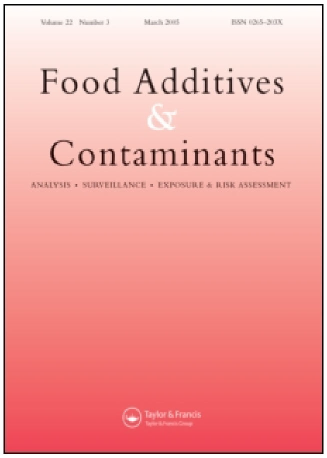

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Public information campaign on aflatoxin contamination of maize grains in market stores in Benin, Ghana and Togo

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Abstract
Rotary International with the International Institute of Tropical Agriculture (IITA) conducted an information campaign from 2000 to 2004 to increase public awareness of aflatoxin in Benin, Ghana and Togo. Key informant interviews with 2416 respondents showed poor baseline knowledge of aflatoxin and its health risks. The campaign included monitoring of aflatoxin contamination in maize grains from market stores in 38 cities and towns. Aflatoxin concentration in contaminated samples ranged from 24 to 117.5 $ng\,g^{-1}$ in Benin, from 0.4 to 490.6 $ng\,g^{-1}$ in Ghana, and from 0.7 to 108.8 $ng\,g^{-1}$ in Togo. The campaign significantly increased public awareness that populations were exposed to high levels of aflatoxin. The number of maize traders who were informed about the toxin increased 10.3 and 3.2 times in Togo and Benin, respectively; at least 33% more traders believed the information in each of Benin and Togo; 11.4 and 28.4% more consumers sorted out and discarded bad grains in Benin and Ghana, respectively. This paper concludes that sustained public education can help reduce aflatoxin contamination.

Keywords: *Survey, aflatoxins, animal feed, cereals and grains*

Introduction

In West Africa, maize (*Zea mays* L.) is a principal staple food and an important ingredient of animal feed. In field and storage, maize is infested by arthropods and pathogens which reduce the quantity and quality of harvests (Cardwell 1996; Sétamou et al. 1997; Hell et al. 2000; Adda et al. 2002). One of the most common of these pathogens is the fungus *Aspergillus flavus*, which produces aflatoxin, especially on stored produce and feed ingredients. Aflatoxin contamination of stored maize is common in Benin (Hell et al. 2003) and Ghana (Kpodo et al. 2000). Consumption of aflatoxin contaminated cereals and grain is a major health risk. Recently in Kenya, for example, acute aflatoxin poisoning through consumption of maize grains contaminated by the toxin over two years caused more than 100 human deaths (Azziz-Baumgartner et al. 2005). Chronic exposure to aflatoxin is more insidious than is acute poisoning. Aflatoxin poisoning aggravates kwashiorkor in children, increases risk of liver cancer (Peers et al. 1987; Wild 1993), retards child growth and development (Gong et al. 2002; Cardwell and Henry 2004; Egal et al. 2005), and undermines immune systems (Turner et al. 2003; Jiang et al. 2005). In poultry, aflatoxin-contaminated feed causes stunted growth, reduced productivity and death of the birds (Hamilton 1971). Aflatoxin contamination also acts as a trade barrier on export markets (Wu et al. 2004).

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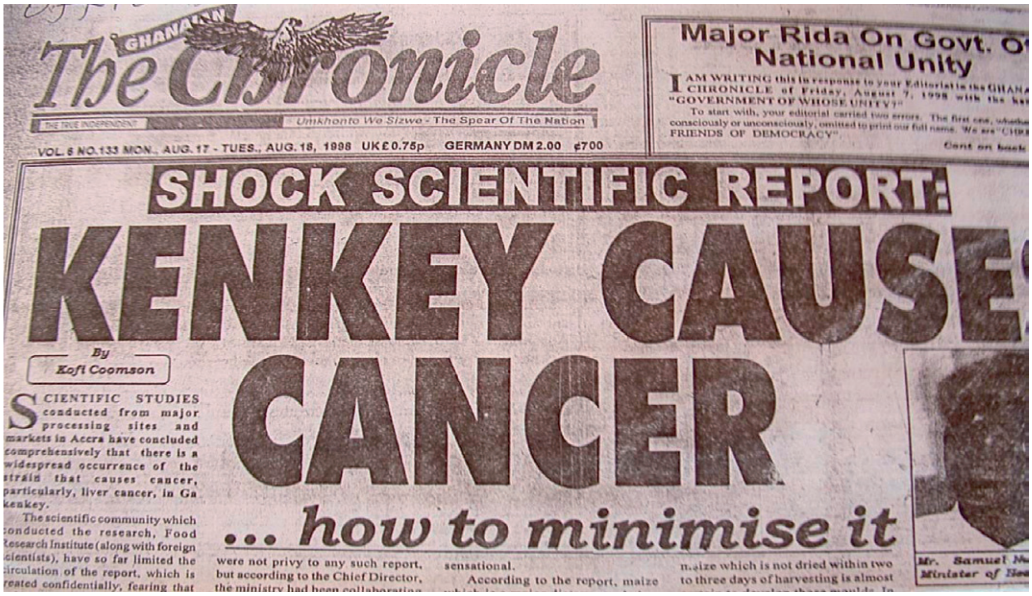

Figure 1. Aflatoxin scare by a newspaper article in Ghana, 1998.

