Livestock industrialization, trade and social-health-environment impacts in developing countries: a case of Indian poultry sector

Mehta, Rajesh and Narrod, Clare and Tiongco, Marites

Research and Information System for Developing Countries

December 2008

RIS A Think-Tank of Developing Countries

RIS is a New Delhi-based autonomous policy think-tank supported by the Government of India and devoted to trade and development issues. Its work programme focuses on policy research and capacity building on multilateral trade and financial negotiations, regional economic cooperation in Asia, South-South cooperation, new technologies and development, and strategic policy responses of developing countries to globalization, among other issues. The work of RIS is published in the form of research reports, books, discussion papers, policy briefs and journals.

RIS has networked effectively with other prominent policy think-tanks, government agencies, industry bodies and international organizations in Asia and other parts of the world for collaborative research and joint activities. It has a consultative status with UNCTAD, and has been accredited to the Summit Meetings of NAM and WTO Ministerial Conferences. It has conducted policy research and other activities in collaboration with other agencies, including UN-ESCAP, UNCTAD, UNU, Group of 77, SAARC Secretariat, Asian Development Bank (ADB), the World Bank, and the South Centre.

For more information about RIS and its work programme, please visit its website: www.ris.org.in.

— Policy research to shape the international development agenda

RIS
Research and Information System for Developing Countries

Core IV-B, Fourth Floor
India Habitat Centre
Lodhi Road
New Delhi-110 003, India.
Ph. 91-11-2468 2177-80
Fax: 91-11-2468 2173-74-75
Email: dgoffice@ris.org.in
Website: http://www.ris.org.in
Website: http://www.newasiaforum.org

RIS Discussion Papers

Livestock Industrialization, Trade and Social-Health-Environment Impacts in Developing Countries: A Case of Indian Poultry Sector

Rajesh Mehta,
Clare A. Narrod
and
Marites M. Tiongco

RIS-DP # 146

RIS
Research and Information System for Developing Countries

Livestock Industrialization, Trade and Social-Health-Environment Impacts in Developing Countries: A Case of Indian Poultry Sector

Rajesh Mehta,
Clare A. Narrod
and
Marites M. Tiongco

RIS-DP # 146

December 2008

RIS
Research and Information System for Developing Countries

Core IV-B, Fourth Floor, India Habitat Centre
Lodhi Road, New Delhi – 110 003 (India)
Tel: +91-11-2468 2177/2180; Fax: +91-11-2468 2173/74
Email: dgoffice@ris.org.in

Livestock Industrialization, Trade and Social-Health-Environment Impacts in Developing Countries: A Case of Indian Poultry Sector

Rajesh Mehta*, Clare A. Narrod**
Marites M. Tiongco**

Abstract: This paper presents the results of an empirical study of the Indian Poultry Industry which is specially focused on the social and environmental outcomes generated by the rapidly increasing scale of egg and broiler production in India. Among the effects of these rapid changes that occurred in the poultry industry include increased risk for animal health, changes in demand patters in terms of amount, quality, and food safety, higher prices for high value items; but there is also a threat to smallholders that they will be excluded from more demanding markets. There are important questions, which have arisen with the industrialization of poultry activity in India. Is the scaling up of production driving small producers to disadvantage on account of high transaction costs, policy distortions and environment externalities? Why do some poultry farms have higher incomes than others? Do large farms earn more profit per unit of output than small farms? What explains the differentials in efficiency? An attempt is made here to take stock of these changes and to assess their social and environmental outcomes particularly those that affect the welfare of poor. The paper starts by examining the state of the Indian Poultry Industry, then it goes in dealing with selected socio-economic, health, and environment changes that affect the competitiveness of livestock production including domestic institutional arrangement of food safety standards.

Keywords: Indian poultry sector, livestock industrialization, competitiveness, transaction costs, environmental externalities, contract farming.

The authors gratefully acknowledge many institutions and individuals that have facilitated the undertaking of this study. This paper is based on project report produced as part of the IFPRI-FAO entitled "Livestock Industrialization, Trade, and Social–Health-Environments Impacts in Developing Countries," which was carried out from 2001 to 2003. Grateful acknowledgement of support is made to the Livestock, Environment, and Development (LEAD) initiative housed at Food and Agriculture Organization of the United Nations (FAO) and the International Food Policy Research Institute (IFPRI). We thank Dr. Henning Steinfeld, FAO, and Dr. Christopher Delgado, IFPRI, at the time of this study, for their encouragement, support and consistent interest in the project. We owe a heavy intellectual debt to R.G. Nambiar and S. Subramanyan for their significant contributions to the country report.
Needless to say, all observations and conclusions are our own and we alone are responsible for any shortcomings.

* Senior Fellow, Research and Information System for Developing Countries (RIS), New Delhi, Email: rajeshmehta@ris.org.in

** Senior Fellow and Post-doctoral Fellow of International Food Policy Research Institute, Washington D.C.

1. The Indian Poultry Industry

1.1 Growing Productions of Eggs and Broilers

The Indian poultry industry is classic example of how a largely backward venture has transformed into a major vibrant commercial activity. In the early 1970s, India's poultry industry was still a small traditional sector with a head count of only 4 million broilers per year.[1] Poultry at this time was considered an expensive luxury, as maize the primary input was expensive. Most Indian poultry producers at this time were using local breeds whose Feed Conversion Ratio (FCR) at that time was very low relative to commercial hybrids that were being used in many developed countries.[2] Since then, the Indian poultry industry has undergone a sea change on both industrial and technological grounds so as to meet the growing domestic demand. First, productivity was improved through the introduction of high yielding hybrids produced through pure lines. In the early 80s, companies like Venkateswara Research and Breeding Farm, and Cobb Ventress Inc. started joint breeding program leading to establishment of pure line operations and with their genetic pool, hybrids acclimatized to Indian conditions. The company has been consistently doing research based on information collected from broilers and broiler- breeds, using latest technology. The main objective of this research is to produce desirable (profitable) parent birds suitable to Indian conditions. At present the company enjoys 86 per cent share of layer market (DOC), and 65 per cent share of Indian broiler market.[3] With the use of these breeds the size of laying hen housed grew from hen house[4] production of 250 egg per bird used for industrial purposes in the early 70s to hen houses producing close to 315+ eggs per bird[5]. Second, in broilers, the Feed Conversion Ratio (FCR) has gone down from 3 kg of feed for 1 kg of chicken meat in 1970 to less than 2 kg of feed for 1 kg of chicken meat in early 2000.[6] The later figure is comparable to the FCR of developed countries,[7] despite the fact that India does not add tallow nor use other growth promoters including hormones as inputs for fattening the broilers.[8] In addition the body weight of broiler of contract farmer has increased from 1.8 Kg. in 1980 to 2.3 Kg.[9] What facilitated this was that many integrated operations stared using linear programming to ensure that they were able to formulate the most efficient feed given access to nutrients and changing prices. Third, size of individual poultry farms has increased. In

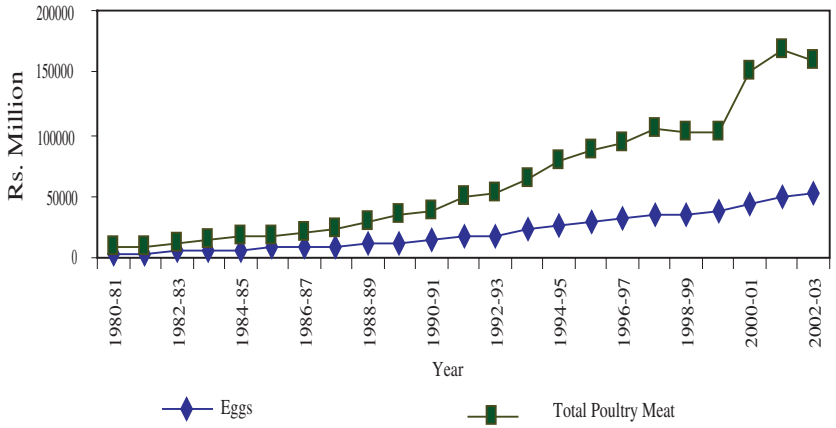
Table 1.1: India: Production of Eggs and Poultry Meat, 1980-2003 (Quantity)

Year	Bird Eggs* (incl. Hen Eggs) (nos. in Bilion)	Poultry (Chicken) Meat** (000 tonnes)
1980	10.1	179
1990	21.1	342
1995	27.2	578
2000	36.6	1,080
2004	41.0***	1,650

Notes: * Data for financial year(Apr.-Mar.),
Source: Govt. of India, Department of Animal Husbandry

earlier years, commercial broiler farms constituted on an average a few hundred birds (200 – 500 chicks) per cycle. Today, units with fewer than 5000 birds are becoming rare, and units with 5000 to 50,000 birds per week cycle have become common.[10] Similarly in layer farms, units with a flock size of 10,000 to 50,000 birds have become common in 2004.[11] The net effect of all these incremental changes is the rapid jump in production of eggs and broilers.[12] In 2004, India produced 41 billion eggs and 1.6

Figure 1.1: Production of Eggs and Poultry Meat, 1980-2003 (Rs. Million)

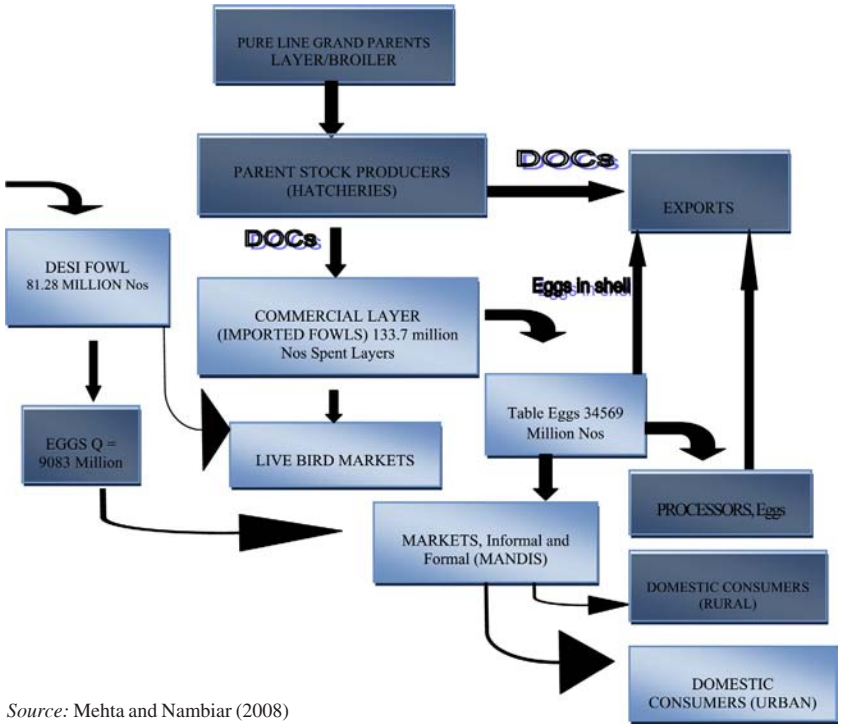


Source of Data: Government of India, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, (dahd.nic.in)

million tonnes of poultry meat compared to only 10 billion eggs and 0.18 million tonnes of poultry meat in 1980-81, as shown in Table I.1 (Figure I.1 displays production of eggs and poultry in value terms).[13]

Over the years, the production of eggs and poultry meat has risen at a rate of 8 to 10 percent per annum. In 2004, India was the world's fifth largest egg producer, and the eighteenth largest producer of broilers. Besides table eggs and broiler meat, another end product of the industry is egg powder. Organized facilities have been set up for the manufacture of egg powder and frozen processed broiler meat to cater to the growing demand of the export markets. Today India exports these products mainly to EU, South Asia, and Middle East. A typical structure of supply-chain of India Poultry sector is given in Chart 1.

Chart 1: Supply Chain of Indian Layer 2005-06



Source: Mehta and Nambiar (2008)

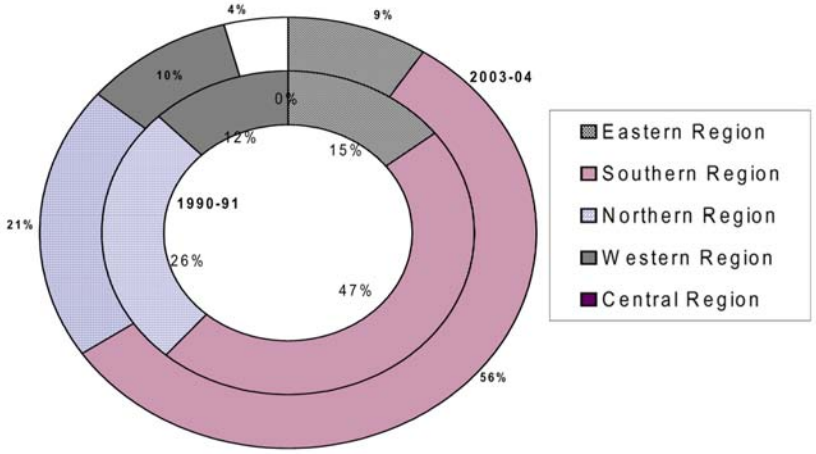
Table 1.2: Value of Output of Poultry as per cent of India's Gross Domestic Product (GDP) at current prices- Indian Rs.

Year	Value of output from Poultry: Eggs + Poultry Meat (Rs. Million)	Total GDP (Rs. Million) (Percent)	Share of Poultry in GDP
1980-81	7950	1308070	0.6
1990-91	37490	5110520	0.73
1995-96	86800	10732710	0.8
2000-01	149610	19029980	0.79
2002-03	158650	22494930	0.71

Source: G.O.I., National Accounts Statistics, C.S.O., various issues.

The total capital investment in poultry equipment, production, processing is estimated to be around at Rs.10, 000 crores.[14] In terms of contribution to GDP (at current prices in local currency), poultry accounted for something less than 1 percent of GDP (Table 1.2), based on government official sources. The share was 0.60 per cent in 1980-81; rose to 0.79 percent in 2000-01;

Figure 1.2: India: Region-wise Production of EGG, 1993-94 and 2003-04



Source of Data: Govt. of India, Department of Animal Husbandry, Dairy and Fisheries, New Delhi Website.

and then slumped to 0.71 percent in 2002-03 (Table 1.2). The decline in share of the poultry in 2002-03 is due to higher growth in other sectors of Indian Economy (18.2 per cent) as compared to growth of poultry sector (6.1 per cent). In this context it should be remembered that the share of agriculture (including livestock) in GDP has been consistently declining during last two and a half decade, but the importance of livestock sector in general and the poultry sector in particular has been increasing. The poultry sector accounts for about 10 per cent of livestock output. Poultry meat comprises of around two-third of the value of poultry output and eggs one-third.

