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# **Quality assurance mechanisms for air pollution impacts on vegetable systems in India**

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## **Summary**

The levels of air pollutants are rapidly increasing in many ‘megacities’ of the developing world. Air pollution reduces both the yield and nutritional quality of crop plants, and is also a major source of heavy metals which can accumulate at toxic levels in the edible portion of crop plants in urban and peri-urban (UPU) areas. This article aims to increase understanding of the impacts of environmental pollution on the livelihoods of the poor in urban and peri-urban India, and to contribute recommendations for public and private mechanisms to improve food safety and quality assurance in developing economies.

## **Keywords**

Asia, food safety, India, institutions, pollution, urban

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# **Quality assurance mechanisms for air pollution impacts on vegetable systems in India**

## **1 Introducing urban air pollution**

“behind the rising prosperity in the developing world lurks the shadow of lethal air pollution from motor vehicles, smokestacks and hearths” (World Bank, 1998: 99).

According to the recent GEO report (United Nations Environment Programme, 1999), almost 3000 million people live in urban areas. Most of the growth in the world's population is taking place in developing countries, and most of the projected increase of 1000 million people between 1999 and 2010 is likely to be absorbed by developing country cities.

The 'ecological footprints' of cities can be vastly greater than their physical area because of the demand for energy, food and other resources, and the regional impact of their wastes and emissions to air, soil and water. Among the most serious environmental problems in cities is air pollution, which is reaching crisis dimensions in most LDC cities.

### **Air pollution and food quality**

The levels of air pollutants are rapidly increasing in many 'megacities' (urban populations greater than 10 million) of the developing world (United Nations Environment Programme, 1999). Respiratory hazards from air pollution in urban areas are widely acknowledged. Another reason for concern is the major threat posed by air pollution to crop production in urban and peri-urban (UPU) areas, where the livelihoods of urban inhabitants are dependent on access to cheap and safe food of high nutritional quality.

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). The majority of highly perishable products, including many vegetables that are consumed in Indian cities, are produced in peri-urban areas. For example, 50-70% of cauliflower and 70-90% of spinach that is marketed in Azadpur (the largest fruit and vegetable market in Asia) is produced in Delhi and the six surrounding peri-urban districts. Mother Dairy, the main co-operative providing produce to Delhi consumers, also procures 70% of its produce from these urban and peri-urban areas.

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 metals such as lead, cadmium, zinc and copper which can accumulate at toxic levels in the edible portion of crop plants. For lifestyle reasons, poor populations are more susceptible to environmental metal poisoning. However, compared with degradation of the physical environment, the management of health hazards associated with environmental contaminants has been accorded “benign neglect” (Nriagu, 1992: 2). Nevertheless, public awareness of the health, education and economic implications of unsafe food systems in developing economies is growing fast. According to Motarjemi, “it should be remembered that the developing countries bear the heaviest burden of foodborne diseases in the world” (1996: 82).

There is currently little information on the integrity of the domestic supply chain for horticultural produce in UPU areas of developing countries. Pre- and post-harvest contamination is likely to be widespread. Levels of morbidity and economic losses with adverse effects on livelihoods of poor people are likely to be considerable. Data on sources

and levels of food system contamination are scarce; and knowledge of best practice in food production and handling, and of the availability of appropriate technologies, are thin and unevenly spread. Moreover, the regulatory regime for environmental pollutants, and for hazardous technologies and production practices is likely to be weak.

Recommendations made in a recent study of health impacts of peri-urban natural resource development (Birley and Lock, 1999) included further work to be undertaken on:

- post-harvest decontamination of food crops;
- studies of the safety of similar foods along the rural-urban continuum;
- intersectoral action with a multidisciplinary focus;
- further studies to clarify the severity and extent of pollutant uptake by food plants.

Subsequent work logically should involve establishing appropriate quality assurance mechanisms. This article reports the first stage of an interdisciplinary study of the impacts of air pollution on urban food quality in the developing world, and makes inferences about potential approaches to improving quality assurance. The geographic focus for this work is India – Delhi and Varanasi - but it draws on research elsewhere and will have global implications for poor people in urban and peri-urban areas. The project aims are:

- to increase understanding and awareness of the impacts of environmental pollution on the livelihoods of the poor consumers in urban and peri-urban India;
- to determine both the constraints to, and opportunities for, vulnerable smallholders and traders to participate in safe food systems;
- to contribute to recommendations for improving food safety and quality assurance (QA).

Following this introduction, the article is structured in five parts. The next two sections discuss air pollution impacts on UPU food systems, and the quality assurance concepts associated with these hazards. Section four is a literature-based account of QA in practice: the science, economics, institutions and policy environment concerning food safety. Section five discusses the elements of the policy environment in India that bear on food safety and QA. The final section presents a framework for developing mechanisms to enhance the integrity of the UPU vegetable systems in India.

## **2     *Air pollution impacts on UPU food systems***

### **Sources of pollution**

The adverse effects of air pollution have been associated with three major sources. They are sulphur oxide and solid particulates from fossil fuels; photochemical oxidants and carbon monoxide from motor vehicles; and miscellaneous pollutants such as hydrogen sulphide, lead and cadmium emitted by smelters, refineries, manufacturing plants and vehicles (Birley and Lock, 1999). Increased numbers of motor vehicles, power generation, domestic fuel use, refuse burning and other sources all contribute to the problem. Particular cities present particular problems: India's economy relies heavily on coal, which contributes high levels of SO<sub>2</sub> emissions. In Delhi, where the population is growing at 3.8% per annum - and in Mumbai - levels of particulate matter exceed World Health Organization recommended levels by a factor of three (United Nations Environment Programme, 1999).