Standards for allowable limits of aflatoxin in food for human consumption vary from country to country. The allowable level is 5–20 ng g^{-1} in Canada and the USA, 4 ng g^{-1} in France and the Netherlands, and 30 ng g^{-1} in India (Henry et al. 1999; FAO 2004). Generally, 4–30 ng g^{-1} is widely recognized as the acceptable limit of aflatoxin in food (Williams et al. 2004), and 20 ng g^{-1} as an internationally recommended maximum limit of aflatoxin contamination (FAO 2004). In West Africa, committed national efforts are lacking to increase public awareness of the toxin and its impact on health and food security. In 1998, such a situation in Ghana led to public panic triggered by a sensational front page newspaper report (Figure 1) that 'kenkey', a common maize-based food, contains aflatoxin and causes cancer (Anon. 1998).

In 2000, concerns about poor public awareness of aflatoxin in West Africa led to a partnership between researchers and Rotary Clubs in Ghana, Benin, Togo, France and the USA. The partners aimed to increase public awareness of aflatoxin and its health risks, and thereby help reduce cases of aflatoxin contamination in the three West African countries. The technical partners, the International Institute of Tropical Agriculture (IITA) and national food standard boards in Benin, Ghana and Togo had on-going activities and prior experience to contribute to the information campaign. Rotary International provided a worldwide network of business and professional leaders dedicated to humanitarian services to contribute to and benefit from the campaign. This paper summarizes results of the information campaign.

Materials and methods

To demonstrate the prevalence of aflatoxin in Benin, Ghana and Togo, 1219 maize grain samples (0.5 kg each) were collected from market stores in 38 cities and towns (Figure 2) and analysed for aflatoxin content. In Benin and Ghana, each market store was sampled three times: May 2000, and January and July 2001. In the first sampling period the sample size per administration region was 50 in each of Northern, Central and Southern regions, and 19 in South-eastern regions of Benin. In each of the second and third sampling periods in Benin, the sample size was 50 for each of the regions except no sample was collected during third sampling period in the Southern region. In Ghana, the sample size was 40 for each of the three sampling periods in each of Greater Accra, Central, Ashanti, Brong-Ahafo and Eastern regions. In Togo, 100 samples were collected and analysed, but in 2000 only. Traders or storeowners provided information on source of grains and duration of maize storage in the markets.

Each sample was placed in paper bags and stored at -20°C pending analysis. Aflatoxin was extracted and quantified in each sample according to methods used by Thomas et al. (1975). Aflatoxin extracts were spotted on pre-coated thin-layer chromatography plates and aflatoxin contamination levels determined using a fluorescence densitometer (Shimadzu, model 9301(PC)S, Kyoto, Japan). The calculated aflatoxin concentration per sample was grouped into two categories of contamination levels as per Cardwell (1996): percentage of samples with less than 20 ng g^{-1} aflatoxin represented low

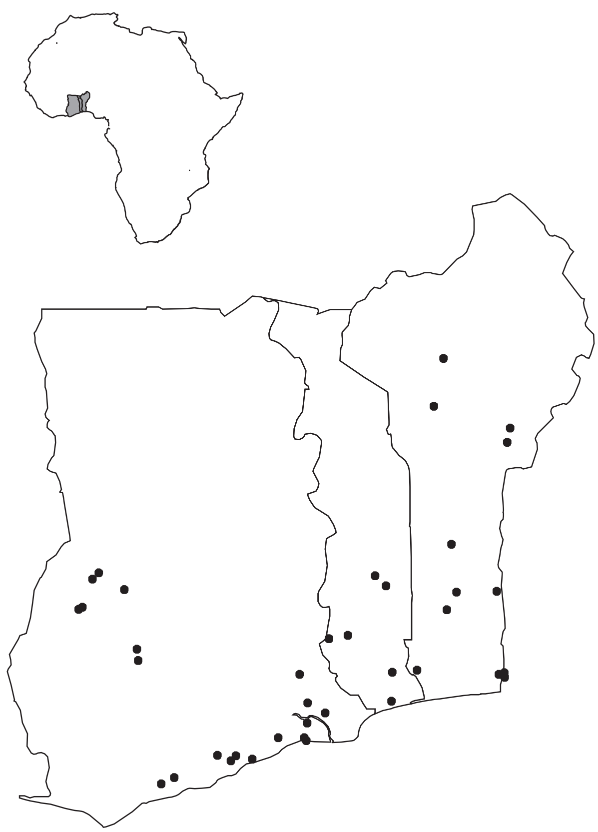

Figure 2. Aflatoxin monitoring sites in (left to right) Ghana, Togo and Benin, 2000 and 2001 (the insert shows a map of Africa showing the location of the three West African countries).

contamination, and percentage of samples with more than 20 ng g^{-1} aflatoxin represented high contamination.

