Accra.
4. Nerquaye-Tetteh, G.A. (1989) *Extension of Research Results to End-users: Success Stories and Failures – a Case Study of the FAO/Chorkor Smoker.* FRI Project Report. Food Research Institute, Accra.
5. Ghana/Netherlands Fish Project Document (1988) *Regional Training and Applied Research Project for Artisanal Fish Processing in West Africa.* Food Research Institute, Accra.
6. Lokko, P. (1984) *Extension of a Practical Village Level Fish Smoking Technology with Women in Coastal Ghana (Chorkor and Akplabanya).* UNICEF, Accra.
7. Lokko, P. (1990) *Baseline Socio-economic studies of Nungua and Tema U Compound – Two Pilot Fishing Villages in the Greater Accra Region of Ghana. Ghana/Netherlands Artisanal Fish Processing and Applied Research Project Report.* Food Research Institute, Accra.
8. Lokko, P. & Ansong, S. (1994) *Post Adoption Impact of the Introduction of the Chorkor Smoker to Pilot Villages.* FRI Project Report. Food Research Institute, Accra.
9. Food Research Institute (1975) *Ghana Food Composition Tables.* Food Research Institute, Accra.
10. WHO (1983) *Measuring Changes in Nutritional Status*. WHO, Geneva.
11. Waterlow, J.C., Bizina, R., Keller, W., Lane, J.M., Nickman, M.Z. & Tanner, M. (1977) The presentation and use of height and weight for comparing the nutritional status of groups of children under the age of ten. *WHO Bulletin* **55** (4), 489–498.
12. Dugdale, A.E. (1985) Family anthropometry: a new strategy for determining community nutrition. *Lancet* **21**, 672–673.