### **Impacts on crop output and value**

Phytotoxic gases have been found to cause yield reductions of 40% or more on rice and wheat output on the outskirts of Lahore, Pakistan, and on spinach and mustard on the outskirts of Varanasi, India. Air pollution also has the potential to reduce the nutritional

quality of crop plants, with important implications for consumers, particularly the poor (Marshall, Ashmore and Hinchcliffe, 1997; Ashmore and Marshall, 1999). Air pollution can also affect the quality of F&V products by causing physical defects. Consequent reductions in income for vegetable producers and suppliers arise from visible damage to the edible portion of the crop (Taylor, Ashmore and Bell, 1987), reductions in shelf life, and by making the products more susceptible to post-harvest pest and disease attack (Bell, McNeill, Holden, Brown and Mansfield, 1983).

### **Impacts on crop safety**

There are also major concerns over toxicity in food crops caused by emissions of fluorides (particularly associated with brick kilns that are prevalent in peri-urban areas) and heavy metal deposition (for example lead, cadmium, zinc and copper). These can accumulate at toxic levels in the edible portion of crop plants. The health effects of contaminants such as heavy metals are much researched. 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 specially vulnerable (United Nations Environment Programme, 1999: 31):

“There is particular and growing concern about the threats that chemicals pose to children's health. The main problems include both acute exposure leading to poisoning, and chronic, low level exposure causing functional and organic damage during periods of special vulnerability, when neurological, enzymatic, metabolic and other systems are still developing. Exposure of unborn children to toxic chemicals may produce irreversible effects... Recent research suggests that these chemicals may affect the ability of children to learn, integrate socially, fend off disease, and reproduce”.

### **3     *Airborne pollution hazards and QA concepts***

Quality is a complex of properties and characteristics of a good or service that satisfy a customer's implicit and explicit needs. Food safety is a subset of the broader concept of food quality, and includes a number of dimensions:

- product safety: freedom from environmental and other contaminants and sources of toxicity (chemical and biological) injurious to health;
- product attributes: both objective (nutritional and other physical characteristics such as shelf life, appearance, flavour, texture, and other presentational aspects including labelling), and subjective (utility in respect of economic value, consumer preferences and satisfaction, including range of choice....);
- production and post-harvest handling techniques: process, or 'best practice' in respect of technology and inputs including choice and application of agrochemicals and organic fertilizers, processing and storage.

Quality attributes have been divided by others into different subsets: safety, nutrition, value and packaging, and process attributes (Hooker and Caswell, 1996; Caswell, 1998). Assuring food safety is a complex task involving a range of stakeholders and disciplines throughout the food chain. Different environments, production practices and food products present different challenges, and the dimensions vary in importance between food systems and cultures.

Interpreted as a quality attribute, food safety can be interpreted as a 'search' or 'experience' good (Nelson, 1970). QA systems for such safety hazards are likely to use market-mediated incentives (Segerson, 1999). Other safety attributes are 'credence' goods, for which information cannot be discerned even after repeated consumption (Darby and Karni, 1973), and QA may involve control, reduction or elimination by regulation. However, even in the



absence of market-driven incentives, regulation or controls may not be necessary if firms can be induced by policy incentives or constraints. These attributes, the incentives and potential QA mechanisms for hazards resulting from airborne contaminants are resumed in Table 1.

**Table 1** *QA for airborne pollution effects on UPU horticultural products*

<b>Quality/safety attributes</b>	<b>Example</b>	<b>Likely incentive framework</b>	<b>Potential assurance mechanisms</b>
'Search' goods	<ul style="list-style-type: none"> <li>physical appearance: freshness; variety; size and shape; colour; maturity; visible injury</li> </ul>	<ul style="list-style-type: none"> <li>market-mediated</li> </ul>	<ul style="list-style-type: none"> <li>information through inspection</li> </ul>
'Experience' goods	<ul style="list-style-type: none"> <li>organoleptic characteristics: freshness; flavour; texture; smell</li> </ul>	<ul style="list-style-type: none"> <li>market-mediated</li> </ul>	<ul style="list-style-type: none"> <li>information through reputation effects: repeat purchase; labelling; branding; provenance</li> </ul>
'Credence' goods	<ul style="list-style-type: none"> <li>production and post-harvest technologies</li> <li>nutritional value: nutrient content, especially vitamins and minerals; freedom from environmental contaminants such as heavy metals</li> </ul>	<ul style="list-style-type: none"> <li>public policy incentives and constraints;</li> <li>mandatory interventions</li> <li>public information provision</li> </ul>	<ul style="list-style-type: none"> <li>control through: scientific testing and implementation of accepted standards; (self-) certification self-regulation through market structure and conduct; institutions creating and enforcing liability</li> <li>information on 'best practice' production technology, post-harvest and household handling</li> </ul>

### **QA mechanisms in developing countries: demand and supply**

Swinbank (1993) has reviewed the complexity of the economic issues surrounding food safety. Poorer societies characterised by food scarcity, lower life expectancy and lower levels of education, are likely to demand less food safety than richer societies. But food safety is probably income-elastic, so that as incomes rise, more food safety is demanded. Unnevehr and Jensen (1999) also link the demand for food safety to growing affluence, among other things. In short, in economic terms, food safety is a 'luxury' good. Besides income and prices, the demand for food safety probably depends also on perceived risk – which is a function of the level and value of available information and of individual attributes such as age and education.