The aflatoxin information awareness campaign was initiated in 2000 with a public opinion survey to provide baseline information on respondents' knowledge of the toxin, the health and productivity risks it poses, and of agronomic and grain storage practices to limit grain contamination by the toxin. The survey was conducted with 681 maize farmers, 760 market traders, 685 consumers, 227 poultry farmers, and 63 feed mill operators in Benin, Ghana and Togo. Results of the survey guided the development of a shared vision on campaign theme, messages and approach at a professionally facilitated subregional stakeholders' communication workshop (James et al. 2000). Workshop participants were representatives of the target groups covered in the public opinion survey, media houses, national policy/decision-makers concerned with agriculture, health and trade and Rotary Clubs in Benin, Ghana, and Togo.

In small group sessions, participants proposed 16 campaign themes. At plenary, participants selected 'Quality maize for better health: this is a message from Rotary International' as the campaign theme. To support delivery of the theme, workshop participants agreed upon a set of 23 mutually reinforcing messages on known practices that promote aflatoxin contamination and research recommendations to limit or prevent mouldiness and pest infestations which predispose grains to infection by *A. flavus*. The messages emphasized timely harvesting, thorough drying of maize cobs and grains, sorting to remove damaged and discoloured grains at storage and shelling, and grain storage in well ventilated structures (Hell et al. 2000; Adda et al. 2002). The workshop also drafted a set of promotional materials to accompany the campaign messages.

National communication workshops adapted the messages and promotional materials to meet country-specific peculiarities. In Ghana, whilst the word 'aflatoxin' was used in the campaign, the partners adopted 'mouldy maize' as a proxy for aflatoxin contamination in most statements during campaign activities. This was to avoid scaring the public away from the campaign, especially in light of a 1998 newspaper headline which suggested that a local staple maize-based food causes cancer because it contains aflatoxin (Figure 1). This cautionary approach guided campaign delivery in the other countries. Promotional materials were also adapted to country-specific needs. In Benin and Ghana, maize cobs were printed on promotional materials, but in Togo the partners adopted maize grains in order to avoid inadvertent association with a political party that has maize cobs as its logo.

In 2001, the regional campaign was launched in Lomé, Togo, by the Togolese Prime Minister assisted by diverse Government Ministers and policy-makers, members of Rotary International, the Diplomatic Corps, national food standards boards, and representatives of maize traders and farmers, poultry farmers, and media houses from Benin, Ghana and Togo and the USA. Similar kick-off ceremonies were subsequently held in Benin and Ghana.

The food quality awareness messages were delivered from 2001 to 2004 through a variety of channels and promotional materials (Table I). Twenty-two of the 38 cities and towns covered in aflatoxin monitoring were targeted by the campaign. Communication methods used were: radio and television adverts, panel discussions, community workshops and interpersonal discussions. Results of aflatoxin monitoring were incorporated in campaign messages. Behavioural change for good grain handling practices was reinforced through promotional materials such as billboards, car/equipment stickers, t-shirts and buntings focusing on the food quality theme. During interpersonal discussions at market and social centres, Rotary club volunteers used handbills illustrated with aflatoxin-related

Table I. Aflatoxin information campaign delivery in Benin, Togo and Ghana, 2001–04.

Country	Promotional materials	Message delivery channels: Television broadcast	Radio broadcast	Other methods	Cities and towns covered
Benin	Promotional inserts, t-shirts and caps, car stickers, buntings, key holders, posters	3-min adverts preceding daily evening and night news for 6 months; role-play by traditional folk groups twice a year; two documentaries and one panel discussion per year	15 messages in French and local language broadcast once every 2 weeks in the year	community workshops and interpersonal contacts at markets, social centres, medical, and extension centres; focus group talks with opinion leaders; local press for news releases	6
Ghana	As in Benin	role-play by traditional folk groups; two documentaries; two adverts/spots; one panel discussion in local languages	20 messages broadcast as jingles in English and local languages	live role-play by traditional folk groups at market centres; interpersonal contacts at social centres; local press for news releases	13
Togo	As in Benin plus 20 billboards in Togo	two adverts/spots intermittently each year	15 messages in French and local language broadcast once every 2 weeks in the year	as in Benin, plus national aflatoxin quiz competition in schools	3

images to further promote public understanding of food quality issues raised in the campaign and to help enhance individual compliance with maize grain handling practices, as proposed by the campaign.

To assess social benefits of the campaign, key informant interviews were carried out 8 months after the campaign, in 2005, with members of the same target groups who had provided baseline information. The respondents were 1331 maize farmers, 1942 traders, 2536 consumers, 1245 poultry farmers and 131 feed mill operators in Benin and Togo only. Results of the pre- and post-campaign public opinion surveys were categorized into three aflatoxin awareness indicators: (1) informed about aflatoxin and its health risks, (2) believed the information received about aflatoxin contamination and (3) willing to adopt advice on good maize grain handling practices (i.e. sort out and discard mouldy maize).

All statistical analyses were done using the SAS program (SAS 2001). The binomially distributed aflatoxin contamination data were analysed using generalized logistic regression model to test for significance of differences between years and regions within countries. The test statistic was the log-likelihood chi-square (χ^2), and pair-wise comparison of percentages was done using the two-sample z-statistic test. A two-sample z-statistic test of proportions was used to test significance of differences between pre- and post-campaign affirmative responses for each of the awareness indicators. Similarly, a chi-square test of homogeneity was used to test significance of differences between affirmative responses of pre- and post-campaign by respondents in the countries. To find out if the campaign had similar effects on awareness indicators, data were split and analysed for the different groups of respondents separately and compared with overall country summary of all respondents.