1.2 Regional Variation in Poultry Development

A novel feature of Indian poultry is that its development in the country has not been uniform regionally. As can be seen in Figure 1.2 the four southern states – Andhra Pradesh, Karnataka, Kerala and Tamil Nadu – account for more than half of India's egg production during 2003-04. The eastern and central regions account for about 13 per cent of egg production, while the northern and western regions account for the remaining 31 percent of egg production. The importance of southern region is because of many factors: (i) reduced capital and variable costs of production (FCR is minimum in South India), due to less disparity in weather conditions, (ii) increased consumer demand, because relatively large number of household are consuming egg and poultry meat[15] and relatively higher level of per capita consumption[16] (iii) readily availability of DOCs at lower prices, due to location of hatcheries, (iv) presence of relatively large number of integrators and (v) presence of most of poultry processed plants.

1.3 Independent and Contract Farming

The structure of India's poultry industry varies from region to region. While independent and relatively small scale producers (including desi fowls) are relatively large, integrated large scale producers have a growing share of output, particularly in South and Western regions[17]. Contract farming in India is still not legal, and poultry sector falls under State rules. The integration process was started by Venkateshwara Hatcheries in early-eighties in the region of South and North; but it miserably failed in most of the areas. It was again started during early-nineties when large number of small and medium farmers stopped producing chicken products. Integration started using services of some of these experienced farmers with infrastructure like

shades, electricity, etc[18]. This became more popular in South and then West. In North, it could not become popular, probably due to different reasons like (i) there was significant difference in the cost of production during different seasons, (ii) farmers were not ready to honour contract integrators, if market prices were high, and (iii) a large number of the farmers had been benefited from green revolution in Punjab, Haryana and Western U.P. However, there are two or three exclusive integrators in North along with some national level integrators.

Some integrators also include large regional firms that incorporate all aspects of production, including the raising of grandparent and parent flocks, rearing day old chicks (DoCs), contract farming, produce compound feed, providing veterinary services to their hatcheries and contract farmers, and wholesaling for DoCs/compound feed/output of contract farmers, etc Apart from supplying of contract farmers' poultry output to their processed units, some large scale integrators are supplying to Institutional sectors (hotels, etc) and open market.

1.4 Consumption, Prices and Demand

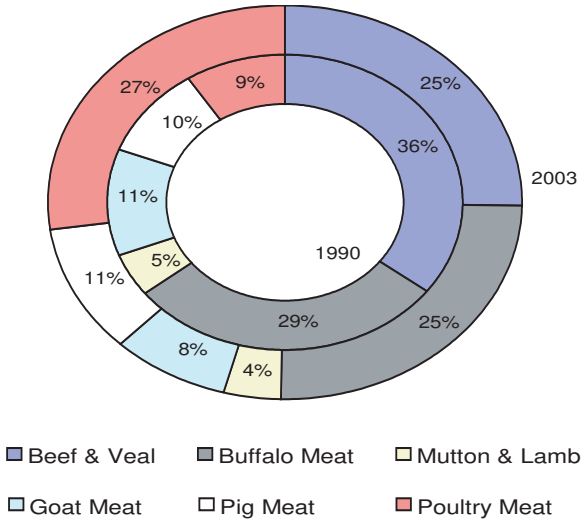
Even though India is the world's fifth largest egg producer and the eighteenth largest producer of broilers, domestic demand is relatively small with per capita consumption of these products is meager – 41 eggs and around 1 kg of poultry meat[19] as against the recommended levels of 180 eggs and 11 k. gm of poultry meat per capita per annum.[20] This is perhaps a reflection many consumers considering still poultry products not to be vegetarian. Despite this, there is considerable variation in the per capita consumption between rural and urban areas and also across the regions. Average per capita consumption of eggs is only half in rural areas compared with urban areas. In seven states (out of 35 states/Union territories), the per capita egg consumption is less than 9 per annum[21]. Similarly, per capita consumption of poultry meat is 0.24 kg in rural areas and 1.08 kg in urban areas.[22] In spite of relatively small consumption (vis-à-vis other countries) of poultry meat, the picture is changing in terms of total basket of Indian meat production and consumption. During last one and half decade (1990-2004), the growth of poultry meat production grew at 13.3 per cent per annum[23] compared to 4.79 per cent per annum of other meat products (beef & veal, buffalo meat, mutton & lamb, goat meat and pig meat), leading to maximum

production of poultry meat during 2003. (Figure 1.3). This switch to poultry products to some extent is driven by the relative small increase in domestic prices of eggs and broilers compared to fish as shown in Figure 1.4.

Price of eggs had been rising consistently under the pressure of inflation during the last two decades, but it has started showing declining trend after outbreak of Avian flu in Feb. 2006. However, it started increasing within three months. Broiler prices also showed increasing trend till 2000, but declined after that. Egg prices are seen to have shot up by 5.24 per cent per annum (1985-2005) and that of poultry meat by 1.97 per cent per annum, during same period[24]. The price of fish however is seen to have increased faster than that of eggs and broilers 8.09 per cent per annum between 1982-83 and 1998-99.

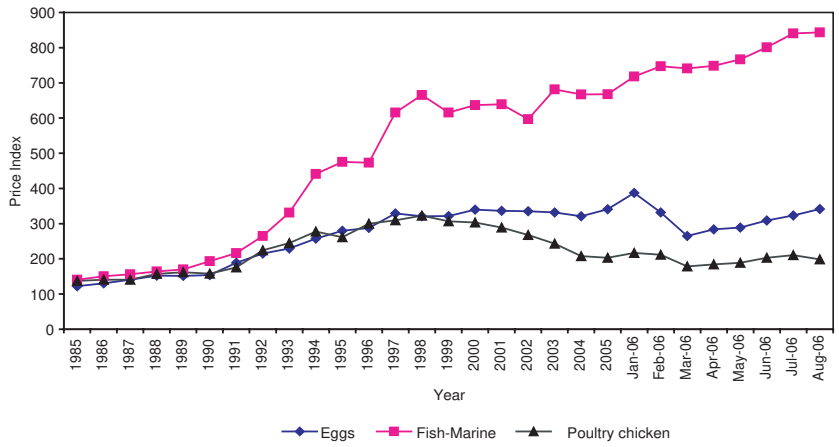
The consumption data originating from the India's National Sample Survey (NSS) rounds reveals many interesting facts. First, 42 percent of households do not eat fish, meat or eggs, i.e. vegetarians. Over time there

Figure 1.3: Meat Production in India: 1990 (=3710 Th. tonnes) to 2003 (=5898 Th. tonnes);



Source of data: FAO Stat

Figure 1.4: Wholesale Price Index of Eggs, Fish-marine and Poultry Chicken, 1982-Aug.'06 (Base Year: 1980-81=100)



Source: GoI, Office of Economic Advisor, Department of Industry, *Index Number of wholesale Prices*, Various Issues.

has been a slow change from vegetarianism to non-vegetarianism. The change is more visible in rural areas than in urban areas. For instance, between 1987-88 and 1999-2000 the increase in the proportion of households consuming any one of the three items namely fish, meat or eggs is only one percentage point in urban areas, while in rural areas this proportion increased by 4 percentage points[25]. Second, calculation of income elasticities of demand for different commodity groups show that the commodity group, 'meat, fish or eggs', occupy the second position in the consumption basket of rural people (milk and milk products occupying the first position), while in the urban consumption basket of the cited group occupies the third position. The estimated income elasticity is 1.01 in rural areas and 0.66 in urban areas[26]. Third, the price elasticity also follows the same order. 'Meat, fish or eggs' have high price elasticity of 0.75 in rural areas and 0.68 in urban areas. Fourth, estimates of income and price elasticities calculated for each of the four expenditure groups[27] show that these elasticities tend to decline as one move from 'poor' to 'non-poor' and 'rich'. The income elasticity is low for the 'rich', 0.5 in rural and 0.6 in urban areas. The other three income groups in rural areas have high-income elasticities ranging from

1.3 to 1.7. In urban areas, only the expenditure class of 'very poor' has income elasticity greater than unity. Price elasticities are greater than unity for 'very poor' and 'poor' in rural areas and 'very poor' in urban areas. One significant policy implication of these estimated elasticities is that there is lot of scope in raising the demand for poultry items in rural areas.

1.5 Exports/Imports of Poultry

India's participation in the world trade in poultry has so far been negligible. During 2003, the world trade (exports) in poultry meat amounted to around 10 million metric tonnes. But India's export of poultry was only 6.9 thousand tonnes i.e. 0.07 percent of the world's exports on a volume basis[28]. As shown in Table 1.3, egg and egg-based products account for most of India's poultry exports. Exports of hatching and table eggs have increased dramatically due to a higher demand from the Middle East and south eastern countries – from 1.52 thousand metric tonnes ($ 1.2 million) in 1990 to more than 48.58 metric tonnes in 2004($ 37.4 million). Similarly, exports of egg powder increased from a meager amount of $ 0.02 million in 1990 to 23.3 million in 2003. After 2003, however, exports of egg powder have declined to 19.5 million in 2004.

The top export markets for India's table and hatching eggs are Kuwait, Oman, Saudi Arabia, UAE and Yemen. Similarly, the market for egg powder

Table 1.3: India's Export of Poultry, 1990-2004
(Quantity in tonnes, Value in 000 US$)

Year	Chicken Meat-Fresh,Chilled, or Frozen		Birds Eggs without Shell Dried		Birds Eggs without Shell Liquid		Hen Eggs with Shell		Poultry Total
	Qty.	Val.	Qty.	Val.	Qty.	Val.	Qty.	Val.	Val.
1990			22	19	1	2	1524	1154	1175
1995	70	60	305	1249	44	97	13175	4238	5644
2000	84	92	957	2481	4539	6620	11344	12741	21934
2003	4473	4422	3239	10717	6969	12675	42319	29912	57726
2004	1404	1407	2202	6265	3248	13281	48582	37416	58369

Source: FAOSTAT; FAO Statistics Division, 2006.

Table 1.4: India's Import of Poultry, 1990-2004
(Quantity in tonnes, Value in 000 US$)

Year	Chicken Meat-Fresh,Chilled, or Frozen		Birds Eggs without Shell Dried		Birds Eggs without Shell Liquid		Hen Eggs with Shell		Poultry Total
	Qty.	Val.	Qty.	Val.	Qty.	Val.	Qty.	Val.	Val.
Val.	Qty.	Val.	Qty.	Val.	Val.				
1990	—	—	—	—	—	—	—	—	—
1995	—	—	—	—	—	—	—	—	—
2000	0.01	0.12	—	—	—	—	23	40	40.12
2003	7	8	44	156	40	103	43	78	345
2004	—	—	—	—	—	—	300	675	675

Source: FAOSTAT; FAO Statistics Division, 2006
— Negligible

consists of countries of the European Union (EU) and Japan. India also exports live poultry in the form of DoCs to other South Asian countries.

As shown in Table 1.4 Indian imports of poultry products have been negligible because of a web of import restrictions. Only hotels and restaurants were permitted to import poultry meat under import licensing till early 2000. However, beginning April 1, 2001, all quantitative restrictions on India's imports have been dismantled, and poultry items can be freely imported.

This, it is feared, would lead to significant imports and un-remunerative prices to local producers forcing them to close their shops. There are several reasons behind this alleged fear. First, poultry processors in a large number of developed countries are said to earn their profits by selling their breast portion of chicken, which is conveniently promoted as lean/white meat at a premium price in their own markets. The leg portion (the leg quarter), on the other hand, is treated as dark meat and may get targeted for Asian markets at a throwaway price. In the Indian market, the thigh and leg quarters are preferred. Therefore, when imported leg quarters at throwaway prices are dumped in local markets, local producers are definitely going to be hurt. Second, Foreign governments, especially the US and EU, support

poultry exports with subsidies. The amount of subsidy works out to be substantial.[29] The result is an un-level playing field in which the ball inevitably bounces towards the Indian market. Third, effective April 2001, (a) chicken may be imported without license but subject to an import duty of 30 per cent for whole chicken fresh/chilled/frozen, and 100 per cent for cut in pieces[30], (b) Imports of grand parent breeding stock placed without any barriers and (c) Some additives such as lysine, methanine, choline, chloride, and vitamins can be freely imported.

1.6 Employment

There is no official employment statistics relating to poultry sector in India. However, some reliable statistics on employment by usual activities including livestock is available for select years. The latest comparable data is available only for years 1993-94 and 1999-2000. All India rural employed workers in livestock sector were 7.89 million and 7.96 million during 1993-94 and 1999-2000 respectively[31].

According to the industry sources, there has been an increase in the number of people involved in the poultry industry, over the years. Three decades ago, when egg and broiler production was 10 billion and 30 million, respectively, the total employment numbers in the poultry sector was small[32]. With the demand for poultry increasing, this sector employed around 2.0 million people in 2003[33]. At least 80 percent of employment in the poultry sector is generated directly by poultry producers, while 20 percent is engaged in feed, pharmaceuticals, equipment and other services required by the poultry sector. Additionally, there may be a similar number of people roughly 2.0 million who are engaged in marketing and other channels servicing the poultry sector[34].

2. Commercialization of the Indian Poultry Sector

Today, the world population is just over six billion people. By 2020, it is predicted that 7.5 billion people will inhabit the world and eating around 327 million tonnes of meat. The outlook for poultry meat appears to be most favorable among different types of meat, with all market fundamentals expected to demonstrate strong growth. World production, consumption

and trade are all seen by most international organizations to accelerate during the next few decades. Most of this growth is expected to originate in non-OECD countries[35]. Lower price of poultry meat relative to the price of other meats, combined with rising income and changing food habits in most of these countries, including India, is expected to strengthen the demand for meat.

For many countries with a relatively low per capita consumption it is expected that economic improvement would favor growth in the poultry sector relative to other livestock products[36]. India is no exception and the Indian poultry sector will likely witness drastic changes in terms of structure, production, and processing in the next decade. In order to meet the growing consumer demand it is likely that there will be a move to larger integrated operations having their own breeding farms, feed mills, hatcheries, and processing units who contract out production and the role of small independent farmers will decline. Further as much of the growing demand is in urban areas with consumers demanding safe food, it is expected that large investments will also flow into infrastructure development for production, processing, cold chain management, and marketing of poultry products.

2.1 Food Safety Concerns for India

Like many developed countries increasing consumers in India are expecting safe and hygienic food and looking towards the government to be the one to ensure such. The Indian government over the years has developed different rules to try to meet consumer's expectations. Both the Prevention of Food Adulteration Act, 1953 for domestic purposes and the Export Quality Control Act of 1963, which is governed by the Export Inspection Council(EIC) of India for export purposes were developed in an effort to make regulations of health and hygiene mandatory for processing plants. Government is trying now to harmonize its food standards with Codex standards and trying to put all these laws under one agency so as to avoid problems associated with the multiplicity of standard formulating agencies and implementation agencies. However, at present, most of the food safety emphasis is concerning export consignments.