Where incentives and information flows are imperfect, the market alone may fail to provide the level of food safety demanded by society. According to Bunte (2000) product demand grows when perceived quality rises due to improved health and safety measures. Efficient markets and cooperative trading relationships signal demand changes and enhance the flows of information and incentives. However, in non-cooperative vertical supply chain relationships firms may under-deliver safety improvements: individual profit-maximizing firms will not consider the positive externality of increased output and profits accruing to other firms, nor the broader socioeconomic benefits resulting from improved health and safety. Quality specifications with the appropriate monitoring and enforcement methods may serve as a mechanism to internalize the health benefits within the food chain.

### **Approaches to regulation: public or private?**

Market failure to deliver the level of safety to meet public health requirements and consumer demands constitutes economic grounds for public policy intervention (Unnevehr and Jensen, 1999). However, the existence of market failure does not mean that intervention can

necessarily improve the performance of unregulated markets. Even where there are positive net benefits, the distributional consequences of regulation need to be understood (Antle, 1999), as do the structural effects, and the technological and scale barriers to market access.

Approaches to public food regulation range from low to high levels of intervention: from the provision of information, through the development and enforcement of standards, to prior approval. Unnevehr and Jensen (1999) distinguish between information-based incentives for private market solutions and direct command and control interventions. The former may be provision of information to consumers, lowering information costs through improved testing mechanisms, branding, labelling, (self-)certification schemes, and laws creating enforceable liability. Reputation effects and trust are additional private mechanisms which are of considerable importance in advanced economies, and probably no less important in developing economies: “in India you do business with people with whom there is prior mutual trust” (Basu, 1992: 344).

Food safety regulations can take two broad forms, according to Hilmer, *et al.*, (2000). Performance standards specify a quality level that a firm’s output must meet, involving enforcement through testing, but allowing the firm autonomy over its production process. Process standards specify procedures required to produce output of the desired quality – the prior approval previously referred to.

Under a light regulatory regime one might expect differing levels of voluntary compliance to high sanitary standards, or ‘sanitary propensity’ (Hilmer *et al.*, 2000). High levels of intervention create the potential for firms to ‘capture’ the regulatory process and thereby attempt to co-opt the regulatory system to gain competitive advantage. This phenomenon,

together with the enforcement problems that arise from a heavy regulatory approach - evident, for example, in the case of India below (Harriss-White, 1995) – suggest that where the institutional framework is weak regulation must be approached with caution.

### **The public-private balance**

Analyses of QA mechanisms in the US and the UK have highlighted the importance of the appropriate balance between the ‘carrot’ and ‘stick’ approaches (Fearne and García, 1999; Segerson, 1999). In advanced economies, there are increasing concerns about the costs to the industry of regulatory compliance. The costs to the regulatory authorities are those of the enforcement of performance measures through product testing, and to firms are the costs of conforming to industry-wide standards that may not be appropriate. HACCP (Hazard Analysis Critical Control Points) process standards are becoming widespread because they are considered to be less costly.

Whether or not food chain stakeholders engage in QA activities depends in part on the mix of incentives to which they are subject. Incentives may be positive, and result in the voluntary adoption of appropriate QA mechanisms. They may be negative, either purposive (in the form of policy-mediated sanctions for non-compliance such as fines), or consequential (in the form of declining market share and exclusion from the market).

There is a growing consensus that both public and private sector initiatives are necessary in enhancing the integrity of food systems. National and international regulatory initiatives to impose ‘due diligence’ requirements and legal liability cannot work alone. Nor can the task to secure the integrity of the supply chain be left to individual or firm initiatives in response to market forces.

For India, Drèze and Sen argue that the contrast between market-based and government-based economic decision making requires a clear understanding of the context: “There are variations in market forms... And there are diversities in the nature of governments” (1995: 18), and the two forms of economic decision-making are interdependent. Markets need an institutional framework, and the government may have a role in initiating market-reliant growth. As Basu argues, “In reality, an effective market is one which operates freely, but *within* a structure of norms and legal institutions” (1992: 341).

At the state level in India, Drèze and Sen note among other things the essential role of three factors. There must be: a) well-functioning public (ie state-provided) services; b) public (ie democratic and participative) action; and c) a particular type of public action – the political organization of deprived sections of the society. They note how these three preconditions explain improving living conditions in Kerala when contrasted with Uttar Pradesh. “Underlying many of these contrasts is the general importance of politics in the development process” (1995: 54). To this, one might add political leadership. Currently it is widely-held that the rapid changes in the state of Andhra Pradesh are attributable, at least in part, to the influence of regional politics, and of the reformist chief minister, Chandrababu Naidu, who is a charismatic technocrat (Financial Times, 2000).

Elsewhere, Drèze and Sen reinforce their assertion that public action is vitally important. In the context of food safety, consumer pressure might be the form of public action expected to play a role in bringing about improved QA. “Public action can also affect outcomes without having to work through swaying government policy” (1995: 89).