Results

Participating maize traders indicated that the storage duration of maize ranged from 8 to 30 weeks in markets and that maize could be stored for up to 2 years in high maize production regions and on poultry farms. All market stores sampled in Benin, Ghana and Togo sold maize grains that were contaminated with aflatoxin. Significantly more samples were aflatoxin contaminated in Ghana than in either Benin or Togo ($\chi^2(1) = 22.81$, $p < 0.001$). In Benin the percentage of aflatoxin-positive samples averaged 20.1, 11.5 and 19.0% in the 2000 rainy and dry seasons and in the 2001 rainy season, respectively. The figures in Ghana were 42.5, 56.5 and 29.0% in the 2000 rainy and in the dry seasons and 2001 rainy season, respectively. In Togo an average of 26.6% of the samples analysed were positive for aflatoxin.

In the three sampling periods the aflatoxin concentration in contaminated samples ranged from 24 to 117.5 ng g^{-1} in Benin, from 0.4 to

Table II. Distribution of high aflatoxin contamination of maize grains in market stores in Benin and Ghana, 2001–04.

Country and region	May 2000		January 2001		July 2001	
	Sample size	Percentage of samples with > 20 ng g^{-1} aflatoxin	Sample size	Percentage of samples with > 20 ng g^{-1} aflatoxin	Sample size	Percentage of samples with > 20 ng g^{-1} aflatoxin
Benin						
Northern region	50	6.0^{ab}	50	4.0^{a}	50	0.0^{a}
Central region	50	14.0^{a}	50	14.0^{a}	50	2.0^{a}
South Eastern region	19	5.3^{ab}	50	6.0^{a}	50	0.0^{a}
Southern region	50	2.0^{b}	50	14.0^{a}	0	0
Ghana						
Greater Accra	40	27.5^{ab}	40	7.5^{ab}	40	5.0^{b}
Central region	40	40.0^{a}	40	2.5^{b}	40	7.5^{b}
Ashanti region	40	20.0^{bc}	40	17.5^{a}	40	17.5^{ab}
Brong-Ahafo	40	15.0^{bc}	40	22.5^{a}	40	30.0^{a}
Eastern region	40	10.0^{c}	40	10.0^{ab}	40	17.5^{ab}

Within each country and season, percentages with the same letters are not significantly different at $p = 0.05$.

490.6 ng g^{-1} in Ghana, and from 0.7 to 108.8 ng g^{-1} in Togo. Across locations in the 2 years of sampling the percentage of maize samples with more than 20 ng g^{-1} aflatoxin contamination (high contamination) ranged from 0 to 14% in Benin, from 2.5 to 40% in Ghana (Table II) and was 5% in samples analysed in Togo. The percentage of samples with high aflatoxin concentration was significantly higher in Ghana than in Benin ($\chi^2(1) = 17.75$, $p < 0.001$) in 2000 but not in 2001 (($\chi^2(1) = 0.65$, $p = 0.420$). The first and third sampling periods were in the 2000 and 2001 rainy seasons. In Benin, differences in the percentage of rainy samples with high aflatoxin concentration were insignificant between years ($\chi^2(1) = 1.02$, $p = 0.313$) and sampling locations ($\chi^2(3) = 6.21$, $p = 0.102$). In Ghana, however, differences in percentage of rainy season samples with high aflatoxin concentration were highly significant between years ($\chi^2(1) = 7.61$, $p = 0.006$). In both Benin and Ghana, the percentage of samples with high aflatoxin levels was higher in the central regions than in the other regions of each of the countries (Table II).

Across countries the percentage of target groups who rated the aflatoxin awareness information campaign as good was 53.3, 50.3, 49.1, 44.9, and 42.0% for consumers, traders, feed mill operators, farmers and poultry farmers, respectively. A small percentage of the target groups rated the campaign as inappropriate: 6.1, 6.0, 5.0, 4.8, and 2.9% for farmers, traders, poultry farmers, feed mill operators and consumers, respectively. Across all target groups in the countries, the top most effective channels for information transfer were radio and television (Figure 3).

In the three countries the percentage of maize farmers and traders who were informed about aflatoxin believed the information and adopted the

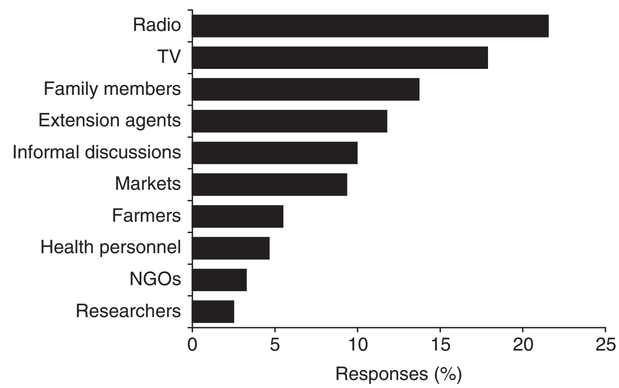

Figure 3. Relative importance of aflatoxin awareness information sources in Ghana, Togo and Benin.

campaign messages was significantly higher after the campaign compared with the baseline figures (Table III). The campaign significantly increased the percentage of consumers who were more informed about the toxin and who believed the campaign information. However, the change in level of good grain handling practices amongst consumers was insignificantly different from an already high level before the campaign. Whilst the campaign did not significantly increase the percentage of poultry farmers who were informed about the toxin (Table III), it did significantly raise the level of belief and adoption of good grain handling practices amongst poultry farmers.