Table 2.1: India: Different Ministries/Acts Dealing with Food Safety of the Poultry Sector

Central Government Ministries	Act
Ministry of Agriculture	Insecticide Act Meat Food Product Order 1973
Ministry of rural development: Directorate of marketing and inspection (DMI)	Agricultural Produce (Grading and Marking) Act
Ministry of health & family welfare	Prevention of Food Adulteration Act, 1954
Ministry of food processing industries	Fruits & Vegetable Products (Control) Order – FPO 1955
Ministry of commerce	Export (Quality Control & Inspections) Act, 1963
Ministry of civil supplies, consumer affairs and public distribution	Standards of Weights & Measures Act Standards of Weights & Measures (Enforcement) Act Bureau of Indian Standards (BIS) Act, 1986
Ministry of environment and forests	Environment (Protection) Act, 1986, Environment (Protection) Third Amendment Rules, 2002

Source: Mehta and George (2005)

In India, there are a number of legislations that are relevant to food safety of the poultry sector in its entire chain (chart 1). The most important legislations under different central government ministries are given in Table 2.1. The salient features of most of the above mentioned legislations with present relevance are given in Mehta and George (2005)[37]. In this context, it is important to highlight that Bureau of Indian Standards (BIS) and Directorate of Marketing and Inspection (DMI) are the two nodal agencies to deal exclusively with voluntary standards of poultry items in the domestic market.

The multiple domestic institutions is one of the main problems in following food safety standards. Keeping in view experience of other countries, India has developed "one food law", (also known as India Food Safety and Standard Bill) in 2005. However, the advantages and challenges of this law will be known after some time, because the law was approved in Indian Parliament in late 2006.

2.2 Processed Poultry Products and Export Markets

As shown in section I, egg powder is major item of Indian poultry. Prior to 1996, there were six egg-processing units, and all of them were exporting to the EU. All these units were set up to cater export market, because there is negligible demand for egg–powder in India. In 1996, the EU delisted India from the list of approved countries for import of egg powder on grounds that these units had not submitted their residue-monitoring plan (RMP).[38] As a possible result, export of egg powder, which stood at $28.77 million in 1997 declined drastically to 13.62 million in 2000. The frequent changes in food safety standards in India's destination markets, particularly EU, has led to in many difficulties for Indian processors leading to closer of three units (out of six).

At the same time, there was not a single agency set up by India to understand the problems of export supply, including egg powder. The matter was shunted from one ministry (department) to another so that this tardy approach may also have affected the country's exports. A second problem is with regard to granting equivalence by external market to countries like India in the export of egg powder. Even ten years after the submission of a list of units to be notified, the EU has not set up a commission to inspect these units and grant equivalence. A third example is that of Non-acceptance of Domestic Certification: Invariably, the test certificates issued by Indian laboratories are not accepted by the EU or other developed countries as they are not accredited to laboratories in the developed countries. Fourth, Environment and Welfare Issues adopted by EU have begun to constrain the export performance of developing countries like India.[39]

Part of the problem in poultry also stems from the complex nature of the industry. Vertical integration has not taken root very strongly. Integration in India is mostly horizontal.[40] A large number of the poultry operations are operated by independent producers – hatchery operators, feed operators[41], commercial farmers, etc. In this complex situation of so many players in the whole chain, maintaining food safety becomes a major problem.

2.3 Food Safety Issues: Steps by Government and Processors

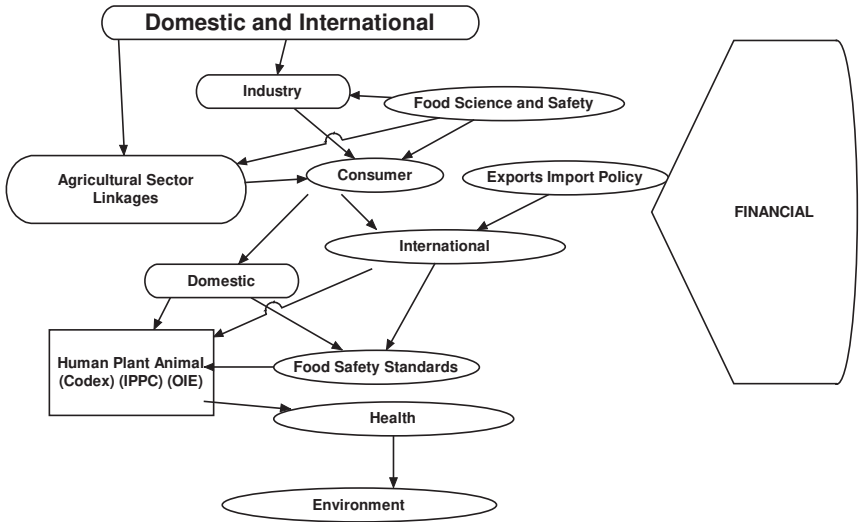
Domestic institutional mechanism is now gearing upwards to international food safety standards. The "three sisters" of the international standards,

namely the Codex, the IPPC and the OIE, are being addressed at different apex national level institutions. The relevant processing industry specific association or confederation like CLFMA forms an essential part of these interactions.

The domestic institutional and legal framework is developing itself into a web of inter-linkages. Be it the commercial interests or the health safety issues at the national level, a set of legal framework have already found in place. In association with industry-specific associations and commodity-specific export promotion boards, financial and environmental issues are also addressed. A simple picture of these complex inter-linkages can be viewed in the Figure 2.1.

Avian Influenza (AI) is one of most important issues in recent years. Although, it has been circulating for centuries, India however had remained free from major AI till mid-February 2006[42]. The first outbreak in India

Figure 2.1: Linkage of Various Institutions in Food Processing



Source: Mehta and George (2005).

occurred in 2006. Between January 27 and April 18, 2006, outbreaks of HPAI virus subtype HSNI were reported in two districts (Navapur and Jalgaon) of Maharashtra and adjoining areas in Gujarat and Madhya Pradesh. Control measures initiated included culling the entire poultry population, destruction of eggs, feeds, consumables, litter and other potentially infected material in a 10 kilometer radius of the outbreak location, restriction on the movement of poultry, poultry products and personnel to and from the affected areas, and cleaning and sanitation of the infected area. More than one million birds and over 1.5 million eggs were destroyed, and farmers compensated for their losses. The government carried out surveillance (clinical, virological and serological) in a 15 kilometer radius of the outbreak area. Surveillance was also carried on throughout the country through random sampling of observed abnormal mortality of poultry and wild migratory birds. On August-11, 2006, the government declared that India has regained its notifiable AI-free country status as per OIE regulations.

The confirmation of avian flu led to drop in the price of chicken from Rs 36/Kg to Rs 16/Kg. The main markets of Maharastra were the worst affected where business dropped by 40 percent . Production declined from 15 lakh birds to 12 lakh birds, and in case of eggs, production declined from 12 lakhs to 8 lakhs. Governments of other Indian states banned imports of poultry from Maharastra. According to industry sources the total estimated loss to poultry industry is reported to be around Rs 12000 Crore. Big integrators like Venketeshwara Hatcheries and Godrej Aggrovet are reported to have suffered huge losses.

After the country was declared “Avian influenza free” on August 26 by the Deptt. of Animal Husbandry, erosion in poultry off-take has slowed down. In October 2006, exports grew by 5.4 percent to Rs 26.5crore. On account of the downfall in exports in the earlier months, the total off-take during April-October 2006 was down by 27.7 percent at Rs 127.7crore. Exports to all major markets had fallen with the sharpest downfall in the intakes by UAE, Kuwait and Oman.

After the first outbreak in two western states, India recorded a multiple of AI in the eastern states like Manipur, Tripura, and West Bengal, during

2007 and 2008. On July 25, 2007, an outbreak was located in small poultry farm in far-east (an east district of Manipur). Within 15 days, 336000 birds were culled, and 28000 eggs destroyed and 131 metric tonnes of poultry meat burned.

The strains of H5N1 virus were confirmed in West Bengal during Jan. 2008. It was worst ever in India, covering 14 of its 19 districts. The communist-ruled state briefly contained the outbreak by culling more than 4 million birds. Poultry sales in the state had fallen by about 70 per cent in the January – March 2008, and traders were still struggling to over come losses. But the virus re-surfaced in tea-growing 15th District in May 2008. As per official statement, the West Bengal virus was reported only in backyard birds and not in any commercial farm. West Bengal borders Bangladesh where the virus has been detected in more than half of the countries 64 districts. The disease was first detected in Bangladesh in Feb. 2007 and was almost dormant by late 2007 but made a forceful comeback in January 2008.

A major amount of compensation to farmers/traders is being given by Government. According the official sources compensation has been fixed at Rs. 50 for layer, Rs. 20 for a chic, Rs. 75 for a duck and Rs. 2 for an egg. This amount is close to the market prices. India has so far not reported any human infections, but experts fear the H5N1 strain into a form which can be easily transmitted from person to person leading to a pandemic.

In view of the global threat of outbreak of AI and apprehensions of a human pandemic, it was necessary to take steps to ensure preparedness in case of an outbreak of AI. Major steps taken by GOI to control avian flu at (i) Pre-outbreak level, (ii) steps to be taken in the case of suspicion and (iii) specific action plan in case of outbreak. Most of these action plans have been prepared in consultation with WHO and other International organisation like OIC. Some broad points of Indian latest action plan to control avian flu has been in given in Annex I. When H5N1 virus is notified in any area of India, a red alert is issued and Government issues the state of the position every day.

2.4 Complementarities: A Case of Processors and Contract Farming

In the case of egg powder (mostly 100 percent export oriented units) there is close relationship between egg processor and contract layer farmers. Similarly, chicken processing units also procure broilers from contract farms, and the supply chain is maintained. The processing units own some of the farms themselves and in other cases they procure broilers from contract farms[43]. However, the processor sells value-added products through a network of distributors/retailers/directly to institutions where supply is in bulk or on yearly basis. In some cases chicken-based food outlets have now become vertical integrators[44].

Started in the year 1984, Suguna Poultry Farm Ltd. is today one of the leading poultry companies in India with a steadily increasing global presence. Its turnover exceeded 8.1 billion rupees in 2004-05. What makes Suguna Poultry special is its pioneering efforts in contract farming with help of thousands of small farmers to grow along with the company. It has also gone global and entered into partnerships with several international players.

In contract farming all the inputs such as Day Old Chicks, feed, medicines and daily care are the products supplied by Suguna. The contract farmer has to take care of daily management of the farm until the birds grow to the stage of marketability. The farmer owns the shed and for taking care of the birds. He is paid a fair amount namely, growing charges for the services he rendered for looking after the birds growth in his farm. To some extend responsibility rests with the company. Everything comes to his farm shed and same way it is taken from his farm gate. There is negligible risk for the farmer such as market volatility, raw material price fluctuations, etc. They are assured of a regular income at equal intervals.

2.5 Issues and Impact of Changing Food Safety Standards on Exports

The WTO agreement on the application of sanitary and phyto-sanitary measures sets out the basic rules for food safety for human, animal and plant health standards. It allows countries to set their own standards, but it

also stipulates that regulations must be based on science. They should not arbitrarily or unjustifiably discriminate between countries where identical and similar conditions prevail.

One of the problems in these standards is that they are so stringent that many countries have difficulty in implementing them nationally. India has been no exception and is trying to harmonize its standards with Codex so that it falls in line with all these agreements. Though, Indian standards for egg processing plants have been derived from USDA and EU Regulations, many countries like Australia and Malaysia do not recognize these standards. Similarly, the importing countries do not approve the veterinary certificate issued by competent government approved authorities like export inspection agencies and insist on a separate certificate issued by foreign consulting firms. In some cases, even the importing companies have their own specifications, which vary from their own national standards. However, there is a feeling in the Indian industry that sometime the importing countries particularly for egg products are using these measures discriminately. It is, therefore, quite evident that despite the best spirit of SPS Agreement these measures in some or other garb are being used to hinder exports from India.[45]

The Indian poultry sector, particularly egg processing units have already started integrating themselves with the global system. All the egg processing units in India are already HACCP compliant. Similarly, the chicken processing units are in line for adoption of HACCP, and many have already adopted. But it would not be out hof place to mention that only bigger units who have the manpower, infrastructure and financial strength can adopt HACCP and ISO 9000 type of measures. Small and marginal farmers and small units engaged in processing may find it difficult to implement these systems. In the following paragraph we give a case study which shows that how WTO is unable to meet supply-side issues.

An Indian consignment of "Egg Powder" was rejected in the EU[46] because the destination market included additional element known as MRPL or "minimum required performance limit", in May 2003. The rejection based on these additional criteria, MRPL, was not known to the Indian

establishment, because the new standard had to be met within 2-3 weeks.[47] In addition, it was also not clear whether the consignment met additional criteria or not, because the competent authority had not tested for the criteria. However, on re-examination it was found that the consignment met the additional criteria also. Since the re-examination of the consignment took some time, the consignment developed more problems due to longer shelf life at port.

The establishments whose consignment was rejected had a valid equivalence issued by the EU. And yet there was a "Rapid Alert' issued in EC as a routine that went to all importing countries. However when the consignment was declared to be meeting the additional element of MRPL, the 'Rapid Alert' was neither withdrawn nor importing countries de-alerted. The loss of reputation and increases in costs both implicit and explicit in this whole episode is going to take a long time to recover.

In this context, illustrations can also be provided from the Shrimp export ban by EU from the developing countries in general and Bangladesh in particular. The classical African peanut export ban, again by EU, on account of *afflatoxin;* rejection of fish consignments from Kenya on account of bacterium which causes Cholera; are a few of the experiences that the developing countries are not able to forget while SPS implementation issues are under discussion.[48]

2.6. Some Issues Related to Animal Health Welfare

There is no simple objective measure of welfare or general consensus of what welfare involves and, thus, all the emphasis to be given to any aspect of husbandry and economics. This arises because of inadequate understanding by at least some and possibly many people of one or more of the following disciplines: ethics, animal physiology, athology, diseases, pathology and epidimology. There are so many divergent groups involved that they have opposite ideas, interpretation and objectives and it is difficult to arrive at a consensus applicable to all. Therefore, welfare of livestock is lost in the ensuing often-acrimonious arguments. One of the difficulties arises from the large number of animals involved. One may consider 100,000 birds in one house, as a small unit whereas a million birds is a reasonable

size, which is economically viable. Both may follow good health husbandry practices but both must face the inevitable welfare problems of environment, nutrition and disease control. One must also keep in mind that the present industrial agriculture is required to feed a very large human population. We can broadly put objectives and measures of animal welfare, which can be assessed, in poultry houses as (1)Visual inspection and resulting assessment, (2)Ensure that freedom from thirst, freedom from pain, (3)Measurement of space available for hen, (4)Absence of behavioural anomalies likes fear, hysteria, cannibalism, feather picking, and vent picking, (5) Measurement of husbandry and flock health, and (6) Lab estimates of various physiological functions and hormone levels.

