Food hazards and consumer awareness: air pollution effects in India

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Summary

The levels of air pollutants are increasing in many 'megacities' of the developing world. Air pollution can both the yield and nutritional quality of crop plants, and is also a major source of particulate contaminants that can accumulate at toxic levels in the edible portion of crop plants grown in urban and peri-urban (UPU) areas. This paper presents new knowledge on the impacts of UPU environmental pollution and on food safety attributes of the vegetable marketing systems in India. It reports results of market studies in Delhi and Varanasi, and of a study of consumer perceptions and awareness of food safety hazards. Conclusions concern the potential for market-mediated quality assurance methods and the need for targeting the urban poor in creating public awareness of hazard levels and mitigating procedures.

1 Introduction

About half (47%) of the world's population now live in urban areas, and the percentage is expected to reach 65% by the year 2050 (UNEP, 2002). Among the most serious environmental problems to affect urban populations is air pollution, which is reaching crisis dimensions in many 'megacities' greater than 10 million people (UNEP, 1999). A relatively unresearched reason for concern is the threat posed by air pollution to crop production in urban and peri-urban (UPU) areas. The contribution of UPU production to urban food demand throughout the world, particularly of perishables, can vary from 25-100%, and may involve a high percentage of families (Birley and Lock, 1999). Air pollution reduces both the yield and nutritional quality of crop plants, with important implications for consumers and producers, particularly the poor. Air pollution is also a major source of heavy metals that can accumulate at toxic levels in the edible portion of crops.

Compared with degradation of the physical environment, the management of food hazards associated with airborne contaminants has been neglected. There is currently little information on the integrity of supply chains for food in UPU areas of developing countries.

This paper reports an interdisciplinary study of the impacts of airborne contaminants on vegetable quality in urban India, on approaches to food quality assurance, and on levels of food safety awareness. Section 2 discusses air pollution impacts on food systems. Section 3 introduces quality assurance (QA) concepts and approaches to mitigate hazards. Section 4 presents results from exploratory studies into quality concepts and hazard awareness among vegetable consumers in Delhi. Section 5 summarises and presents conclusions.

2 Air pollution impacts on UPU food systems

2.1 Sources and effects of air pollution

Population pressures leading to increased numbers of motor vehicles, power generation, domestic fuel use, refuse burning and other sources all contribute to the problem of airborne heavy metal contaminants. Toxicity in food crops caused by heavy metal deposition (for example lead, cadmium, zinc and copper) from a wide range of industries has potentially serious long-term consequences. Exposure to heavy metals has been linked with developmental retardation and reduced IQ among children, various cancers, kidney damage, and the development of autoimmunity. Children appear to be especially vulnerable (UNEP, 1999: 31): 'The main problems include both acute exposure leading to poisoning, and chronic, low level exposure… Recent research suggests that these chemicals may affect the ability of children to learn, integrate socially, fend off disease, and reproduce'.

2.2 Initial contamination results, Delhi and Varanasi

Critical points of potential contamination in the vegetable supply chain begin with the impact of large and small-scale industries at sites of production. During transportation to wholesale and retail markets and roadside retailing, vehicular emissions can add to the pollutant burden. Households may exacerbate contamination through domestic emissions during food storage and preparation.

Initial results from research in Delhi have found highly toxic levels of lead (Pb) exceeding the limits prescribed by the Indian government in fresh vegetables important to the poor (Marshall, 2000). Thorough washing of the vegetables reduces Pb concentrations by up to 80%, a clear indication that the majority of the contamination came from aerial deposition. In Varanasi where samples were taken from retail, wholesale and field outlets, Pb levels were generally within permissible limits, but zinc (Zn) exceeded permissible limits in a number of vegetables. A significant correlation between Zn deposition and levels in vegetables was found in the rainy season and winter season (Agrawal, 2001).

In summary, the literature, data from previous research, and data from a growing body of empirical evidence from the current study signal that air pollution is a safety hazard in the supply of vegetables to Indian cities from UPU agricultural areas. The wholesale and retail functions of the marketing system have been highlighted in work to date as critical points both as sources of contamination and as potential entry points for QA mechanisms (Poole, Marshall and Bhupal, 2002).

3 Food safety and quality assurance

3.1 Public approaches

Approaches to public food regulation range from low to high levels of intervention, from information-based incentives for private market solutions to direct 'command and control' interventions. Generally, both public and private sector initiatives are necessary in enhancing the integrity of food systems (Fearne and García, 1999; Segerson, 1999). Regulatory initiatives to impose 'due diligence' requirements and legal liability cannot work alone, due

to legislative and judicial failure. Moreover, the (limited) capacity of the state is important in respect of successful public policy implementation (Drèze and Sen, 1995), which requires:

- a well-functioning public (ie state-provided) services;
- public (ie democratic and participative) action; and
- a particular type of public action – the organization of deprived sections of the society.