Figures 4–6 summarize the status of country level aflatoxin awareness amongst maize farmers, market traders, and consumers respectively. Before the information campaign, the percentage of maize farmers who were informed about aflatoxin was significantly higher ($\chi^2(2) = 108.8$; $p < 0.001$) in Ghana (44%), than in Benin (11.6%) and Togo (6.8%). After the campaign, 46.4 and 39.3% more

Table III. Aflatoxin awareness amongst target groups before (pre-C) and after (post-C) awareness campaign in Benin, Ghana and Togo, 2001–04.

	Farmers			Traders			Consumers			Poultry Farmers		
Awareness indicator†	Pre-C	Post-C	Percentage change	Pre-C	Post-C	Percentage change	Pre-C	Post-C	Percentage change	Pre-C	Post-C	Percentage change
Respondents aware of aflatoxin (%)												
Informed	20.8	53.2	32.4***	26.7	56.9	30.2***	25.2	63.5	38.3***	60.0	60.9	0.9 n.s.
Believed	54.6	76.9	22.3***	58.5	78.1	19.6***	60.0	84.3	24.3***	83.0	91.2	8.2 **
Adopted	51.1	75.7	24.6***	55.4	91.8	36.3***	81.3	84.5	3.2 n.s.	48.9	68.8	19.9***

***$p < 0.001$ (significance level); **$p < 0.01$; *$p < 0.05$;
n.s., not significant. †Informed, respondent has heard about aflatoxin contamination of maize grain and its health risks; Believed, respondent believed the information on aflatoxin and its health risks; Adopted, respondent adopted advice/campaign on good grain handling practices; Pre-C, pre-campaign/baseline awareness of respondent; Post-C, post-campaign awareness of respondent.

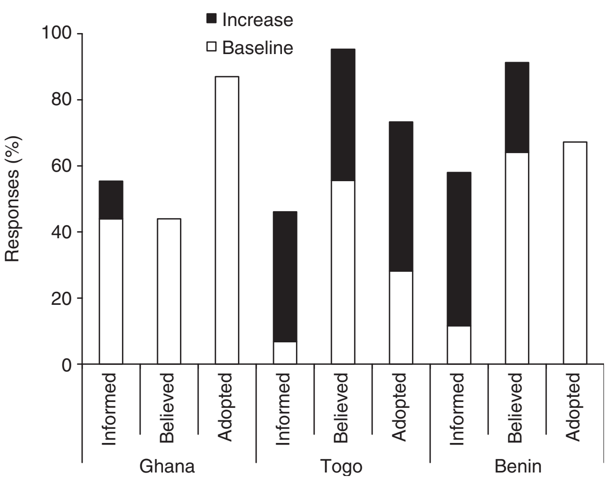

Figure 4. Aflatoxin awareness amongst maize farmers before and after information campaign in Ghana, Togo and Benin.

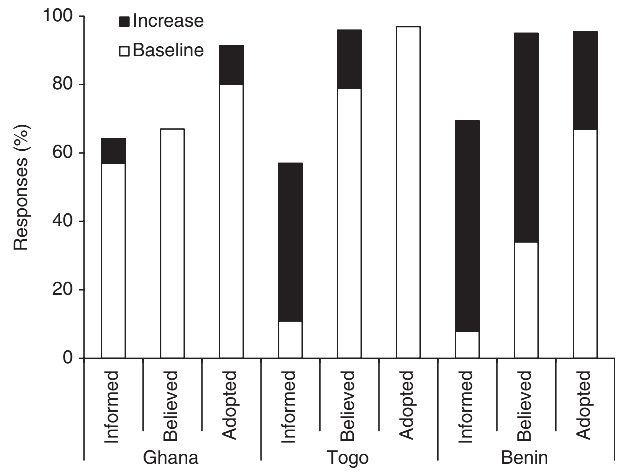

Figure 6. Aflatoxin awareness amongst consumers before and after information campaign in Ghana, Togo and Benin.

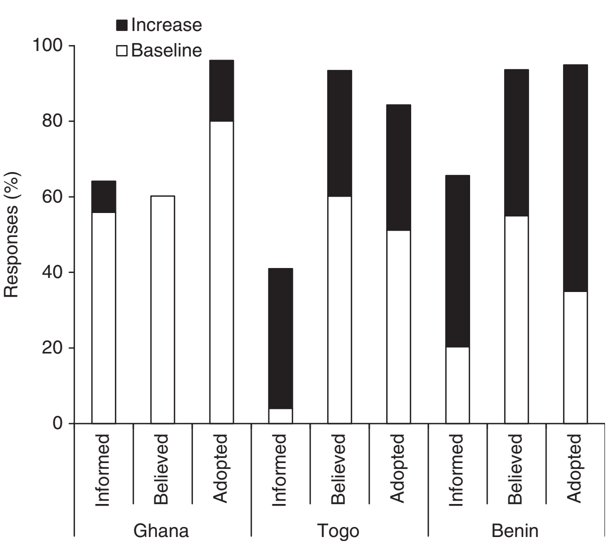

Figure 5. Aflatoxin awareness amongst maize traders before and after information campaign in Ghana, Togo and Benin.

of the farmers were informed about the toxin in Benin and Togo, respectively; and 27 and 30% more of the farmers believed the information after the campaign in the two countries. The campaign did not increase the level of belief or message adoption amongst farmers in Ghana.