These assertions are consistent with the climate of economic and policy adjustment that seeks to find an efficient and effective balance between intervention and regulation by the state, and private sector activity in response to incentives created by the market. In the words of the World Bank: “At the core of today’s environmental agenda is identifying creative ways of combining markets, governments, and civil societies to promote efficient mechanisms for the generation, diffusion, and use of sound environmental knowledge” (World Bank, 1998: 116).

#### **4      *QA in practice***

##### **Science, economics and institutional development**

Food quality assurance is a multidisciplinary endeavour. The literature provides pertinent examples of the interplay of a range of factors contributing to food quality assurance.

The review by Collins (1993) of the improvements in the British food system in the 19th century is instructive for other economies. Improvements in food quality were not just a matter of genuine scientific achievement, but also of institutional development, improved commerce and more efficient market organization. The regulatory framework was enhanced from 1860 onwards by establishing public analysis, introducing penalties for adulteration, and formulating clearer descriptions of punishable offences.

Changes in business culture played a part, with the development of business ethics such as fixed prices, fair dealing and value for money. By the late 19th century firms traded on their reputation for honesty, integrity and quality. Trade associations developed, and there were major changes also in the structure and organization of the industry, accompanied by a fall in real food prices and growth in real incomes. Distributors were increasingly concerned with securing control of their suppliers, even to the point of integration with overseas production.

Improvements in transport technology, physical infrastructure, food handling techniques and conservation technologies improved supply conditions. Concentration in manufacturing led to higher standards through the application of improved technology, greater standardization of products, and the generation of steady profits. Increased competition played a part in increasing market concentration, not just in manufacturing but also in retailing.

Loss of specialization of food handling trades, and the increased dependence on merchandizing forced moves towards assured quality. As incomes rose, distributors competed more on quality, service and freshness than on price. Branding evolved “in response to the anarchy of the marketplace with its multiplicity of products of unknown origin and doubtful quality” (Collins, 1993: 108)

Comparable organizational and institutional changes in the UK food system of today are driven by many of the same factors that were at work 100 or so years ago. Above all, advanced food industries are driven by the need for control of the food chain in order to satisfy consumer demands in respect of product quality – including food safety - and value-for-money. “Efficient response to consumer demands for traceability and market performance in a range of dimensions is the major contemporary driver of the structural changes in food markets in Europe” (Poole, 1997a: 10).

Further evidence of the evolution of technological and institutional approaches comes from Brazil. Resende (1993) states that the level of food safety in Brazil is associated with the level of socioeconomic development, and shows how consumer protection was enhanced by measures in the 1988 Constitution that established the municipalization of food control

services. The dynamic and modern food control mechanisms introduced then have been associated with improved primary health care and a unified health system.

The relevance of institution-building to food safety in India is worth noting. Commenting on the economic restructuring that was initiated in India during the last decade, Basu (1992) asks: “Do we have the institutions for markets to function effectively? Suitable social norms and a legal framework are a prerequisite for an efficient market. Do we have this base?” (p. 338-9). He continues: “The inability to sign contracts and have them enforced through the government is, I think, one of the main factors behind the inefficiency of the Indian economy” (p. 344).

Thus there is a range of factors which will determine the feasibility of different approaches to QA, and hence the appropriate balance between market-mediated mechanisms and public intervention. These are summarized in Table 2.



**Table 2** *Factors conditioning the effectiveness of QA mechanisms*

<b>Private and voluntary mechanisms</b>	<b>Public and regulatory mechanisms</b>
<ul style="list-style-type: none"> <li>• market organization:</li> </ul> level of intermediary concentration degree of vertical coordination existence of horizontal trader associations pricing efficiency and signalling effects	<ul style="list-style-type: none"> <li>• institutional efficiency:</li> </ul> quality of regulation contract enforcement mechanisms capacity of central and local government political leadership
<ul style="list-style-type: none"> <li>• commercial attitudes to exchange:</li> </ul> fixed prices and value for money trust, fair contracts and repeat dealing	<ul style="list-style-type: none"> <li>• technological development:</li> </ul> handling technologies marketing and processing infrastructure
<ul style="list-style-type: none"> <li>• public participation:</li> </ul> awareness of safety hazards propensity to public (consumer) action	<ul style="list-style-type: none"> <li>• scientific capital:</li> </ul> knowledge of safety hazards standards and testing

**Food systems, contracts and information**

Efficient and effective vertical transmission of information and incentives is an important constituent of the mechanisms for QA. Information and incentives are likely to play a part in QA mechanisms at least as important as policy, especially where the regulatory environment is weak. Even in advanced food systems, deficiencies in the flow of information through market systems have been found to be a source of market imperfection in matching market intermediaries' perceptions of quality to consumers' preferences and demand characteristics (Poole and Baron, 1996; Poole, 1997b). Contractual relationships and even written contracts are an important mechanism to address agency problems in food systems (Poole, Del Campo Gomis, Juliá Igual and Vidal Giménez, 1998) and these issues are directly relevant to the establishment of QA mechanisms (Compés López and Poole, 1998). Basu envisages that

written contracts, or “a limited contract-enforcing regime” may even have a part to play in reducing transaction costs in the agricultural sector in India (1992: 347). Paradoxically, contracts may serve to enhance trust in the trading community (Poole, Kydd, Lynch and Poulton, 2000a; Poole, Seini and Heh, 2000b).