Welfare assessment is, however, more complicated for several reasons. The information of the above criteria is acceptable to everyone. There are a large number of hens in major poultry houses where traditional systems or battery cages are used. Caged houses containing over 100,000 hens or even more are now being built and there may be small farms in deep-litters with a size of 500 or 1000 birds. It is generally easier visually to assess individual animals in small flocks up to 100 than larger flocks where individual birds can be overlooked. In cages, hens are presented to the observer in good light and in small numbers as each cage hold a small flock. However, in the smaller flocks of traditional system, sick and bullied hens are much more likely to be overlooked as they may be hidden by equipment or dark corners. This is an important challenge to both management and caretakers in cages and more importantly in traditional systems. In India, the medium and big farms keep birds in cages whereas small and marginal farmers still have the traditional deep-litter system. In Europe, issues of animal welfare, antibiotic and ground water quality may become major concerns and cages have to be done away with by 2012 but there is no such concern in India as of today. But considering the globalization and international trade in poultry products these issues may be live in India after few years because of pressures from importers from countries like Western Europe and US. These countries may not import from India if poultry is produced in A-4 size cages However, one has to find acceptable systems of production.

In urban areas some animal health welfare enthusiasts have been raising their voices for animal welfare and humane treatment to the livestock. In future, some issues may become of some consideration even in India: (i) efficient in circulating balanced nutrients and in reducing leakage of such nutrients in air and water, (ii) sophisticated production methods with lower turnover of raw materials and energy, and (iii) sustainable forms of energy like solar energy, bio-fuels, etc.

2.7 Waste Disposal Concerns for Producers

In US and Western Europe, there is a great concern for waste disposal of poultry excreta as well as rendering material from processing units. This is more so in EU and USA since they have very intensive system of production because of the climate and most of the houses need heating systems because of the cold climate. In India, most of flocks are kept in open houses and it is only in winter months, that too, in a few regions when the heating systems have to use for few days. The excreta of birds, whether in cages or through deep-litter is used as fertilizer by the agricultural farmers for different crops and as of today there is no such problem of excreta waste disposal.

Regarding waste from processing units of chicken, some of the units have got rendering plants, which properly use the blood, feathers, intestines, etc., and other waste material recovered from processing of the chicken. However, by-products from rendering plants are not reused in poultry production. Moreover, most of the poultry units in India are located in rural areas and as such do not cause several environmental problems. But looking into the future global concerns over such issues, India will have to look into these matters more objectively and make plans to sort them out.

2.8. Environmental Pollution in Poultry Products

In many countries, there has been an increasing concern over environmental pollution since most of the houses use massive energy to provide heating and in turn these production units produce lot of ammonia and other gases. The processing units of chicken also produce plenty polluting elements and concerns has been raised time and again pertaining to the quality of ground water, risk of leakage of poisonous material, etc. In India, these issues are not yet critical, though, they are discussed now at various seminars and discussions

on poultry production. As organic production systems are gaining relevance in many countries, organic production systems are designed to produce optimum quantity of food by using management practices that aim to avoid the use of agro-chemical inputs that, in turn, minimize damage to the environment and wildlife. These issues may crop up in India too after few years.

The organic philosophy for clear environment is that production should be carried out in small flocks in small units which would create greater risk of infection which will lead to greater risk of diseases as medicines and feed additives will not be used for this type of farming. Since growth promoters, hormones etc. are not used and there is not very intensive poultry production and houses are open there is a big difference between Indian and western production of broiler and eggs. Therefore, the problems may arise only when the international trade takes place and the countries raise objections to such production systems as not compatible with their own production systems. No serious thought has been given to this problem.

2.9. Conflicts between Poultry Productions, Producers/Processors, and Local Population over Environmental Issues

Presently, there is no conflict between the producers of poultry products, farmers, and population living around them since these farms are not supposed to be creating any health hazards. But as the urban population grows and moves towards rural areas and becomes more alive to environmental issues, this may become a problem of future as the poultry industry grows along. However, there is big problem (a) with poultry slaughters, as Indian people prefer slaughtering in their presence, and (b) availability of quality water. A very significant portion of Indian broilers are slaughtered in small road side shops with no provisions for meeting minimum conditions. Many times it has been found that the blood, feathers, intestines, etc are thrown into nearby areas creating a health hazard for local community. Strict vegetarians object to poultry or other meat shops in their nearby areas. Although, Govt. of India has special conditions for approval of poultry slaughter houses, it is seldom followed by poultry slaughter shops/houses (Annex II).

The quality of the water used for the poultry sector in hatcheries, farming and processing has to meet some minimum standards. That quality of water

is generally not available to local public even for drinking purpose. In some areas, it leads to major conflict between producers and local population. This problem will further aggravate with increasing poultry production, in future. With the growth in poultry, the need for water (and grains) would increase. Since the Indian population is also increasing, the poultry growth will would place a challenge to policy makers about how to balance the consumption of water (and grains) between the human and the birds.

2.10. Constraints on the Growth of Poultry Industry

A major constraint affecting the growth of the poultry industry in India is the lack of basic infrastructure such as storage and transportation including cold chain facilities. As a result, there are wild price fluctuations in the prices of poultry products, i.e. eggs and broilers. Another constraint to growth is an inefficient marketing system. A third problem relates to prices of feed resources. Maize or corn plays a major role in broiler production, as it constitutes 50 to 55 percent of broiler feed. As the broiler industry is growing at the rate of 15 percent per annum, the demand for maize is thus likely to increase. Presently, India grows around 11-12 million tonnes of maize[49], and only 5-6 million tonnes are available for poultry which is insufficient if the current growth rate of the industry is to be maintained. Fourth, though poultry is an integral part of agriculture and treated on par with livestock in India, it faces restrictions on use of agricultural land, attracts higher electricity tariffs/ sales tax than that of agriculture, pays tax on income earned from poultry farms, and is subject to different land/labor laws including the minimum wage act. Fifth, in India there is no tradition of processed poultry in which the poultry is frozen, which provides higher shelf life to the poultry. Here the poultry is kept alive thus there is no shelf life of poultry.[50] This leads to wide price fluctuations thus impacting the profitability of poultry farms. Sixth, lack of vertical integration of poultry industry is another important problem Indian poultry industry is facing.

In other counties, particularly developed ones, a number of other issues like environment, food safety and animal welfare etc. are important in the context of poultry production. The following section gives the present state of the position of some of these issues in India.

3. Research Questions, Hypotheses and Methodology

3.1 Specific Research Questions

As the main objective of this study, as earlier stated, is to identify factors in the scaling up of poultry production in India and to assess its implications for social and environmental outcomes, particularly the ones that the welfare of the poor we start by looking at ways to separate out the technological, economic and policy driven aspects so to understand which types of policy actions may be more pro-poor and welfare enhancing. Keeping this as our proximate goal, we frame questions for investigation as follows:

(a) Why do some poultry farms have higher nominal profits per unit of output than others?

(b) Why do some farms have higher negative environmental impact per unit of output than others? Do the negative environmental externalities explain the relative competitiveness?

(c) To what extent are these differences across farms due to differences in transaction costs and environmental externalities, or due to greater or less technical/allocative efficiency?

(d) Once above mentioned factors in (c) have been taken into account, what is the relative importance of each of these across farm sizes?

(e) Do contract farms earn higher nominal profits per unit compared with independents of a similar scale?

3.2 Hypotheses

These questions lead us to frame following hypotheses for testing:

(1) Small-scale producers reap lower profits per unit of output than do large farmers (i.e. economies of scale).

(2) Small-scale producers are not less efficient if family labour is not costed and true environmental externalities are taken into account.

(3) Profits of small-scale producers are more sensitive to 'transaction costs' than are those of large-scale producers.

(4) Small farmers expend a higher amount of effort or investment in pollution abatement per unit of output than do large farmers; and this situation creates a lower capture of environmental externalities per unit of output by small farms.

(5) Contract farmers have higher nominal profits per unit compared with independents of a similar scale.

3.3 Methodology

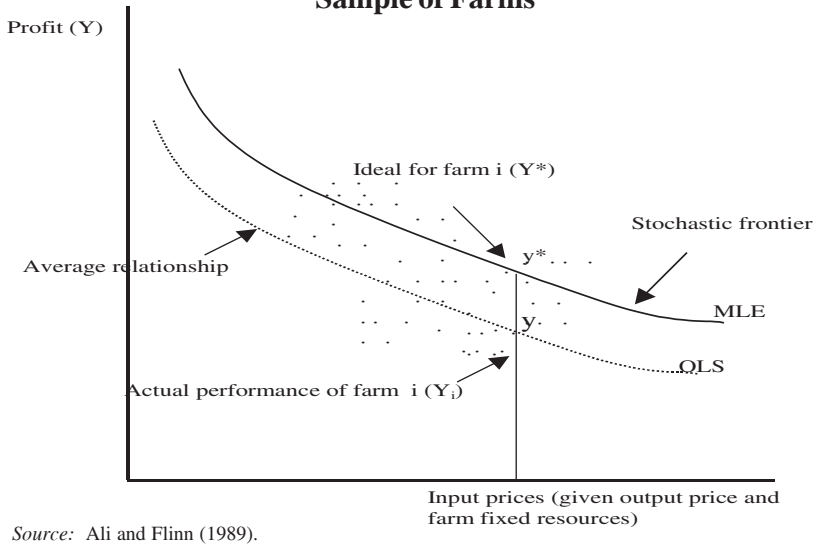
In testing above-mentioned hypotheses, we use two important approaches:

1. Simple statistical tests, like difference in mean value of profit of large and small farmers, contract and independent farmers.
2. Stochastic Profit frontier Function, for estimating determinants of relative profitability incorporating the cost associated with[51]

Stochastic Profit frontier Function

A standard way of assessing farm–specific relative profit efficiency is to estimate a "profit frontier" across a sample of farms, and then to measure how far each farm in the sample lies below the frontier. Given a set of prices, the average farm with that level of resources will fall below the frontier. Thus, a regression firm on data from a sample of farms of different sizes of profits against input and output prices and fixed factors of production (capital, labor, etc.) will always lie below the theoretical frontier. The frontier itself has to be estimated in some fashion looking at data for farms that perform best at each level of resources. Fried, Lovell and Schmidt (1993) described a variety of approaches to this.

Figure 3.1 Frontier (MLE) Stochastic Profit Function for a Sample of Farms



Source: Ali and Flinn (1989).

The measurement of "most efficient" can be improved by estimating a *stochastic* profit frontier.[52] In this study, the dependent variable is profit, and the independent variables are farm–specific fixed resources (family labor, sunk capital), farm–specific input prices (DOC, feed, medicines, capital stock, etc.), and farm–specific output prices. The actual performance of each farm in terms of profit can then be compared to an ideal performance level for that farm, given its resources and prevailing input and output prices. The difference between the ideal and the actual profit for that farm is the farm's relative profit inefficiency. Following Ali and Flynn (1989), Figure III.1 traces a profit frontier for a sample of farms; each dot corresponds to the actual outcome in terms of profit for a specific farm; points on the stochastic frontier curve (estimated by maximum likelihood method, or MLE) are fully efficient farms (on the frontier) and all points below are inefficient farms in terms of their specific resources at prevailing input prices.

Farm–specific profit efficiency (deviations below the frontier) are measured as the ratio of actual profit per unit (Y_i in Figure III.1 for a farm i) and ideal profit (Y*). The measure of farm efficiency embodied in Y_i/Y^* is bounded by 1 (best; on the frontier) and 0 (worst; no profit). Farm–specific inefficiency is the distance below the frontier, $(Y^* - Y_i)$.

Step 1: The stochastic profit frontier. A somewhat general form of stochastic profit frontier Function can be written as

$$Y_i = f(X_i, W_i, P_i; \beta)\exp(v_i - u_i)$$

where = profit of poultry farm i. In this study it is measured as

$$Y_i = (P_iQ_i - C_iQ_i) \text{ …. …. …. …. …. (1)}$$

where P_iQ_i is total revenue from poultry farm *i* (manure sales included); C_iQ_i is total variable costs of different inputs (DOCs, feed, electricity, water, medicines, vaccines, deprecation and hired labor) for securing revenue (excluding family labor) of farm *i*; X_i = vector of fixed factors used to obtain Y_i (e.g., buildings and equipment, fixed capital stock, etc. to control for differences in farm resources); W_i = vector of farm–specific input prices;

P_i =Output prices[53], β = vector of unknown parameters to be estimated; and v_i, u_i are random error terms.[54]

The term (v_i) is usual error term and u_i represents inefficiency of farm i. .

Step 2: Technical inefficiency determinant model. We follow Battese and Coelli (1995) and presume that the expected value of farm-specific inefficiency is function of farm-specific characteristics which are different for different farm. To estimate u_i (inefficiency) term, we assume $u_i \sim N(\mu_t, \sigma_u^2)$, where the mean inefficiency is a deterministic function of P explanatory variables where: $\mu_t = z_i\delta$ where δ is a Px1 vector of parameters to be estimated. The is a column vector of order Px1 represent P explanatory variables observed for farm *i* associated with technical inefficiency effects (u_i), Thus, the technical inefficiency effect, u_i in equation (1), can then be specified as

$$\mu_i = \delta_o + \sum_{p=1}^{P} z_{ip}\delta_p + e_i \text{ …. …. …. …. (2)}$$

where is the inefficiency error term, defined by the truncation of the normal distribution with mean equal to zero and variance σ^2. The truncation of occurs at $e_i \geq z_i\delta$.

Specification the Model

The exact form of the stochastic regression equation used in this study can be written as:

$$\text{In } Y_i = \beta o + \sum_{l}^{L}\beta_{0l}D_{il} + \beta_i \ln P_i + \sum_{j=1}^{J}\beta_{ij}\ln W_{ij} + \sum_{k=1}^{K}\gamma_{ik}\ln X_{ik} \text{ … … (3)}$$

(dummies) (out. prices) (inp. prices) (fixed factors)

$$+\frac{1}{2}\sum_{k=1}^{K}\sum_{j=1}^{J}\alpha_{ikj}\ell nX_{ik}\ell nW_{ij} + \frac{1}{2}\sum_{k=1}^{K}(\varphi_{ik}\ell nX_{ik})\ell nX_{ik}$$

(Price-factor interactions) (Factor interactions)

$$+ v_i - u_i$$

(random error) (random technical inefficiency effect)

where Y_i is the profit of the i-th farm defined in equation (1); W_{ij} is the price of input j (j= hired labor, capital, feeds, DOC, medicines, electricity, other inputs, used by the i-th farm); X_{ik} is the fixed factor k used by the i-th farm (k = is the value of breeding stock, value of buildings and equipment, total farm labor in hours, and other fixed capital stock); and D_{il} is a vector of dummy variables for farm i (l =production arrangement, gender, scale, region/zone, access to credit, access to information).