The weight of evidence about the public sector intervention in food markets in India suggests that although there are regulatory instruments that could serve as mechanisms of improved quality control, it would be infeasible to entrust food quality assurance to strong regulatory control (Ahluwalia, 1993; Howes and Jha, 1994; Harris-White, 1995; Suryanarayana, 1995; Mooij, 1999; Ramaswami and Balakrishnan, 2002). Private initiatives must form part of the framework of incentives and controls.

3.2 Private approaches

Efficient and effective transmission of private information and incentives is an important constituent of the private mechanisms for QA. Information and incentives are likely to play a part in food QA mechanisms at least as important as policy, especially where the regulatory environment is weak. But the task to secure the integrity of the supply chain cannot be left to individual or firm initiatives in response to market forces, because of market failure: food safety is a 'luxury' good and will be underprovided by the market, especially where effective demand is weak - as is likely among the poor and deprived sections of society in India.

3.3 A range of QA mechanisms

Initiatives to improve food quality assurance can be expected to operate at three levels in India, and will range from strong intervention to implement controls on emissions and industry location, through actions facilitating improved market coordination, to information dissemination and creation of awareness (Poole et al., 2002):

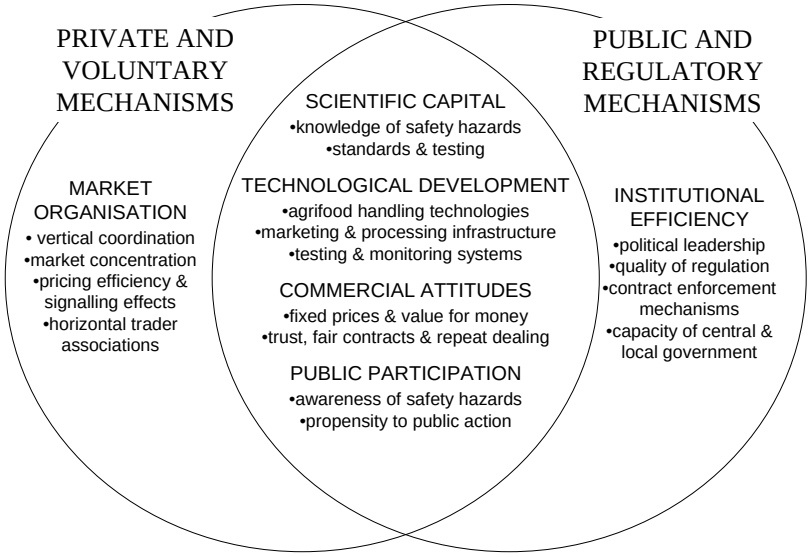
- macro level: national or Central government/State/city;
- meso level: market system from input supply to consumption;
- micro level: individual producers, traders and consumers.

For India, enhanced food QA will be associated with strategies, including information dissemination, at each level:

- development of scientific capital concerning hazard analysis and control;
- an enhanced legislative framework: food and environmental standards and regulation;
- commercial initiatives: supply chain restructuring including increasing concentration and traceability; and institutional innovations such as branding and labelling.

Thus there is a range of factors that will determine the feasibility of different approaches to QA, and hence the appropriate blend of market-mediated mechanisms and public intervention. In summary, efficient, effective and relevant food QA mechanisms in developing countries such as India are likely to involve improved scientific knowledge, institutional responses through both regulatory and market mechanisms, and commercially propitious business attitudes. These concepts are summed up in Figure 1 below.

Figure 1 Factors affecting the feasibility of food QA mechanisms



Demand for food safety will be skewed towards the wealthy sectors of the populations, for whom private QA mechanisms may be effective. Traditionally, private wholesale merchants, retailers and street vendors have been the mechanism linking producers and consumers. Latterly, newer marketing arrangements have evolved in response to the rapid rate of population growth, urbanisation and the consequent increased dependence on formal transport systems from rural to urban areas, and also growing export opportunities. The more sophisticated retailers, such as those within the INA market in south Delhi, argue that their competitive advantage lies in product range, selection of high quality samples, and direct sourcing from 'professional' vegetable growers. Reputation is reinforced as vegetables are sold alongside goods that bear labels with the store name, weights, prices, use-by dates – and delivery within 15 km.

That new quality-conscious enterprises should be developing is significant. Together with the decommoditising of the fruit and vegetable sector into branded, packaged, and labelled produce lines, the evolution of market supply and demand is creating opportunities for quality initiatives that potentially can serve as models for the mass market.