Transaction cost economics has provided a framework to analyse the costs and benefits of food quality standards for a number of researchers. The origin of transaction costs is uncertainty, conventionally attributed to three sources: a) behavioural characteristics such as opportunism; b) market structural characteristics such as limited information and asymmetric information, and specific assets; and c) transaction characteristics such as repeat purchasing. The costs involved are those of activities or policies undertaken to mitigate uncertainty: search and information provision; negotiating; monitoring and enforcement. Uncertainty is mitigated – or assurance is created – about search, experience and credence attributes of food (Table 1) through activities - or responses - analagous to the potential QA mechanisms:

#### Information responses

- inspection;
- reputation;
- public dissemination;

#### Control responses

- monitoring of hazards;
- enforcing standards;
- sanctioning infractions;

## Structural responses

- horizontal market concentration;
- vertical market coordination and contractual arrangements.

Adapted from Poole (1998).

On the one hand, transaction costs are often increased by food safety regulations, product liability law and customer requirements. Raising transaction costs creates incentives to achieve better market organization (Hobbs, 1995; Holleran, Bredahl and Zaibet, 1999). Institutional innovation to reduce transaction costs such as searching for good suppliers, negotiating specifications, monitoring performance, and enforcing compliance is a likely result. Holleran *et al.*, (1999) argue that it is the cost of carrying out transactions which creates the private incentives for adopting voluntary food quality assurance programmes.

Ziggers' approach to food safety and industry organization is similarly new institutionalist (2000). He emphasizes the role of management and cooperative inter-firm relationships (or ill-specified 'partnerships') in establishing controls mechanisms such as QA systems. Vertical integration, he argues, is a logical control mechanism.

## **The wider policy environment**

It has been argued that international food safety assurance standards are – or should be - converging (Caswell and Hooker, 1996). In the international arena, the priority of the Codex Alimentarius Commission (CAC) is to protect the health of consumers and ensure fair practices in the food trade. The significance of the CAC food code for consumer health protection was underscored in 1985 by the UN Resolution 39/248 in which guidelines were adopted for the development of consumer protection policies. In the 1997 biennial meeting of

the Codex about 75% of delegations were from developing countries (Codex Alimentarius Commission, 1999).

An example of QA mechanisms within the CAC is the “Recommended International Code of Practice – General Principles of Food Hygiene” (CAC/RCP 1-1969, Rev.3 (1997)). Food safety is defined as assurance that food will not cause harm when it is prepared and/or eaten according to its intended use. A positive approach to food quality and safety also embraces production, marketing and distribution practices that impair nutritional and economic quality characteristics of food, such as nutrient levels and shelf life.

The ‘General Principles’ sets out provisions for Good Manufacturing Practices based on risk assessment principles, including Hazard Analysis Critical Control Point (HACCP) guidelines (Oriss, 1999). Among the measures taken by CAC to provide assistance to developing countries has been developing and publishing training manuals on food inspection and quality and safety assurance, particularly with respect to the application of the HACCP system in the food-processing industry (Codex Alimentarius Commission, 1999).

### ***HACCP (Hazard Analysis Critical Control Point)***

The HACCP procedure for food products is the most widely disseminated mechanism for enhancing food chain integrity. HACCP was advocated by the World Health Organization as long ago as the early 1970s, and is regarded as “the universally recognized and accepted method for food safety assurance” (Motarjemi et al., 1996: 77). HACCP substitutes easily monitored control processes for costly testing, targets specific hazards, and can be linked to system-wide risk assessment. Most commonly, the safety hazards are conceived as microbial in nature. Properly the concept of hazard should cover any biological, chemical or physical

agent with the potential to cause an adverse health effect – including inferior nutritional content and heavy metal contamination.

HACCP involves a series of seven sequential steps Bryan (1992). They should encompass the food chain from production, through harvesting, processing & manufacture, distribution, preparation, to the consumption of agrifood products. According to Motarjemi, “in view of the high prevalence of food-borne diseases in the developing world, and the limitation of resources, the potential benefits that the application of the HACCP system may afford in comparison to the problems faced are more important for developing countries...” (1996: 82).

Developed as a firm- or plant-level tool to enhance safety of processed foods, the application of HACCP industry-wide is necessarily different. The approach needs to be inclusive of the multiplicity of stakeholders in a given food chain. HACCP approaches to food safety have been used in the WHO Healthy Cities Project, begun in 1986, and which emphasized the importance of health linkages to peri-urban marketplaces. The main hazards to food safety arising from the marketplace were due to contamination during transport, lack of quality control standards, improper handling, storage and environmental conditions, and misrepresentation or adulteration leading to health, nutritional or economic problems for the consumer (Birley and Lock, 1999).

To sum up, efficient, effective and relevant food QA mechanisms in developing countries are likely to involve improved scientific knowledge, accompanied by technical and institutional responses through both regulatory and market mechanisms, and commercially propitious business attitudes. Information and incentives are likely to play a part in QA mechanisms at

least as important as policy, especially where the regulatory environment is weak. The next section evaluates the regulatory environment for food safety in India.

## **5      *The policy environment in India***

### **The Indian Constitution**

Bhagwan's review of the Indian Constitution (1999) furnishes important contextual detail concerning the institutional framework and the potential for regulatory efficiency in India. The Constitution creates a federal state with powers distributed between the Central Government and the constituent units (25 States and 7 Union Territories), and enshrines the notion of 'vigilant public action' in the governance of the country.