The technical inefficiency effects (u_i) generated in equation (3) are assumed to function of P variables as defined in eqn. (2).[55]

The RHS variables of equation (2), that is the z_{ip} includes proxies of differential access to credit for capital/feeds, subsidized veterinary medicines, access to feed of known quality, subsidies and taxes (for differences in policy distortions), access to potential and other source of income, access to markets for output, access to information, distance to nearest city or residential area, and a measure of the farm specific internalization of negative environmental externalities produced by that farm.

The details of measuring the farm-specific internalization of environmental externalities and its impact on profitability and rationale for the approach described below are found in Delgado et al. (2008). For this study the variables for environmental mitigation include all costs of disposing manure, labor spent collecting and drying manure for sale (evaluated at market rates), and cost of compliance in meeting environmental regulations. In addition, the spreading of manure on crops is considered to transform a potential externality (pollution) into a positive contribution to soil structure and fertility. The value of this benefit is estimated as the return of all manure sold for spreading on the fields of others (the reason it is purchased) at its sale value at the producing farm gate. Manure spread on one's own fields is valued at what it could have been sold for, at the farm gate. Thus, if manure is spread in the field and has any market value (i.e. it is not merely disposed of), the latter is included in the internalization of the externality. An index of environmental mitigation is created, measured as rupees per kg of output. The profit per unit thus depends on environmental mitigation expenditures, but environmental mitigation expenditures are also

influenced by profit. Thus an instrumental variable for environmental mitigation is created by regressing the index on a series of exogenous determinants. This approach provides insights into why some farms are more prone to spend more on environmental mitigation than others. The predicted value of the dependent variable from these regressions-environmental mitigation-can then be used as an explanatory variable in the second stage regression that explains why some farms are closer to the profit frontier than others.

4. Data and Survey

To test above mentioned hypotheses empirically, household surveys were conducted to collect detailed disaggregated data on variable costs, fixed costs, and revenue.

4.1 Location of Sample

The two locations selected for this purpose were Andhra Pradesh and Haryana (see Figure IV.1). The former, i.e. the state of Andhra Pradesh ranks first in poultry production, with around 7000 poultry farms, each one with an average size of ten thousand birds or more.[56] The latter, i.e. Haryana ranked only tenth in egg production (637 million eggs in 1997-98). In Andhara Pradesh, commercialization of poultry has come a long way, and has been expanding the scale of operations, whole Harayana is picking up. The details of location of sample survey are given in Mehta et al. (2003).

4.2 Sample Size and Composition

The next step consisted in drawing a sample. In India no census of poultry farms has ever been conducted. In order to select a sample without adequate information regarding the population of poultry farms a multi-pronged approach was used. First, a directory listing the names and addresses of poultry farms (especially for Haryana) was consulted. As this information in the directory was old and did not contain the names of new entrants the National Egg Coordination Council, which kept records of its members, were consulted. Third, integrators helped to provide a list of poultry farms in their respective areas. The pooling of this information enabled us to gain an approximate idea of the size of the poultry population in the two survey locations. Using some subjective judgment,

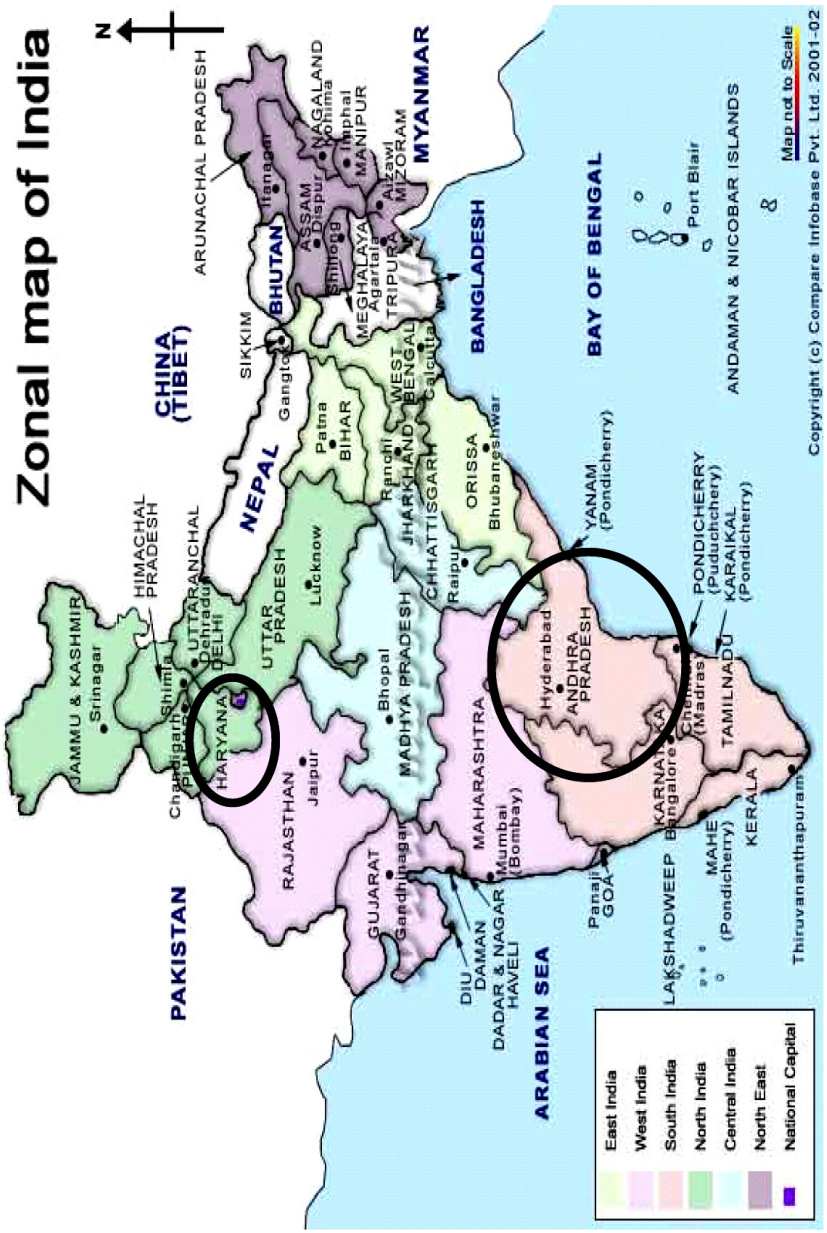


Figure 4.1: Location of Sample Survey: States of India

Table 4.1: Details of Sample from Indian Poultry Survey, 2002

Sr. No.	Farm category	No. of farms		
		Andhra Pradesh	Haryana	Total
Layers				
1	Layer small (<1000 birds)	22	41	63
2	Layer large (>=10,000 birds)	58	40	98
	Total (layers)	80	81	161
Broilers				
3	Broiler small independent (<10,000 birds)	58	35	93
4	Broiler independent large (>=10000 birds)	8	35	43
.	Subtotal (broiler independent)	66	70	136
5	Broiler - contract small (<10,000 birds)	13	4	17
6	Broiler – contract large (>=10,000 birds)	1	5	6
	Subtotal (broiler contract)14	9	23	
	Total (broiler)	80	79	159
	Grand Total	160	160	320

Source: Mehta et al. (2003)

while also leaving enough scope to capture diverse characteristics of poultry units such as nearness to urban/rural areas or main road/kutcha road, we selected 160 farms in both Andhra Pradesh and Haryana to sample. Details of this sample include the number of broiler or layer farms in the two states and these are shown in Table 4.1.

The field survey was carried out in Andhra Pradesh and Haryana during October-December 2002. The data originating from the survey was checked and cross-checked for consistency, and wherever gaps or inconsistencies were noticed, these were rectified by revisiting the farm in January 2003.

4.3. Estimation of Revenue, Cost and Profit

Estimation of revenue, cost and profit per annum in the case of poultry involves a complex procedure because of differences in the reference period used for the different input items. A layer unit, for instance, consists of a

number of batches in order to have a continuous flow of income. Data on output and most of the inputs are collected for only the latest completed batch, which makes up only a part of the unit. The size of the unit is expressed in terms of the total number of birds in all the batches at a point of time. For instance, if a unit maintains three different batches of 10,000 birds each, the size of the unit is 30,000 birds. Each batch will be completed in about 72 weeks or 17 months. There will be a gap of two to three weeks after the completion of the batch for cleaning and disinfecting the sheds before commencing with the next batch. The duration of the batch varies from 72 weeks to 80 weeks depending on the production rate of eggs. The completion of all the batches is counted as a single and it coincides with the duration of a batch. The duration of a batch is about seven weeks in the case of a broiler unit. Annual estimates have to be derived for both types of units. Furthermore, the data available for a batch has to be multiplied for a cycle. The following method is used to derive the annual estimates for all of the broiler and layer units.

In order to derive the annual output of a layer unit from the output originating from a batch, a multiplier is constructed as the product of two factors: one for converting the batch estimate (about 72 weeks) for one year, and the other for converting the estimate for one batch to the estimate for the entire unit. If x is the duration of the batch (in weeks) and y is the gap between two batches (in weeks), the first factor is 52/(x+y). To illustrate, if the gap between two batches is two weeks and the duration of the batch is 72 weeks, the first factor is 0.7027. The second factor, i.e. the factor for converting the batch to estimate for the year is the ratio of the size of the unit to the size of the batch. If a layer unit of 10,000 birds has 2,500 layers in the latest completed batch, the second conversion factor becomes four. The multiplier for the above unit is 2.8108 (0.7027 x 4.0). Since broiler output is collected for all the batches maintained in a year, the multiplier is unity for output. However, certain items of inputs are collected for the latest batch and for these items; the multiplier is the ratio of unit size to the size of the batch. Thus, only one of the two factors of the multiplier for layer will be applicable for the broiler.

The revenue from a layer unit comes from eggs and manure. As there is some spoilage of eggs, the value of eggs is based on the production of

eggs minus the value of spoilage. A broiler unit produces, and brings in revenue from meat and manure. Information on the quantity of these outputs and their corresponding prices is available. The value of manure is calculated as the total value of manure used either by the farm or by others, and is valued at the market price.

Data on inputs are collected for various reference periods. Information on some inputs such as regular workers is collected for the year, and on other inputs such as casual workers or feed, is instead, collected for the batch. Information on feed is collected for different stages of the bird for the latest completed batch. Expenditure data on electricity, water, phone, etc. are available for the entire unit. Cost items are classified into two categories. Cost items representing the entire unit per year are taken as they are without applying any factor for blowing up. Cost items representing the batch are converted into annual estimates for the entire unit using the multiplier.

4.4 Structural Characteristics of Sample Poultry Units

The detailed information of sample survey consisting of (i) education/ training/experience of decision maker in poultry, (ii) availability of infrastructure, fixed capital/working capital etc., (iii) closeness of unit to urban areas/residence area; technology of poultry production (deep litter or cages), management (proprietorship/partnership) enterprise; present size of units, and age of unit; (iv) mortality rate/yield per bird; (v) hired labour, (vi) sale of output to type of agencies (wholesale/retail/contractor etc); (vii) mode and location of disposal of dead birds; (viii) indicators of environment pollution/environment cleaning, etc., is given in Mehta et al. (2003).

5. Empirical Results

This section presents the empirical results obtained from testing the various hypotheses presented in Section 3. They are discussed here again briefly so as to understand the results of the hypotheses.

5.1 Small-Scale Producers have Higher or Equal Profits per unit of Output than do Large Producers.

This hypothesis is interested in whether small-scale producers have higher or equal profits per unit of output than larger producers. For the purpose of

answering this hypothesis the farm profitability is calculated. Profitability is determined by directly using the farm survey data to calculate profits of individual farms for each layer and broiler operations.[57] Profit (gross revenue less variable cost), is computed directly first for each farm and then averaged. The calculation for profitability is used in the financial (nominal) sense rather than with social prices. Profit was calculated without costing family labor.

In this paper, profitability is defined for both layer-egg production and broiler-meat production as net revenue (total revenue - total cost) per unit of output. For layers the unit is expressed as Rupees per egg. For broilers the unit is expressed as Rupees per bird. The distribution of profitability of layer units is summarized in Table V.1. For layers a number of interesting profitability trends can be observed. First, layer units on the whole, did not appear to be very profitable. Eleven out of 161 sample units demonstrated negative profitability. Of those, which demonstrated positive profitability, a large number fall in the frequency group (profit) of 0.20 - 0.30 rupees per egg? Broiler units, on the other hand, appeared to perform better than layer units. Only three out of 158 units tend to be operating at a loss (negative or zero values). However as with layers, it is difficult to ascertain from the data whether small or large units tend to make more/less profit, since the distribution of units seems to spread evenly across all frequency intervals.

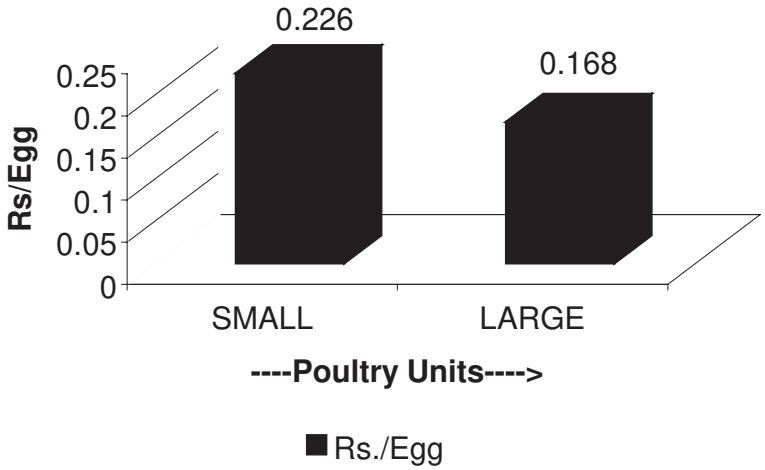
To check these findings if indeed there are differences in profitability across small farms and large farms each group is averaged separately and

Table 5.1: Distribution of Layer Units by Profitability (Rs. / egg)

Profitability (Rs. / egg)	(<10,000 birds) Layer small (No)	(>10,000 birds) Layer Large (No.)
-1.00—0.00	4	7
0.00—0.10	11	18
0.10—0.20	12	24
0.20—0.30	8	32
0.30—0.40	4	2
Total	63	98

Note: Average price of output is Rs.1.19 per egg.*Source of Data:* Mehta et al. (2003).

Figure 5.1: Indian Layers: Profitability of Small vs Large (without family labor cost)



Source of Data: Mehta et al. (2003).