3.4 Implications for the poor, mass market

Whether there will be effective demand from the mass market of poor consumers who are most vulnerable to the hazards outlined earlier will depend on a range of social, economic and demographic factors. In the first place, however, the extent to which market-led quality assurance mechanisms can be effective for the poor effective will depend on two principal factors:

- the ease with which the marketing chain creates incentives and information; and
- the understanding of consumers of food safety hazards.

The next section gives an account of these factors and signals the importance of a third factor, consumer willingness to pay for higher food quality, which is still under investigation. A working hypothesis is that ignorance of, and vulnerability towards, food safety hazards is skewed towards the poorer sectors of the population, and effective food QA will require more public sector participation.

4 Quality concepts and hazard awareness: exploratory research

4.1 Methodology

Exploratory studies of the market system for selected vegetables were conducted in two stages. During November 2000 interviews were conducted in the Delhi Azadpur market among 54 market intermediaries in order to gain an understanding of the market system with respect to sourcing patterns for vegetables, transport methods, value addition and pricing methods. A further study of quality attributes and transaction characteristics in the cauliflower trade was conducted in among 242 market participants in January 2001. The objective of the studies was to uncover evidence of awareness of provenance, information flows on supply and demand conditions, quality incentives, clientisation and non-price contractual terms that might suggest closer vertical coordination – and hence potential for better flows of information and incentives - other than simply through the price mechanism.

4.2 Azadpur *mandi*

Azadpur fruit and vegetable *mandi* (market) is the largest regulated market in Delhi. A total of 50-60 different vegetables are traded daily, depending on seasonality, and total annual arrivals exceed 1.5 million tonnes. Three important vegetables were selected on the basis of perishability, seasonality and physical characteristics: spinach beet (*palak*), okra (*bhindi*) and cauliflower (*gobi*). Interviewees were the three categories of wholesale market actors prior to distribution through small retailers and hawkers:

- assembly wholesalers: assemble vegetables after buying from other markets (within the NCT, peri-urban areas and from outside areas) and/or directly from the producer sellers, and sell in Azadpur market. 15 assembly wholesalers were selected.
- commission agents: negotiate transactions between buyers and sellers for a commission fixed at 6%; but in reality less is charged because of competitive pressures in the market. 15 commission agents were selected.
- mashakhore is a local term used for a functionary between the wholesaler and the retailer, only in Azadpur *mandi*. He is a small wholesaler or a big retailer, buying in quantity and selling in smaller units to the retailers, vendors and consumers. They are numerous, so 8 mashakhores were selected for each vegetable, totalling 24.

Three interviewers were deployed in the *mandi* for a week from 6-11 November 2000. Interviews using a structured questionnaire were conducted from morning to evening depending upon the availability of the respondents. During January 2001, the peak season for cauliflower in Delhi, further interviews were conducted among 150 producer-sellers arriving at Azadpur to elicit baseline information on quality attributes and transaction characteristics.

4.3 Quality concepts

More than half (57%) of producer-sellers said that quality was never a factor in price negotiation. A high proportion of producer-sellers (79%) exchanged information about consumer preferences, and more still (86%) acknowledged that they trimmed and cleaned the product to make it more presentable. Responses confirmed earlier results that freshness was the most important quality attribute (Table 1). This was followed by variety and colour. This is significant inasmuch as gaseous air pollution effects include discolouration for which inspection can serve as an assurance mechanism.

Table 1 Perceived importance of factors determining prices of cauliflower*

Factors	Not important = 0 Slightly important = 1 Moderately important = 2 Very important = 3
Variety	2.53
Stage of maturity	<0.02
Freshness	2.89
Visible blemishes	1.86
Colour	2.09
Shape	0.11
Size	1.69

* mean of 150 producer-sellers

An overview of responses from the total of 277 producers and traders interviewed highlights that the level of awareness of consumer preferences increases progressively through the market chain from producers to wholesaler-retailers. Most importantly, there is potential to use the market system to increase flows of quality information and price-quality incentives. This suggests that creation of awareness about post-harvest contamination can be linked to measures to reduce peri-harvest contamination. Better practices to protect the integrity of produce at the level of production, assembling, wholesale and retail can be promoted to the whole range of market participants. At the same time, disseminating evidence that quality characteristics carry market premia will create an incentive framework for entrepreneurial producers and traders to develop quality-signalling mechanisms such as reputation, packaging, branding and labelling.

4.4 Public awareness of food safety

That public awareness issues are linked to poverty reduction has become evident from analyses of interviews conducted among 500 consumers in Delhi, which found a significant link between poverty indicators and low levels of awareness of food safety issues (Poole, 2002).

Methodology

A formal survey was conducted to identify the levels of awareness of the probability and impact of identified hazards in the vegetable market system. The survey involved 500 at-home face-to-face interviews in Delhi during November 2001. Respondents were the female household decision maker. Two regions (Ali Vihar and Jagdamba Colony in the south-east of Delhi NCT) were chosen purposively as the other teams associated with the project were also working in this area. The sample frame was a CD of the list of voters from the last electoral roll and cases were selected for interview on a randomised serial basis.