Legislative authority is divided into three lists, the Union, State and Concurrent Lists. The Union list is the largest, broadly covering policy areas of national interest: defence, foreign affairs, fiscal and monetary matters. The State list consists "of subjects of local interest and envisages the possibility of diversity of treatment in respect of different items in the different States of the Union" (p. 372). Under certain circumstances, the Union can legislate on these items. They include natural resource sectors such as public health and sanitation, agriculture, forestry, fisheries, education and land revenue.

The Concurrent list includes criminal and civil law and procedures, welfare, social and economic planning, etc. Both the Union Parliament and State Legislatures are empowered to legislate over items in the Concurrent list, but the former takes precedence. The complex multisectoral issues underlying food safety and the multiplicity of stakeholders mean that legislative responses to food safety hazards will not be simple, but can be targeted. An

example is the ‘Prevention of Food Adulteration Act’, which is a national law, the result of an Act of Parliament, whose implementation is the responsibility of the State governments.

### **Food and nutrition policy**

India’s economy has been described as one of the most closed and regulated economies in the world (Ahluwalia, 1993). In fact, since 1991 there have been serious attempts at reform, meaning a policy shift towards liberalization, although reforms have not moved as fast as anticipated (Drèze and Sen, 1995). Intervention in agricultural and food markets in the ‘modern era’ can be traced at least back to the 19th century. Since independence in August 1947, there has been one dominant food policy intervention, the Public Distribution System.

The Public Distribution System (PDS) is a long-standing general entitlement scheme, which in fact predated independence. It began in a small way in certain metropolitan centres in 1939. The central government, mainly through the Food Corporation of India, purchases and stores food grains, sugar, edible oils and certain non-food goods commodities, which are then distributed by the PDS through fair price shops at subsidized prices.

The PDS does not cover vegetable products, nor does it relate directly to food safety. However, it exemplifies intervention in Indian markets. “One of the most important welfare interventions in post-Independent India” (Mooij, 1999: 2), the objective is to address nutritional insufficiency. In principle, the PDS covers the whole Indian population. It has been a focus of much debate in recent years because of the cost, and also because it is alleged to be inadequately targeted and imperfectly administered (Ahluwalia, 1993; Howes and Jha, 1994; Srinivasan, 2000).

Swaminathan [ , 2000 #883] criticises the narrow targeting reforms proposed by the World Bank. She agrees that the PDS has failed to provide cheap food and food security to vulnerable households and individuals, in part due to poor administration. However, she argues that the food subsidy bill is only a small part of government expenditures and is not very high compared to expenditure in other developing countries.

The significance of the PDS extends beyond food policy issues, and its performance exposes the limitations of food market regulation. Suryanarayana (1995) has pointed out that the PDS is not only an important instrument of food policy, but also is part of a greater policy environment. According to Mooij, food policy studies in India tend to overlook reality. He says that the literature overlooks the fact that

“food is not only an article to consume, but also an economic and political commodity, that real food policy is embedded in social relations and shaped by processes ‘on the ground’ rather than a logical result of official statements and intentions, and that the state implementing these policies is not a homogeneous bloc, but a multifarious entity” (Mooij, 1999: 6).

The reported inefficiencies of the PDS illustrate the extent to which current intervention is compromised. The problems of food security, he argues, should be tackled through providing market incentives to producers, distribution in favour of the poorest, an integrated approach to poverty alleviation and food distribution, and of course, better targeting (1995). Mooij argues that because the Indian state is both developmental and rent-seeking, it is unlikely that strengthening the first and weakening the second will come from within the state itself (1999). Rather, effective change is likely to result from public action and popular



participation which, moreover, is not confined to food policy but is linked to other “capability-enhancing terrains of public policy” (p. 253).

### **The potential for regulation in India**

Drawing on case material for food markets in India, Harriss-White (1995) has explored the apparent incongruity of the need for market regulation in the current environment of economic reform dominated by the themes of deregulation and privatization.

From a theoretical starting point, in the tradition of North, she employs New Institutional Economics concepts to explain the existence of institutions which have the functions of enabling, disciplining and constraining market exchange. “These are the necessary elements of a regulatory system” (1995: 586) which are the responsibility of the state, are enshrined in law, and define the operation of the efficient private market economy. Such a framework may have micro (firm level), meso (collective action) and macro (state level) elements. She argues that there are three layers of transaction and supervision costs associated with regulation corresponding to the firm, the collective and the state.

Harriss-White then acknowledges the social and economic complexity of Indian food markets, and the fact that state regulation has been in place since the 19th century, principally defining the conditions of the first transaction, and also managing local economic and spatial markets. She asserts that the evolution of the Regulated Markets Acts has exhibited centralizing tendencies that have been frequently ineffectual: markets have been regulated, but regulation has failed. Laws are hardly ever implemented, may be ignored, may be creatively reinterpreted, flouted by the powerful, imposed on the weak, used as threats... She comments that informal collective institutions have tended to evolve in the place of ineffective formal regulation.

Market imperfections remain rooted in incentives to private and public rent-seeking, and social institutions such as gender and ethnicity that create structural imperfections, condition market conduct and determine performance outcomes. Foreign-funded projects to overcome market imperfections add an additional layer of complexity to the regulatory environment with consequences which are unpredictable because of the failure to understand the complexities of the market system.