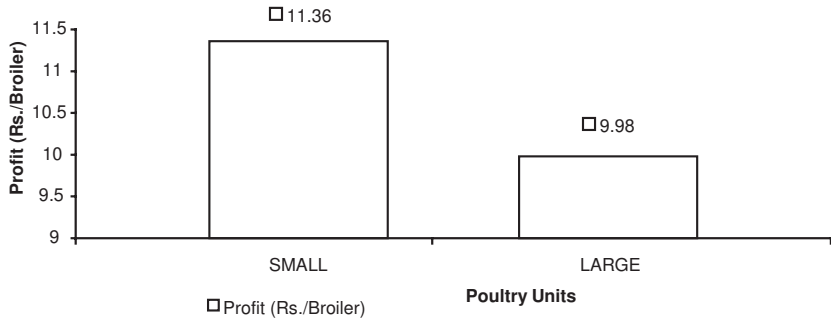
the differences between the two averages are statistically tested so as to confirm/reject the hypothesis. The estimated mean values of profitability for the small and large farms (as reported in Figure 5.1 and 5.2) were statistically tested using t-statistics for difference in mean values.

For the layer case the null hypothesis $\left(H_0 : \bar{x}_{small} = \bar{x}_{large}\right)$ is not rejected.[58] However it is difficult to have much confidence in these findings as they are not statistically significant at the 5 percent level. For the broiler case, the statistical test[59] for equality of average profitability (without family labor cost) of large and small farmer is significantly not accepted. The profitability (without family labor) of small farmer $\left(H_0 : \bar{x}_{small} = \bar{x}_{large} vs.\ \mathrm{H_A} : \bar{x}_{small} = \bar{x}_{large}\right)$ is higher than large farmers.

5.2 Efficiency of Small vs. Large Producers

The investigations so far sought to determine the profitability of small versus large producers. These investigations did show some difference in the average profitability of small producer's vis-à-vis large producers, but

Figure 5.2: Indian Broilers: Average Profitability of Small vs Large (without family labor cost)



Source of Data: Mehta et al. (2003).

the difference was not large enough to pass the test of statistical significance. The question that now needs to be probed is whether small or large producers are more efficient. The methodology employed to answer this question involves estimating the frontier profit function and explaining the differential performance of sample farms (away from the frontier line) in terms of differences in transaction costs and pollution abatement costs. As a first step towards estimating the frontier profit function, the dependent variable, profitability PRi = (TRi - TVCi), where PRi = Profit in Rs. of ith unit, TRi = Total Revenue of ith unit, TVCi = Total Cost of ith unit; is regressed with frontier variables. The explanatory variables of the frontier are:

price of (day old) chicks
wage rate (of male workers)
price of feeds
price of output (eggs or broilers)
family labour
value of capital stock
Wage Rate x Family Labour
Interest rate
Value of capital stock * interest rate
Wage rate * Scale Dummy
slope of labor housing -

A large number of workers have been provided with houses. Ideally, the rental value of the houses should be included in the wage rate

variable. We do not have the rental value of these houses. In case this rental value is not included in wages, the observation of wages (provided with houses) is downward biased. To capture this downward bias (errors in observations), we included a slope dummy for wages. The slope Dummy has value =1 if labourer is provided accommodation, or = 0, otherwise.

We expect profitability to be inversely related to price of inputs - price of chicks, wage rate and price of feeds; and positively related to output price (of egg or broiler) and factor inputs - family labor, value of capital stock.

Technical efficiency/inefficiency across farms are sought to be explained in terms of differences in 'transaction costs' and 'pollution abatement costs'. The proxy variables selected for transaction costs are: age of the decision maker (in years); education of the decision maker (dummy variable =1 for secondary and above); information source (represented by dummy variable); distance to output market; access to credit (dummy = 1 if credit obtained); years of experience in poultry; and Region/state characteristics (Dummy = 1 for Haryana and 0 for Andhra Pradesh). Pollution abatement costs is measured as [costs of controlling flies + dead bird disposal cost + cost of pollution payment + manure disposal cost + value (included imputed) of manure used /consumed].

From the estimated coefficients one can make inferences about the direction and magnitude of the contribution of each determinant to the relative inefficiency of the farm in question. A significant positive coefficient means a positive contribution to increased inefficiency and vice versa.

Results

The estimated regression results of frontier function for broiler and layer are separately displayed in Tables 5.2 and 5.3, respectively.[60]

The estimated results (of pooled data) reported in Table 5.2 show profitability to be negatively related to the price of feeds, and positively related to the price of broiler. The coefficient of value of capital stock is found to be statistically significant with proper sign. Since the pooled data may lead to "aggregation bias", the results are estimated separately for

Table 5.2: Profit Efficiency Estimated and Explained on Indian Broiler Farms

	Small* N=93	Large* N=42	Pooled* N=135
Stochastic Profit Frontier			
Price of chicks	–0.77 (0.27)	–2.35 (1.00)	n.s.
Wage Rate	n.s.	n.s.	n.s.
Price of feeds	n.s.	–1.21 (0.53)	–1.58 (0.36)
Price of output (Broiler)	3.59 (0.58)	5.59 (0.86)	4.64 (0.56)
Family labour	n.s.	2.11 (0.96)	n.s.
Value of capital stock	n.s.	-10.79 (0.73)	0.79 (0.39)
Wage Rate x Family Labour	n.s.	n.s.	n.s.
Interest rate	n.s.	-54.29 (0.95)	2.79 (0.92)
Value of capital stock x Interest rate	n.s.	8.22 (0.55)	-0.55 (0.29)
Constant	n.s.	146.30 (0.99)	–6.89 (1.17)
Explainers of Inefficiencies			
Constant	n.s.	n.s.	-2.90 (1.21)
Age of the decision maker	n.s.	n.s.	n.s.
Information source (dummy variable = 1 for radio, TV, newspaper)	n.s.	n.s.	n.s.
Region (Dummy, North = 1)	n.s.	n.s.	n.s.
Pollution abatement costs	n.s.	n.s.	n.s.
Has access to credit, dummy	n.s.	n.s.	n.s.
Output Market Distance	0.64 (0.33)	n.s.	0.81 (0.16)
Experience	n.s.	–0.90 (0.33)	n.s.
Log likelihood function	–100.72	–36.39	–165.74
LR test (one–sided)	39.92	9.35	64.85
Gamma (g)	0.94 (0.04)	0.51 (0.36)	0.15 (0.30)

*Contract farmers not included
Note: "n.s." means statistically insignificant at 10 percent. Numbers in parentheses are standard errors.
Source: Authors' estimation using data from Mehta et al. (2003).

large and small broilers. Similarly the results of small and large farms show estimated co-efficient have expected signs. Prices of inputs, i.e. DOCs, interest rate and feed have negative co-efficient value and significant (exception being price of feed for small scale farms, which is insignificant) . Price of output has statistically highly significant value in both small and large farms. However some co-efficients of regression equation are statistically not significant, particularly in small broiler farms.

Table 5.3: Profit Efficiency Estimated and Explained on Indian Layer Farms

	Small N=62	*Large* N=96	*Pooled* N=158
Stochastic Profit Frontier			
Wage Rate	7.30 (0.68)	n.s.	n.s.
Price of feeds	–1.69 (0.95)	–1.53 (0.24)	–1.46 (0.25)
Price of Egg	2.04 (0.99)	1.00 (0.45)	0.93 (0.42)
Family labour	–6.07 (0.62)	n.s.	n.s.
Value of capital stock	n.s.	n.s.	n.s.
Slope of labour housing	n.s.	0.02 (0.01)	n.s.
Wage Rate x Family Labour	1.62	n.s.	n.s.
Wage Rate * SCALE DUMMY	n.s.	–	0.60 (0.22)
Feed Conversion Ratio	n.s.	n.s.	n.s.
Constant	–46.53 (0.99)	6.91 (3.68)	10.64 (6.25)
Explainers of Inefficiencies			
Constant	n.s.	3.56 (1.13)	4.64 (1.60)
Age of the decision maker	n.s.	–3.43 (0.62)	–3.36 (0.98)
Region (Dummy, North = 1)	n.s.	n.s.	–6.80 (2.05)
Pollution abatement costs	n.s.	–6.39 (1.04)	6.29 (2.58)
Education of Decision Maker	n.s.	–3.07 (0.69)	n.s.
Has access to credit, dummy	n.s.	n.s.	n.s.
Information source (dummy variable = 1 for radio, TV, newspaper)	n.s.	0.81 (0.42)	n.s.
Output market distance	n.s.	0.88 (0.16)	n.s.
Log likelihood function	4.24	–4.78	–8.01
LR test (one–sided)	18.92	83.46	104.31
Gamma (g)	0.99 (0.0001)	0.996 (0.002)	0.99 (0.002)

Note: "n.s." means statistically insignificant at 10 percent. Numbers in parentheses are standard errors.
Source: Authors' estimation using data from Mehta, et al. (2003).

Similarly, the estimated results (of pooled observations) reported in Table 5.3 for layers show profitability to be negatively related to the price of feeds; and positively related to value of capital stock. Similarly, the slope of labour housing has a positive sign in small and pooled data. The coefficient of family labor is found to be not statistically significant.

5.3 Farm-Specific Inefficiency is Affected by Transaction and Environment Mitigation Cost

The second step regression results (inefficiency effects due to transaction costs, and pollution abatement costs) for broilers and layers are also displayed in Tables 5.2 and 5.3, respectively. The estimated coefficient (inefficiency effects), based on pooled data (of small and large broiler farms) displayed in Table 5.2 show that market distance (the higher the distance of market from farm, higher the inefficiency) had a significant impact, for small scale and pooled (combined small + large) farms. Similarly the "experience" (higher) is also statistically significant, for large broiler farms.

The estimated δ coefficients for layer (inefficiency effects based on pooled data) displayed in Table 5.3, that show variables, namely, age of decision maker, and pollution abatement costs, as being statistically significant in explaining inefficiency effects across farms. Thus one can see from a careful inspection of this table that inefficiency effects are inversely related to the age of the decision maker (i.e., the higher the age of the decision maker, the lower the inefficiency effects and vice versa) and regional/state character (the more the state imposed distortion, the higher the inefficiency effects and vice versa). These data can be interpreted as saying that transaction costs (proxies by variables such as age) play a significant role in explaining the technical inefficiency of layer farms. In addition to transaction costs, another significant explanatory variable that explains farm inefficiency is pollution abatement costs. The coefficient of pollution abatement cost is positive and statistically significant in this result, which is based on the pooled observation.[61] Similarly the information source and output market distance have proper sign or statistically insignificant.

How do transaction costs and pollution abatement costs help to explain the comparative inefficiency of small versus large farms? Alternatively, do the transaction costs and pollution costs play a significantly greater role in explaining the technical inefficiency of the small farm than it does for the large farm? To test this, the second step regression was re-estimated separately for small and large farms. The estimated results for layers and broilers are displayed in Tables 5.2 and 5.3, respectively.

First, take a look at the results displayed in Table 5.2 for broilers. A glance at these results shows that the efficiency of large-scale broiler producers is influenced by transaction costs. For large-scale broiler producers, the most significant variable affecting efficiency is experience. Many coefficients in the Indian broiler sample (Table 5.2) were insignificant. In the small scale farms, market distance tended to be associated with greater inefficiency, most likely this is because the small scale farms spend more resource (permit) than large farms.

An inspection of layer results shows that transaction costs, pollution abatement costs and policy variables significantly influence the efficiency of the large farm vis-à-vis the small farm. The coefficients of age of farmer, information and market distance (proxies for transaction costs) and pollution abatement costs are statistically significant. The efficiency of large farms is influenced by availability of credit, while "region" dummy affect both small and large farmers. Next, take a look at the results reported in Table V.3, it can be concluded *"Indian layer farms, being in the South, having a younger operator, and making the greatest relative effort at mitigation of environmental externalities all tend to be associated with being relatively less profit efficient. If the large-scale layer sample is considered in isolation, the relatively most profit efficient are those who do the most per unit for environmental mitigation (similar to large-scale broiler producers in the Philippines), and are the best educated. In the case of these larger commercial operations, the higher education is more likely to be used to support the layer enterprise as opposed to commuting to a non-farm job."* Cf. Delgado, et. al. (2008).

5.4 Understanding Manure Disposal Practices and to Look at Environmental Externalities

As shown above we tried to look at how expenditure on environmental mitigating methods may affect efficiency, it says nothing about alternative methods that may exist for disposal or if the farmer is not spending large amounts on environmental mitigation because they have plenty of land or ways to properly dispose of it or other.

Broiler and layer producers from the household surveyed do not appear to think they have environmental problems when they are either able to sell

Table 5.4: Percentage Distribution of Units by Mode and Location of Disposal of Dead Birds

Category	Mode				Location			
	Bury	Incineration	Others	Total	Own land	Public land	Others	Total
Layer small	67.57	5.41	27.03	100 -74	81.08	2.7	16.22	100 -74
Layer large	66.67	14.94	18.39	100 -87	79.31	5.75	14.94	100 -87
Broiler small	30.71	3.15	66.14	100 -127	74.8	1.57	23.62	100 -127
Broiler large	9.38	9.38	81.25	100 -32	1.88	0	88.13	100 -32
All units	46.88	7.5	45.63	100 -320	77.19	2.81	20	100 -320

Notes: Small = less than 10,000 birds.
Large = more than 10,000 birds.
Figures in parentheses represent sample units.
Source of Data: Mehta et al. (2003).

the manure or they are able to spread manure on agricultural lands. Figures A-1 and A-2 in Annex III shows pathways in which broiler and manure and dead animals are disposed of. Markets for both broiler and layer manure do exist and most of the farms surveyed have access to such markets. In fact, 79 percent of small-scale broiler households and 90 percent of the small-scale layer households and almost all of the large-scale broiler and layer growers in the sample are able to sell poultry manure. At the point of disposal, there is more or less zero discharge of waste into the environment for these raisers.

How do the units dispose of dead birds? Do they receive complaints about environment pollution? How much do they spend on cleaning up the environment? Answers to these questions are arrayed in Tables 5.4, 5.5, and 5.6. First, we look at the data given in Table 5.4. About half of the sample units reported that they bury dead birds on their own land, and the rest reported disposing of dead birds by incineration or other means. Next the figures given in Table 5.5 illustrate the negative environment effects generated by sample units. About one-third of the layer units and one tenth of the broiler units reported having received public complaints. Similarly, about 10 percent of layer units and 2 percent of broiler units reported disposing of dead birds on public land.

Instances of sample units spending on pollution abatement are also frequent and are shown in Table 5.6. The data given in this table documents

Table 5.5: Indications of Environment Pollution (percent to all units)

Category	Receiving complaints	Manure not fully utilized	Dead birds disposed on public land	Spending on community for inconvenience
Layer small	16.2	0	4.1	1.4
Layer large	14.9	0	5.8	0
Broiler small	6.3	1.57	2.4	4.7
Broiler large	3	0	0	9.4

Notes: Small = less than 10,000 birds.
Large = more than 10,000 birds.
Source of Data: Mehta et al. (2003).