The questions on food safety were exploratory in nature, and were ‘leading’ in their simplicity, but the request for specific answers to awareness questions introduced a valid check on responses. Table 2 summarises the responses:

Table 2 Awareness and frequency of food safety hazards

Food safety issue	%
I have heard of (specific) food adulteration scares	34.4
I am aware of (specific) health problems from consuming contaminated food	56.0
I know the causes of these health problems	41.0
There are (specific) types of food for which health risks are greater	67.8
My household have suffered (specific) food-related health problems in the past year	25.6
My household consume street food (1-2 x per week)	63.0
I use specific practices to ensure that vegetables are safe to eat	14.2
I believe that air pollution can contaminate food and cause health hazards	91.4
I believe that agrochemicals can contaminate food and cause health hazards	77.8
I have (specific) ideas of how vegetables could be made safer and healthier	29.6

4.5 Cross-tabulation: income*demographic characteristics

Cross-tabulation using SPSS chi^2 analytical procedures identified the significant relationships within the data set that are recorded in Table 3.

Table 3 Cross-tabulation of household demographic data

	Education level of head of household	Age of head of household	Age of respondent	No. of adults in household	No. of children in household	Total no. of persons in household
H'hold monthly income	***	***	*	***	*	***
Education level of head of h'hold	---	ns	ns	ns	ns	ns
Age of head of h'hold	---	---	***	***	**	***
Age of respondent	---	---	---	**	***	ns
No. of adults in h'hold	---	---	---	---	ns	***
No. of children in h'hold	---	---	---	---	---	***

* significant at 95%
** significant at 99%
*** significant at 99.9%
ns not significant

The results are consistent with hypotheses that:

- lower levels of education of head of household are associated with lower household incomes;
- younger heads of household and younger respondents are associated with lower household incomes and smaller households;
- smaller households in respect of number of adults, number of children and total number of persons in the household are associated with lower household incomes.

Moreover, these results are important because level of education can also be expected to affect levels of awareness of food safety hazards.

4.6 Cross-tabulation: income and education levels*food safety awareness

Two principal variables were used to test for relationships between demographic variables and knowledge of food safety hazards. Income levels were found to be positively associated with awareness of a range of specified food safety scares, hazards and quality assurance procedures. There was no significant association between knowledge of safety hazards

arising from airborne contaminants and levels of either income or education. Air pollution is not seen as a food safety hazard. These results are shown in Table 4.

Table 4 Cross-tabulation of household income and education*food safety awareness

	Awareness of:						
	food adulteration scares	hazards from contaminated food	food sources of greater risk	(specified) high risk foods	methods to assure safety of vegetables	hazards from air pollution	hazards from agro-chemical
Monthly income[1]	***	**	***	**	***	ns	***
Education [2]	**	ns	ns	*	***	ns	***

* significant at 95%
** significant at 99%
*** significant at 99.9%
ns not significant

There was also a positive relationship between level of education and frequency of purchase of street food, although there was no relationship between income level and the frequency of purchase of street food.

5 Discussion and conclusions

The studies of the marketing system for vegetables suggest that it is capable of responding to incentives for improved quality. There are information and incentive flows within the mass market, concentrated through market places such as Azadpur, that suggest that wholesale markets are a feasible intervention point (Poole et al., 2002).

Inferences that can be drawn from the statistically significant relationships (sections 4.5 and 4.6) concern the magnitude of the communication challenge in order that the creation of awareness may constitute an effective strategy for increasing the demand for food safety among the poor mass of the urban population.

Public participation involves both the public and private sectors. High level political and judicial support and heightened public awareness through advocacy information dissemination are likely to be important prerequisites for achieving improvements to the integrity of the food chain both in India and other countries. The nature of the food safety message to be communicated, and the appropriate media and mechanisms, will depend on current levels of awareness, and how knowledge is targeted particularly towards the vulnerable, poor, mass of the urban population.

This paper suggests, first, that air pollution is a real source of food safety hazards. Secondly, poverty alleviation in India in respect of improved supplies of nutritious food to urban populations should take account of food quality issues. Thirdly, the market system has potential to respond to signals about quality both from state intervention and from consumer preferences. Fourthly, quality signals from the mass market are likely to be contingent upon creating greater awareness of hazards and hazard-reduction methods. Finally, effective demand will depend on consumers' willingness to pay – the subject of on-going research.

[1] Household income level per month (Rs):
- <= 3000
- 3000-10000
- 10000+

[2] Education level of head of household:
- up to and including primary
- secondary or tertiary

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