She distinguishes two approaches to the debate on market regulation in India: one is the tendency to expand interventionism; and the other is to reduce regulation because no law is better than poor law, poorly implemented. She dismisses both approaches, arguing that regulatory law needs to be reformed and implemented.

Notwithstanding the vested political interests, efforts to implement combative policies in India have not proved totally ineffective. In a discussion on the contentious subject of 'judicial activism' in India, Bhagwan (1999) cites various cases in which the judiciary and Parliament have clashed, sometimes leading to the prosecution of top politicians and bureaucrats. Two prominent environmental cases argued by the judiciary involved the exoneration of the Union Carbide officials from the charge that they had prior knowledge about the Bhopal industrial disaster; and "strict enforcement of environmental laws resulting in closure or relocation of a large number of industries in the Capital which were responsible for spreading pollution" (p. 262).

The latter case is particularly instructive in considering the enforceability of 'good laws' to the disadvantage of vested political interests. However, it does not assuage entirely the doubts

raised by various authors about the generally weak institutional framework. Harriss-White's analysis is at best cautious about state regulation. Nevertheless, evidence suggests that there is potential in India for public sector institutions to verify the quality of food products. An example is Operation Flood, launched in the early 1970s by the National Dairy Development Board to combat milk adulteration. The measures involved the formation of cooperatives, the adoption of quality standards, improved product testing, provision of technical assistance, subsidies for improved processing facilities, and the adoption of branding by the cooperatives. There was a significant improvement to the quality of milk and incomes of a million producers in the target area were doubled by 1979 (World Bank, 1998: 73).

Moreover, Swaminathan argues for continued public sector involvement in food policy [2000 #883]. She notes that the PDS in the state of Kerala is in a class of its own in terms of effectiveness, citing the critical importance of intense public pressure in the 1940s, and good governance in establishing and strengthening the PDS in Kerala. She proposes a full public sector role in food policy, envisaging a strong and effective food security policy. Among her recommendations are reform of the Food Corporation of India rather than privatisation, greater decentralisation, and genuine participation by the poor in organisations at the local level. She reiterates that strong political support and political awareness are prerequisites for public sector performance.

### ***Lessons for food safety***

Within this broad policy scenario, there are lessons for food safety. There may be a place for industry and national initiatives, but micro-interventions provide the precision to tackle market-specific problems. They are likely to take the form of incentives rather than controls. They must account for a range of stakeholder interests (in particular consumer interests, but also those of poor labourers, producers and intermediaries). The objectives should not just

fall within the narrow confines of food policy interventions but take into account also the broader health and education imperatives. Strong political support and public awareness and action are essential for an effective state role in food policy.

## **6      *Developing a framework for horticultural QA in UPU India***

It would be presumptuous to present a framework for food QA in India, with its huge economy, diverse society and complex institutions. However, the foregoing discussion of QA issues serves to highlight areas which must be considered in tackling critical food safety hazards associated with air pollution in Delhi and other UPU areas.

### **Identification of hazards**

A measured policy approach must be predicated on a better understanding of the hazards within UPU horticultural markets. The HACCP procedures provide the starting point for a system-wide multidisciplinary approach to assessing horticultural product quality. The first stage is to identify the sources and nature of industrial contaminants – a task more difficult than that apparent in cities whose industries are characterized by a multitude of small firms.

### **Critical point determination**

Subsequently, the determination of critical points employs a range of techniques involving scientific testing for contaminants and objective nutritional quality, quantitative surveys of consumer perceptions, and participant observation of technology, handling practices and exposure to hazards (Table 3). Quantification of hazards and identification of critical points is to be conducted in relation to accepted national and international standards.

**Table 3**      *Critical point determination*

Market system stage	Field-level production	Wholesale handling and marketing	Retail handling and marketing	Household-level consumption
<b>Quality and safety characteristics</b>				
Safety and contaminant levels	• Testing	• Testing	• Testing	• Testing
Other objective & subjective attributes	• Testing • Surveys	• Testing • Surveys	• Testing • Surveys	• Testing • Surveys
Observed technology & practices	• Observation and appraisal	• Observation and appraisal	• Observation and appraisal	• Observation and appraisal

**Incentive and constraint mechanisms**

At this point, system-wide analysis involving a multiplicity of stakeholders departs from the HACCP procedure which was developed as a firm- or plant level tool (Motarjemi et al., 1996). Moreover, the context, or ‘reality’, of Indian food markets will temper the appropriateness of specification and monitoring of system-wide criteria and controls (Mooij, 1999). Mechanisms such as large scale testing, correction and verification can be ruled out on the same grounds of unfeasibility and high cost that apply to QA systems in advanced economies. Table 3 suggests a range of assurance mechanisms for the different quality and safety attributes of horticultural products at different stages of the market chain.