Table 5.6: Indications of Environmental Cleaning

Category	Control of flies (Rs. per batch)	Removal of dead birds (Rs. per batch)	Shed cleaning (Rs. per batch)
Layer small	368	191	369
Layer large	930	105	700
Broiler small	114	58	471
Broiler large	161	91	583

Notes: Small = less than 10,000 birds.
Large = more than 10,000 birds.
Source of Data: Mehta et al. (2003).

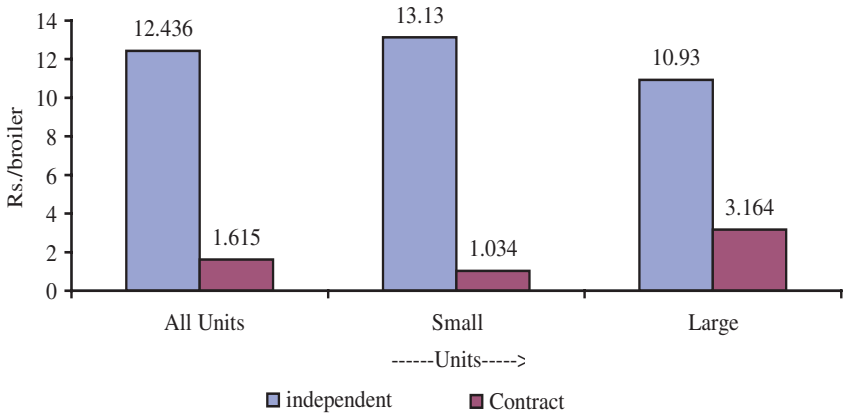
that all the units have been spending on control of flies, removal of dead birds, and shed cleaning. For example, layer units have been spending Rs. 300 to Rs. 900 per batch to control flies, while broiler units have been spending Rs. 100 to 160 for this sort of cleaning up.

5.5 Profitability of Independent vs. Contract Farms of Indian Broilers

A notable feature of the structural change taking place in the Indian poultry industry is the rapid increase in contract farming. Contract farming first made its appearance in layers in early-eighties, primarily to meet the export demand for manufacturing of egg powder. The export demand for egg powder was high and due to rising demand, the number of egg powder plants also increased. At the same time, contract farming in layers also started to flourish. During the last few years, contract farming has started to grow once again, particularly in broilers. The integrator that signed up these poultry growers supplied DOCs and, in most cases, feed, vaccines, and other inputs. The contract between the integrator and the broiler growers remains loose in the sense that the agreement does not legally bind the parties, who operate mainly on mutual trust and confidence.

The question that now needs to be answered pertains to the comparative performance, in terms of financial profit, of independent and contract farms. To determine this, it is necessary to first sum up and draw average profitability separately for the sample population of contract farms and

Figure 5.3: Average Profitability of Indian Broiler: Independents vs Contract Farmers



Source of Data: Mehta et al. (2003).

independent farms. The sample contains 23 contract broiler farms (17 small-size farms and six large-size farms) and 136 independent broiler farms (93 small-size farms and 43 large-size farms). Hence we calculate profitability of contract farms by averaging across profitability of individual units, and repeating the same excise for independent farms. Next, we test the significance of the difference in the profitability between independent and contract farms through statistical methods to determine whether the differences are really significant or not.

Figure 5.3 displays the calculations of the average profitability (without family labour) of contract farms and independent farms, both large and small. A glance at these results shows that, in terms of financial profitability, independent farms on the whole perform better than contract farms. The average profitability in the case of total number of independent broiler farms works out to Rs. 12.43 per bird compared with Rs. 1.62 per bird for contract farms. Not only are the differences substantial, they are statistically significant as well. Almost similar results have been noticed two other studies of Ramaswamy et al. (2006) and Tiongco et al. (2006) as shown in Table 5.7.

Table 5.7: Average Profitability of Independent Vs. Contract Farms (Rs./bird): Comparative Results with other Studies

Category	Mehta et al. (2003)	Ramaswamy et al. (2006)	Tiongco et al. (2006)	
	Average profitability (Rs/bird)	Average Revenue (Rs/Kg.)	Net return Rs/kg of live bird (without fam. labor)	Net return Rs/kg of live bird (with fam. labor)
Independent Broiler : Total	12.436	29.2	4.16	2.25
Contract Broiler : Total	1.615	2.62	1.96	1.46

Sources of Data: Mehta et al. (2003).; Ramaswamy et al. (2006); Tiongco et al. (2006).

When the comparison is drawn between small independent farms and small contract farms, or between large independent and large contract farms, the differences remain substantial and statistically significant enough to prove the prevailing contention that independent farms are more profitable, on the whole, than contract farms.

When comparisons are drawn, however, between small and large farms within the same category (i.e., small contract farm vs. large contract farm, or small independent farm vs. large independent farm), then the differences are not significant enough to state categorically that small farms are more profitable than large farms.

6. Concluding Remarks

Poultry is today one of the fastest growing segments of agriculture sector in India. While the production of agricultural crops has been rising at a rate of around 2.0 percent per annum, this of eggs and broilers has been rising at 8 to 10 percent per annum. India is today world's fifth largest egg producer and eighteenth largest producer of broiler. Propelling up this growth are a combination of factors - growth in per capita income, urbanising population and falling real poultry prices.

A worrisome feature of this accelerated growth is the expanding scale of production and its probable impact on small-scale producer. For the moments, there are many unanswered questions. Is this scaling up of production, knocking small producers away from business? Do small producers earn less profit per unit of output than large producers? Why do some poultry farms earn higher incomes than others? What explains the differentials in profitability across farms? Are small farms inefficient compared to large farms? This paper has sought to address to these vital questions. For this purpose the basic data was used from a primary survey of 320 poultry farm households drawn from two states of India namely, Andhra Pradesh and Haryana. Utilising this data, we sought (a) to determine farm level differences in per unit financial profit across size of operations, and (b) explain sources of differences in financial profit across different sizes of farms through the estimation of frontier profit function by incorporating a number of novel features including indicators of farm-specific transaction costs, environmental externalities and subsidies. Some key results to emerge are:

1. Profitability defined as profits (excluding family labour) per unit of output do not differ much between small size farms and large size farms whether layer or broiler. Alternatively speaking, profitability is not significantly affected by scale of operations.
2. The main factors that determine profitability are price of chicks (Docs), price of labour (wage rate), price of output (eggs/broilers), value of capital stock - inversely related to price of chicks, wage rate, price of feed, and positively related to price of eggs/broilers and value of capital stock (The capital stock is significant only for broilers).
3. Though profitability does not differ much between small farms and large farms, their efficiency differs significantly. Small farms are relatively inefficient; and the principle reasons for their inefficiency are high transaction costs and pollution abatement costs. That is to say, small producers enjoy less advantage compared to large producers in getting credit, information, marketing, transportation and storage facilities (transaction costs); and at the same time are constrained to spend more on collection, drying and transporting poultry manure (pollution abatement costs) to keep poultry sheds and its surroundings environmentally clean.

4. Besides transaction costs and pollution abatement costs, the differences in policy subsidies across region/states are also found to harm the efficiency of small producer more than that of large producer. This comes out from the regression results run separately for small producers. More specifically, small farms in a state like Andhra Pradesh are more inefficient than their counterparts in the state of Haryana because Andhra Pradesh levied a higher percent processing tax on poultry products besides the usual sales tax on poultry feed, while Haryana has no such taxes.
5. There exists significant difference in the profitability of contract farms vis-à-vis independent farms. The profitability of contract farms, whether large or small is lower than that of independent farms.

The study results do provide valuable inputs for policymaking. Approximately 15 million people in India are currently making a livelihood from poultry farming, and many of them are small producers. These small farmers are severely constrained by the cost of inputs/outputs, a lack of adequate infrastructure, poor transport facilities, inefficient marketing system, and no proper means of disseminating information. In order to strengthen these 15 million farmers and make them more competitive, the following policies may be recommended.

First, it must be noted that the poultry industry is highly dependent on the feed industry- feed alone constitutes 65 percent of the cost of broiler and egg production. Therefore, any price movement in the feed sector will have a direct positive effect on the prices of eggs and broilers. The main feed ingredients used are maize, soya, rice bran, and other cereals. Of these, maize is the most critical one in India. Its domestic production of maize has remained almost static at around 11 million tonnes per annum for the last decade or so. The poultry industry alone requires about five million tonnes per annum.

Other users of maize in India include the starch industry; the cattle feed industry, the seed sector, and the general population. Severe shortages of maize have frequently existed, causing the price to shoot up there by leading to crisis and turmoil in the poultry industry. Imports of maize were at one time restricted, but, since April 2000, imports have been approved under Open General License (OGL). However, an import of Maize is subject tariff-quota.

According to estimates prepared by the Poultry Federation of India, the proposed hike in the import duty on maize could increase poultry feed costs by as much as one rupee per kg. It seems likely that such a hike will hurt independent farmers more than contactors and small farmers more than large ones, other things being equal. Larger and more vertically-integrated enterprises have greater flexibility and more resources than small independents to adjust to price rises in a single key input. Providing all producers, but especially smaller ones, with feed at a competitive price might require that: (a) the present TRQ be raised or abolished, and (b) domestic production of maize be increased by increasing the yield per hectare, which is currently the lowest in the world at 1.4 tonnes (as compared with a world average of 4.2 tonnes). In order to increase domestic production of maize, though, India may have to diversify its agricultural production through contract farming and/or cultivation of GMO seed varieties.

Second, government of India need it to make serious efforts to improve the basic infrastructure facilities (stoppage and transportation, including cold chain), access to credit, dissemination of information, and the marketing system, all of which have severely constrained small farmers much more so than large farmers. Third, the government should endeavor to create a favorable economic environment for increasing capital formation and investment in poultry by rationalizing the tax structure and removing distortions in incentives. Several Indian states levy taxes on poultry processing and feed manufacturing, which tends to increase production costs and retard industry growth.

Finally, the Indian poultry sector, classified neither as an agricultural sector nor an industrial sector, receives far less support than its potential contribution might indicate. While the poultry growers continue to pay the same rate of income tax as any other industry, they receive neither subsidized power nor water, unlike the agricultural sector. Poultry producers also do not receive other fiscal and regulatory benefits and concessions available to the industrial sector. This ambiguity in the status of poultry producers is currently hindering the potential of this important sector. Improved governmental policy would treat all small poultry producers as agriculturists, extending the same benefits and concessions to them as to other agriculturists.

Annex I: India: Action Plan to Control Avian Influenza[62]

The strategy of the government of India has been to contain the disease at sources, i.e. at the level of animal itself. This is the principle way to reduce opportunities for spread of the disease and for possible human infection. Therefore disease intelligence active animal surveillance, strengthening the early warning system in the pre-outbreak stage and total culling in prescribed radius resulting in rapid containment in the outbreak phase are critical assets to reduce such opportunities for spread of infection.

I. Pre-outbreak preparedness:

I.1: Surveillance: Need to be in a state of alertness and preparedness: Surveillance is the most important part of the strategy to control and contain Avian Influenza. India has a poultry population of 481 million both commercial and backyard. About 60% of the population is in the commercial sector. It is indicated that the migratory birds play a role in the spread of the virus across countries and continents. India lies within three major internal fly ways of migratory birds. Surveillance will therefore have to include both poultry and migratory birds.

- I.1.1: Poultry owner, especially commercial poultry owners including consultants, franchisees, service providers and those related to rearing of poultry are individually and collectively responsible to immediately report unusual mortality and sickness in birds to the govt.
- I.1.2: The state govts are advised to develop routine surveillance plans. Representative random sampling may be done.
- I.1.3: A system of active and large targeted surveillance has been initiated. It includes immediate response to unusual sickness/ mortality among the birds.

I.2: Sample collection, packing and Transportation: The states must ensure proper collection, packing and transportation of samples, and give particular attention to the quality and quantity of samples forwarded to the labs.

I.3: District collector has to play a central and coordinating role especially concerning aspects of quarantine closure of shops, corporation, money control, ban on sale of poultry related products, administering vaccination plan etc. Therefore the district collector should be thoroughly formalized with the action plan.

II: Steps to be taken in case of suspicion of outbreak of AI:

II.1: In case of suspicion of outbreak of AI such as receipt of any preliminary report regarding unusual sickness or above average mortality of poultry as well as wild and migratory birds at a place for any other source, the investigation officer shall visit the place immediately and ascertain the facts of the case.

II.2: The investigation officer should carry out a clinical investigation with the aim to establish the clinical situation on the farm, including ill and suspect birds. The clinical investigation must be performed on all susceptible species present on the farm, and it must begin for the most peripheral units. All this information must be reported in the epidemiological inquiry report.

II.3: If the preliminary and clinical investigations indicate that it is an unusual situation indicating surveillance of AI, then the investigating officer has to ensure that steps as indicated in the subsequent paras are taken immediately.

II.4: Collection of samples and dispatch for laboratory tests: Samples should be sent to lab immediately.

II.5: Immediate report to Director, Animal Husbandry.

II.6: Identification of alert zones.

III: Action plan in case of outbreak of NAI is confirmed:

III.1: Notification and information of outbreak: In case lab test confirmed the occurrence of Notifiable Avian Influenza; HSAD Bhopal will inform the Govt. of India. The Govt. will dispatch Central Rapid Response teams of Dept of Animal Husbandry.

III.2: The International Agencies are to be notified by the Dept of Animal Husbandry.

III.3: In view of the threat of human infection for particular strain of NAI, public health aviation is to be immediately notified.

III 4: Demarcation of surveillance and infected areas and actions to be taken in these areas.

III.5: Immediate tasks to be carried out by the veterinary officer on confirmation of

(i) Quickly report the state and condition of the farm to determine the nature and scope of operations to be conducted.

(ii) Identify locations on the farm where vehicles leaving the farm can be properly washed and disinfected.
(iii) Active disinfection procedures at the point of entry/exit from the infected premises.
(iv) Ensure that vehicles are washed and disinfected internally and externally.
(v) Absolute ban on movement of poultry.
(vi) Closure of poultry and egg.
(vii) Ban on movement of farm personnel.
(viii) Destruction of birds in the infected zone of 3km radius.

III.6: Compensation to be paid for forced culling. The Government of India will share cost of compensation paid for culling of birds during operations and destruction of infected feed/feed materials up to 50% of total cost.

IV: Bio Security Measures, Advice to persons handling NAI infected poultry etc.

IV.1 Exchange of information with industry/farmers: Following notification of the disease, the Government should take the poultry industry and small poultry farm owners into confidence and inform them periodically about the measures that are being taken to control NAI. Popular poultry and livestock journals and mass media should be encouraged to disseminate information about the Government's initiative on NAI. The support of the industry should be sought for implementing the Government's decisions.