The percentage of maize traders who were informed about aflatoxin was more than ten and three times higher at post-campaign than at pre-campaign in Togo and Benin, respectively. In Benin and Togo, the number of maize traders who believed the campaign information was increased by 33.2 and 38.6%, respectively (Figure 5). In Ghana the campaign did not significantly increase knowledge of or belief in aflatoxin information amongst maize traders.

Before the campaign the percentage of consumers who were informed about aflatoxin in Ghana was 57%, significantly higher ($\chi^2(2) = 182.6$; $p < 0.001$) than in Togo (10.9%) or Benin (7.8%). After the campaign the proportion of consumers who were informed about the toxin was approximately nine and five times more than pre-campaign levels in

Togo and Benin, respectively (Figure 6; $\chi^2(2) = 15.3$; $p < 0.001$). The percentage of consumers who believed the campaign information was 1.2 times more than the pre-campaign baseline levels in Togo and Benin (z-statistic = 8.41 and 21.23; $p < 0.001$), respectively. In Ghana there were no significant differences between pre- and post-campaign figures for consumers who were either informed about aflatoxin or believed in the campaign information.

The campaign did not significantly alter the already high aflatoxin awareness amongst poultry farmers in Benin (65.9%) and Ghana (81.6%) or their belief in the information. In Togo, however, 1.6 times more poultry farmers were informed about aflatoxin after the campaign than before the campaign (z-statistic = 4.12; $p < 0.001$). A higher percentage of poultry farmers believed the aflatoxin information (z-statistic = 1.91; $p < 0.05$) in that country. Also in Togo all feed mill operators reached by the campaign believed the aflatoxin information. In Benin, aflatoxin awareness amongst feed mill operators increased from 35 to 58% following the campaign.

At post-campaign period, there were noticeable differences in grain handling practices by different target groups in the three countries. A total of 60% of all respondents indicated they discarded bad grain whilst 25% of the respondents fed bad grain to animals (mainly poultry and pigs). Amongst traders a significantly higher percentage of respondents in Benin (59%), Ghana (16%) and Togo (33.1%) adopted campaign messages to sort out and discard bad grains destined for sale (minimum z-statistic = 4.32; $p < 0.001$). At post-campaign, the percentage of consumers who indicated willingness to sort and discard bad maize was significantly higher in Ghana (11.4%; z-statistic = 3.03; $p < 0.01$) and in Benin (28.4%; z-statistic = 12.70; $p < 0.001$) than baseline figures. In Togo, however, there was no significant increase in the percentage of consumers who changed their grain handling practices. In both Togo and Benin, significantly more poultry farmers indicated that they implemented the good grain handling practices promoted by the campaign (minimum z-statistic = 3.99; $p < 0.001$); and 43.5% of feed mill operators in Togo indicated willingness to sort out and discard bad grains before the preparation of animal feed.

Discussion

Information dissemination aims to bridge the knowledge gap between those who generate that data (e.g. scientists) and end-users of that information (e.g. farmers, traders, the general public) as a means to motivate behavioural changes for increased productivity. For scientific information to make decisive contributions to national development, it should, however, extend beyond the immediate vicinity of research sites and collaborators and effectively reach a wider audience (Escalada and Heong 2004). Public awareness campaigns are appropriate tools in this regard. In parts of Asia, for example, mass media communication had contributed significantly to change pesticide use patterns by rice farmers leading to economic, environmental, agrobiodiversity and health gains (Escalada et al. 1999; Huan et al. 1999, Heong and Escalada 2004, 2005).

The aflatoxin information campaign in Benin, Ghana and Togo was the first comprehensive effort in the subregion to alert sectors of the populations on health and productivity risks posed by aflatoxin contamination of a staple commodity, maize. Results of the aflatoxin monitoring confirmed previous reports that populations in Benin, Ghana and Togo were chronically exposed to unacceptably high levels of aflatoxin in maize grains (Hell et al. 2000; Adda et al. 2002; Gong et al. 2002; Egal et al. 2005). The observation that central regions of Benin and Ghana appeared to be high aflatoxin risk zones, was similar to previous reports by Hell et al. (2003).

Public awareness campaigns succeed where message reception is unhindered by target audience's prior beliefs and perceptions (Norton and Mumford 1982; Heong and Escalada 2005). The aflatoxin awareness campaign minimized this possibility and strengthened credibility of the information by incorporating location-specific scientific data on aflatoxin incidence and management strategies into campaign messages. Additionally, the high profile nature of campaign launching ceremonies provided institutional clout that would help to promote public acceptance of the campaign. The use of local languages to deliver the messages in each of Benin, Ghana and Togo helped to transcend illiteracy barriers which frequently serve as obstacles to behaviour change. In Togo, use of maize grains and not maize cobs on promotional materials was useful in avoiding conflicts with party political politics and the attendant risk of alienating target audience in the country. Furthermore, by adopting the phrase ‘mouldy maize’ as a proxy for ‘aflatoxin contamination’, the campaign aimed to minimize negative perceptions that had been associated with sensational journalism on the toxin in Ghana (Anon. 1998).