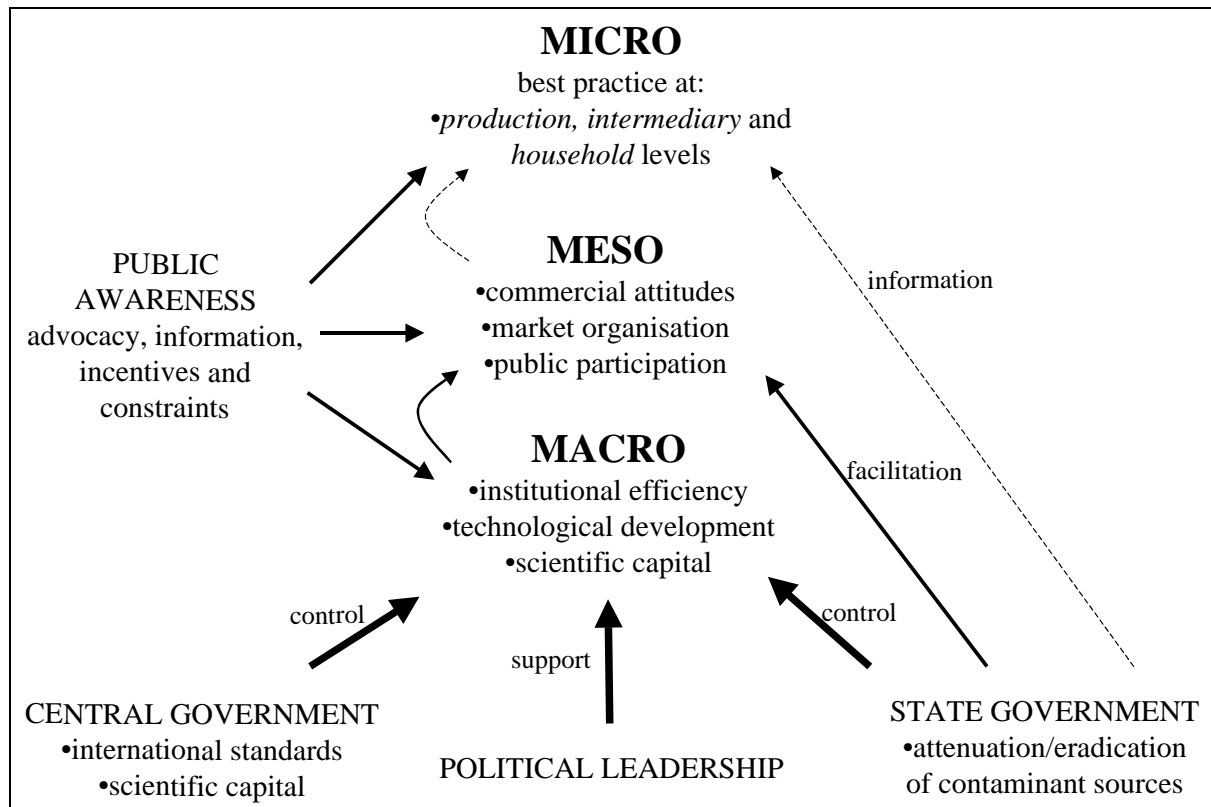
Low levels of health hazard awareness and high rates of poverty mean that effective demand for food safety is probably low. Market failure is likely and public intervention is probably necessary to tackle the social costs. Direct public intervention is likely to be necessary for

improving food quality through implementing emission controls in line with national and international standards.

However, the vast ecological footprints of cities such as Delhi, the atomistic structure of industrial production in UPU areas, and sectoral interactions such as the need for urban employment render infeasible the elimination of sources of airborne contaminants. The importance of these direct MACRO controls is highlighted in Figure 1. Other areas of direct intervention, preferably at the state level, are efforts to improve institutional efficiency, technology and infrastructure. Enhancing these elements of the macro environment is likely to lead to better performance at the meso level through an improved framework of incentives and constraints. Direct intervention in the areas of scientific capital is likely to require central government support.

As indicated previously, the role of the state is not limited to direct interventions. Markets that are efficient in respect of incentive (price and quality) signalling require relatively sophisticated vertical and horizontal coordination. However, 'traditional' direct interventions in market structure, conduct and performance are inconsistent the liberalization agenda and probably would be ineffective. 'Facilitation' that is indirect, but targeted at the MESO-level is a creative alternative.

**Figure 1** *Regulatory and incentive framework for UPU horticulture in India*



First, in an environment in which the Mother Dairy cooperative structure is flourishing, there is an enabling role for the state to facilitate horticultural market re-organization in order to exploit the benefits of market scale, concentration and coordination. Associative organizations involving producers will enable mechanisms such as branding, labelling and self-certification to become feasible.

Secondly, creative public intervention can address the information and awareness issues that are preconditions for effective public participation. Dissemination of knowledge about health hazards and standards through the appropriate public bodies can be allied to support for consumer groups, in the expectation that awareness will lead to the kind of participatory public action referred to above.

Improved market organization and vertical coordination in particular are likely to be fundamental to improve the flow of incentives and information. Again, a facilitatory approach by the state administration is indicated. Emulating the successes of Operation Flood, the public authorities at the level of cities such as Delhi can implement standards and introduce limited scale testing in such a way as to increase transaction costs. Together with heightened public awareness and public action, this has the potential to provide incentives for institutional innovation to mitigate the transaction costs by improving market organization and adopting best practice technologies throughout the horticultural chain.

Finally, the provision of information should be provided through the range of different public entities involved in horticultural production and extension, market regulation, food policy initiatives and consumer organizations. The development of consumer power is likely to be one of the most powerful forces for impelling improved standards, and may take two forms. Firstly, awareness creates the possibility of lobbying by informed local and national consumer organizations, and second may serve to empower the decisions even of consumers of limited purchasing power.

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