Where negative perceptions persist, they could reinforce public rejection of credible scientific information and recommendations to address the problem. A number of the campaign results in Ghana could be rooted in the effects of such perceptions, probably emanating from the news paper article (Anon. 1998). For example, the campaign did not increase the level of belief in and willingness to adopt campaign message amongst farmers. Also, the campaign did not significantly increase knowledge of or belief in aflatoxin information amongst maize traders as well as consumers. However, despite their apparent scepticisms in the campaign messages, Ghanaian traders and consumers indicated willingness to adopt good grain handling practices. The willingness to adopt good grain handling was, however, not reflected in aflatoxin contamination levels in the markets. Aflatoxin monitoring showed high incidence of samples with over 20 ng g^{-1} aflatoxin in the country in each of the three sampling periods.

Grain storage and marketing practices influence variations in aflatoxin contamination levels across countries, locations and years (Hell et al. 2003). Market traders buy maize from different sources and periods, and store the produce over varying lengths of time, e.g. up to 30 weeks in markets stores and up to 2 years on poultry farms. In market stores, previously stored maize is invariably mixed with new stock and stored in bulk (Lutz et al. 1994) often with minimal store hygiene. Favourable and unfavourable storage periods and conditions usually overlap so that maize stored in any particular month or season could still be encountered in subsequent months and seasons. This could contribute more to observed variations in the percentage of samples with more than 20 ng g^{-1} aflatoxin between countries, locations and sampling periods than would have target groups' responses to aflatoxin awareness campaign messages.

Public awareness campaigns help trigger behavioural changes if populations targeted believe in the information received and/or understand the problem fully enough to be convinced to change old habits and practices. The aflatoxin awareness campaign alerted its audience on the existence and nature of the problem. Also, a significant number of maize farmers, traders and consumers believed the messages on aflatoxin contamination of stored maize. However, public awareness campaigns on knowledge-intensive aconcepts, such as aflatoxin contamination, should not be regarded as stand alone interventions to reduce effectively the problems being addressed. Experiences in Asia underline the need for a twin approach in which information campaigns are complemented by experiential learning in order to effectively convince millions of people to adopt certain agronomic practices (Escalada and Heong 2004).

Experiential learning sessions encourage hands-on activities by representatives of target groups to implement certain mass media information messages. The lack of such learning opportunities in the aflatoxin awareness campaign would explain to a large extent the coexistence of high public awareness of aflatoxin (knowledge, belief and willingness to adopt recommendations) with high aflatoxin contamination of stored maize in the countries. This underlines the need to integrate such awareness campaigns with sustained efforts in local capacity building on aflatoxin management. An example in this study was a farmer participatory research to demonstrate the effect of the toxin on broilers and layers and test remedial measures to decontaminate feed of the toxin (Adda et al. 2003). There is also the need to empower food standard boards to institutionalize aflatoxin monitoring as an integral component of national food control and certification systems. Where this happens in a sustainable manner, aflatoxin awareness campaigns will be better placed to increase consumer confidence in traders' claim of quality maize in local markets.

In summary, the campaign alerted the public in Benin, Ghana and Togo on aflatoxin and its health risks and provided a good foundation for longer-term follow-up interventions in these and other countries in the sub-region. Future public awareness activities can preferentially use radio and television spots which were quite effective in reaching the populations. The value of such interventions to society should be looked at from both health and economic perspectives. Maize is essentially grown for domestic consumption in most of West Africa. Whilst good quality maize easily translates to improved health gains, future public awareness campaigns should also target the whole value chain and convince consumers to pay premium price for quality products.

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References

Adda C, Borgemeister C, Biliwa A, Meikle WG, Markham RH, Poehling HM. 2002. Integrated pest management in post-harvest maize: A case study from the Republic of Togo (West Africa). Agriculture, Ecosystems and Environment 93:305–321.

Adda C, James B, Dougnon J, Gbègo J, Toupé A, Ligan C, Awannou S, Tchegninougbo B, Hans-Moevi Y. 2003. Etude Experimentale de l'effet de l'Aflatoxine sur la perfomance des poulets chairs en République du Bénin. Poster presented at the 2nd International Workshop on Food-based Approaches for a Healthy Nutrition, Ouagadougou, 23–28 November 2003.

Anon. 1998. Shock scientific report: kenkey causes cancer. Ghanaian Chronicle 6(133). Available: http://www.ghanaweb.com/GhanaHomePage/health/artikel.php?ID = 19657/

Azziz-Baumgartner E, Lindblade K, Gieseker K, Schurz-Rogers H, Kieszak S, Njapau H, Schleicher R, McCoy LS, Misore A, DeCock K, Rubin C, Slutsker L, Aflatoxin Investigative Group. 2005. Case-control study of an acute aflatoxicosis outbreak — Kenya. Environmental Health Perspectives 113:1779–1783.

Cardwell KF, editor. 1996. Proceedings of the Workshop on Mycotoxins in Foods in Africa, 6–10 November 1995, Cotonou, Benin.

Cardwell KF, Henry SH. 2004. Risk of exposure to and mitigation of effect of aflatoxin on human health: A West African example. Journal of Toxicology: Toxin Reviews 23:217–247.

Egal S, Hounsa A, Gong YY, Turner PC, Wild CP, Hall AJ, Hell K, Cardwell KF. 2005. Dietary exposure to aflatoxin from maize and groundnut in young children from Benin and Togo, West Africa. International Journal of Food Microbiology 104:215–224.

Escalada MM, Heong KL, Huan NH, Mai V. 1999. Communication and behaviour change in rice farmers' pest management: The case of using mass media in Vietnam. Journal of Applied Communications 83:7–26.

Escalada MM, Heong KL. 2004. The case of using mass media communication and behaviour change in resource management. In: Proceedings of the 4th International Crop Science Congress, 26 September–1 October 2004, Brisbane, Australia [CD-ROM]. Available: http://www.cropscience.org.au/

FAO. 2004. Worldwide regulations for mycotoxins in food and feed in 2003. Food and Nutrition Papers No. 81. Rome: Food and Agricultural Organization of the United Nations.

Gong YY, Cardwell K, Hounsa A, Egal S, Turner PC, Hall AJ, Wild CP. 2002. Dietary aflatoxin exposure and impaired growth in young children from Benin and Togo: Cross-sectional study. British Medical Journal 325:20–21.

Hamilton PB. 1971. A natural and extremely severe occurrence of aflatoxicosis in laying hens. Poultry Science 50:1880–1882.

Hell K, Cardwell KF, Poehling HM. 2003. Distribution of fungal species and aflatoxin contamination in stored maize in four agroecological zones in Benin, West-Africa. Journal of Phytopathology 151:690–698.

Hell K, Cardwell KF, Setamou M, Poehling HM. 2000. The influence of storage practices on aflatoxin contamination in maize in four agroecological zones of Benin, West Africa. Journal of Stored Products Research 36:365–382.

Henry SH, Bosch FX, Troxell TC, Bolger PM. 1999. Reducing liver cancer — global control of aflatoxin. Science 286:2453–2454.

Heong KL, Escalada MM. 2005. Scaling up communication of scientific information to rural communities. Journal of Science Communication 4:1–3.

Huan NH, Mai V, Escalada MM, Heong KL. 1999. Changes in rice farmers' pest management in the Mekong Delta, Vietnam. Crop Protection 18:557–563.

James B, Cardwell K, Edorh M, Hell K, Hounsa A. 2000. Public awareness of aflatoxin and food quality control in West Africa. In: Proceedings of the Communication Workshop, Rotary International, Lomé, Togo, 7–9 August 2000. Cotonou: IITA.

Jiang Y, Jolly PE, Ellis WO, Wang J, Phillips TD, Williams JH. 2005. Aflatoxin B1 albumin adduct levels and cellular immune status in Ghanaians. International Immunology 17:807–814.

Kpodo K, Thrane U, Hald B. 2000. Fusaria and fumonisins in maize from Ghana and their co-occurrence with aflatoxins. International Journal of Food Microbiology 61:147–157.

Lutz C, Van Tilburg A, Van der Kamp B. 1994. The process of short- and long-term price integration in the Benin maize market. European Review of Agricultural Economics 22:191–212.

Norton GA, Mumford JD. 1982. Information gaps in pest management. In: Proceedings of the International Conference on Plant Protection in the Tropics, Malaysian Plant Protection Society, Kuala Lumpur, Malaysia. pp. 589–597.

Peers F, Bosch X, Kaldor J, Linsell A, Pluumen M. 1987. Aflatoxin exposure, hepatitis B virus infection and liver Cancer in Swaziland. International Journal of Cancer 5:545–553.

SAS. 2001. The SAS statistical package. Version 9.1. Cary, NC: SAS Institute, Inc.

Sétamou M, Cardwell KF, Schulthess F, Hell K. 1997. Aspergillus flavus infection and aflatoxin contamination of preharvest maize in Benin. Plant Disease 81:1323–1327.

Thomas F, Eppley RM, Trucksess MW. 1975. Rapid screening method for aflatoxins and zearalenone in corn. Journal of the Association of Analytical Chemistry 58:114–116.

Turner PC, Moore SE, Hall AJ, Prentice AM, Wild CP. 2003. Modification of immune function through exposure to dietary aflatoxin in Gambian children. Environmental Health Perspectives 111:217–220.

Wild CP. 1993. Aflatoxin as a human hepathocarcinogen and the possible interaction with hepatitis B virus. African Newsletter on Occupational Health and Safety Supplement 2:2–31.

Williams JH, Phillips TD, Jolly PE, Stiles JK, Jolly CM, Aggarwal D. 2004. Human aflatoxicosis in developing countries: A review of toxicology, exposure, potential health consequences, and interventions. American Journal of Clinical Nutrition 80:1106–1122.

Wu F, David Miller J, Casman EA. 2004. The economic impact of Bt corn resulting from mycotoxin reduction. Journal of Toxicology: Toxin Reviews 23:397–424.