IV.2 Public Awareness/Media Briefing: The poultry farmers associations, cooperatives, NECC, APEDA, etc. should be actively involved in this process. The minimum expenditure required for awareness campaigns can be met from the GOI Fund.

IV.3 Bio-Security Measures: The best way to control NAI is to prevent exposure by imposing strict bio security measures. This can be achieved by advising the poultry owners to adopt following measures in all farms, even though they are not currently infected.

i) Keep distance
ii) Keep cleanliness

iii) Don't let the disease enter the farm
iv) Don't borrow the disease
v) Know the signs
vi) Report sick birds
vii) Follow uniform age group policy
viii) Guidelines for farm personnel

IV.4: Advice about contact with poultry in an area with NAI
IV.5: Raising poultry at home in an area affected with NAI
IV.6: Advice on how to decontaminate the yard/chicken pen
IV.7: Estimation of stores requirements

Annex II: Conditions - Approval of Poultry Slaughter Houses

1. In addition to the general requirements, slaughterhouses shall have at least:

1.1 A room or covered space which is sufficiently large and easy to clean and disinfect

1.2 A slaughter room large enough for stunning and bleeding on the one hand, and plucking and any scalding on the other, to be carried out in separate places. Any communication between the slaughter room and the room or space referred to in point 1.1 above other than the narrow opening through which only slaughter poultry may pass shall have an automatically closing door.

1.3 An evisceration and preparation room which is large enough for evisceration to be carried out in a place sufficiently far from the other work stations, or separated from them by a partition, so as to prevent contamination. Any communication between the evisceration and preparation room and the slaughter room other than the narrow opening through which only slaughter poultry may pass must have an automatically closing door; if necessary, a dispatching room;

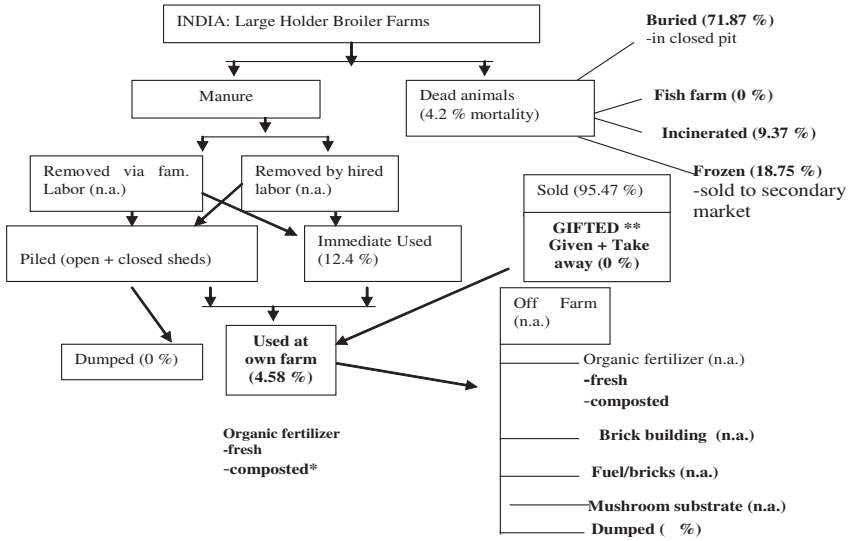
1.4 Oone or more sufficiently large chilling of refrigerating rooms, with a lockable facility, for poultry meat, which has been detained.

1.5 A room or space for collecting feathers unless these are treated as waste;

1.6 Separate wash basins and lavatories for staff handling live birds.

Annex III: Pathway of Broiler Manure and Dead Birds

Figure A-1: Large-scale Farms

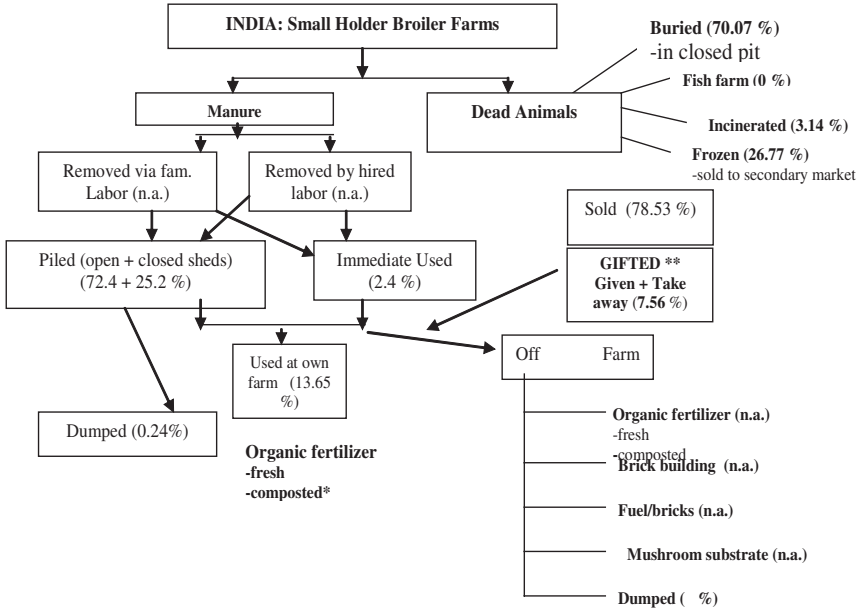


---

* **No. of unit having manure treatment equipment.**
** **Depends on season**
** **Depends on location**
n.a. = not available
Data: Removed by labour/hired labour (not available)

Source: Mehta et al. (2003).

Figure A-2: Small-scale Farms



---

* **No. of unit having manure treatment equipment.**
** Depends on season
** Depends on location
n.a. = not available
Data: Removed by labour/hired labour (not available)

Source: Mehta et al. (2003).

ENDNOTES

1 Government of India, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Livestock Census 1972 (dahd.nic.in). Even now backyard poultry is important, although the share of the egg production from Desi (local) Fowls was 9083 million as compared to 34564 million of improved (commercial or cross breed) fowls, during 2005-06.

2 FCR is amount of feed consumed per unit of the output (say kilogram of poultry meat) produced. It means that the Indian breeds (desi) consumed more feed than the improved breeds. As per GoI Statistics, the average yield for of an improved fowl was 258.29 (inspite of avian flu) egg as compared to that of 111.65 of Desi fowl, during 2005-06.

3 In this context it should be noted that pure line birds can be freely imported in India without any restriction, since 1985.

4 Hen-house production is calculated by dividing the total number of eggs produced by total days in lay.

5 During 1987-1992, the total production of eggs increased by 5.2 per cent per annum. 60 per cent of this growth is contributed by productivity increased (FCR) and 40 per cent is contributed by increase in number of birds. For details see Mehta et al. (2002).

6 Based on discussion with experts during author's survey. As per Landes et al. (2004), FCR in India is around 1.85 (in South India) to 1.90 (in East India). According to Rajan (2007), the FCR is 1.8 in integrator farming.

7 Feed conversion ratio in the US was around 2.2, see Crucikshank (2002), and Lohmann visited on 12/27/2006.

8 Most of tallow is banned in India, due to religious reasons.

9 Rajan (2007).

10 According to Rajan (2007), the integrator's farming can be grouped in three categories (i) large units of 100,000 and above, (ii) medium units of 20,000 to 100,000, and (iii) small unit with less than 20,000 capacity

11 See also Reddy (2001).

12 In other countries, poultry consists of birds such as turkeys, ostrich, chickens, ducks, pigeons, geese, etc. But in India, poultry is largely related to chicken and to some extent ducks.

13 The values can be downward biased for poultry meat, because the Government official statistics is downward biased. See Landes et al. (2004), among other.

14 G.O.I., (2002), (2002), "Report of the Working Group on Animal Husbandry and Dairying for The Tenth Five Year Plan (2002-2007)", Planning Commission, Government of India,

15 See Section, I.4 for details.

16 See Section, I.4 for details.

17 There is no reliable data on this aspect, as contract farming is not legal in Indian states. As per personal communication with industry, the current state of the position of for contract farming (commercial poultry) is: South region – 90%, West – 70%, East – 50% and North – 10%. See also, Suguna Group, (2006).

18 See Rajan (2007).

19 Based on statistics given in Govt. of India, Department of Animal Husbandry, and FAO

20 As per recommendation of "The National Committee on Human Nutrition in India".

21 As per statistics, quoted in Govt. of India, Department of Animal Husbandry.

22 The four states in the southern region exhibit high preference for eggs and poultry meat. The percentage of households consuming eggs ranges between 25 per cent in Karnataka and 52 per cent in Andhra Pradesh (as compared to 34 for all India). Andhra Pradesh leads in consumer preference for eggs as well as poultry meat. Andhra Pradesh, Assam, and West Bengal occupy top position in high preference for poultry products. Another four states viz., Kerala, Tamil Nadu, Karnataka and Maharastra are also important in generating demand for poultry products. For details, see Mehta et al. (2002).

23 Compound growth rate, based on FAO statistics

24 Compound growth rate.

25 For details, see Mehta et al. (2002).

26 The estimates of price and income elasticties have been taken from Mehta et al. (2002).

27 The groups are 'very poor', 'poor', 'not poor' and 'rich'

28 See, Mehta et al. (2005).

29 India can not give export subsidies as per WTO commitments. However, incentives for export promotion, international freight and internal transport can be provided.

30 Custom duties have changed during different financial years.

31 G.o.I. (2006), Basic Animal Husbandry Statistics 2006, Department of Animal Husbandry, Dairying and Fisheries, New Delhi.

32 Personal interaction with industry.

33 See G.o.I (2005), *Draft National Poultry Policy*, Department of Animal Husbandry

34 See Deasi (2004).

35 See Poultry Times of India, (2007)

36 In developed countries, the demand for Pork and Beef is higher than that of poultry. See Poultry Times of India , (2007), among others

37 See Mehta and George (2005)

38 The residue monitoring plan gives details of various residues along with the surveillance system to monitor the residues, name of approved labs, procedures for obtaining test services, name of the Natural Resource Labs, responsibility of the nominated lab, evaluation of the report by the National Referee Lab, description of pesticide residue limits, etc.

39 Mehta, Nambiar and Arockiasamy (2005)

40 In this context, it should be remembered that 95% of broiler meat market is still wet.

41 Only 25% of India's feed used is supplied in the form of compound feed, the rest 75% is still been prepared in small scale or by farmers themselves.

42 Although 2004 outbreak had significant impact on India's Poultry sector. See, Mehta (2006), among others.

43 See Rajan (2007) for details.

44 Arambagh, in W. Bengal, is one such unit.

45 Mehta (2005).

46 In the EU, the food safety standards are different in its member-countries.

47 In this context it should be remembered that WTO SPS agreement says that "reasonable

time" should be given for implementation of new standards. However, the definition of reasonable time is not clear. Although WTO track – II is trying to solve this problem, but has miserable failed. See Mehta et al. (2005), for details.

[48] See Mehta et al. (2005), for details.

[49] See, G.o.I, Ministry of Agriculture, Department of Economic and Statistics, website

[50] Ninety Five per cent Indian's domestic market for poultry meat is wet.

[51] See Delgado et al. (2008), among others.

[52] See Battese (1992), for a survey of this literature.

[53] Weighted averages, where weights are farm-specific transaction quantities.

[54] Note that the frontiers are run separately by commodity (layer and broiler). In most cases sample farms did not engage in producing for sale more than one of our chosen commodities. Where they did, possible economies of scope from joint production were not taken into account for practical reasons, although the model used could incorporate multiple outputs in a straightforward if somewhat laborious way (see, Coelli, Rao and Battese 1998, among others).

[55] For models relating to varying scale elasticities, see Panchamukhi, V.R., et al. (1995).

[56] See APEDA, "A Study on Poultry Sector in Andhra Pradesh" sponsored by Agricultural and Processed Food Products Export Development Authority, Ministry of Commerce, Govt. of India.

[57] See Mehta et al. (2003) for more details

[58] Estimated t-statistics is 2.01.

[59] Estimated t-statistics is 0.62.

[60] Contract farmers were not included in this analysis because (a) there are very few observations and (b) profitability of contract farmers does not depend on prices of inputs etc.

[61] However, the separate regression results of small and large farms show that the co-efficient is negative and highly significant for large firms, and not for small farms. Hence pooled results are not reliable, unless we capture impact of characteristics of small and large firms in regression estimates through 'fixed effect' or 'random effect' models. For such models, see Mehta and Parul (2004).

[62] **Source:** GoI, Ministry of Agriculture, Department of Animal Husbandry, November 2006. The whole action plan consists of 110 pages with details on every aspect. In this Annex, we are presenting only few points.

REFERENCES

Ali, M. and J.C. Flinn. (1989), "Profit Efficiency Among Basmati Rice Produces in Pakistan Punjab." Amer. J. Agr. Econ., May(1989):303-310.

APEDA (2006), Residue Monitoring Plan for 2006, for Drugs and Pesticides for Exported Egg Products to the European Union, March.

Battese, G. E. (1992), "Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications in Agricultural Economics." Agric. Econ, 7:185-208.

Battese, G. E. and T. J. Coelli. (1995), "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data." Empirical Economics, 20: 325-332.

Coelli, T., D.S. Prasada Rao, and G.E. Battese. (1998), An Introduction to Efficiency and Productivity Analysis. Kluwer Academic Publishers, 275 pages.

CMIE (2004), India's Trade

Crucikshank (2002). "Food Conversion Ratios (FCR) and average live weights for animals and poultry", (http://answers.google.com/answers/threadview?id=25449).

Delgado, C., et al. (2008), Determinants and Implications of the Growing Scale of Livestock Farms in Four Fast-Growing Developing Countries, Research Report No. 157, IFPRI, Washington, D.C.

Desai, A. (2004) "An Overview of the Indian Poultry and Future Scenario", All India Poultry Year Book, Special Millennium Issue.

FAO (2006), FAO STAT website

FAO and OECD (2006), "Impact of Animal Disease Outbreaks on Livestock Markets", Committee on Commodity Problems, Inter-government Group on Meat and Diary Products, 21st Seminar, Rome, 13-16 November.

Fried, H. O., C.A. Knox Lovell, and S. S. Schmidt, editors, (1993), The Measurement of Productive Efficiency: Techniques and Applications, Oxford University Press. New York, 425 pages.

Government of India (2002), Report of the Working Group on Animal Husbandry and Dairying for The Tenth Five Year Plan (2002-2007), Planning Commission, Government of India,

Government of India (2006), Basic Animal Husbandry Statistics, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Krishi Bhawan, New Delhi.

Government of India (2007-08), Custom Tariff.

Government of India, Custom Tariff of India, various issues.

Government of India, Economic Survey, various issues.

Government of India, National Income Accounts Statistics, various issues, Central Statistical Organisation.

Kearney, A.T. and the Confederation of Indian Industry (CII): "Retail in India: Getting organized to Drive growth", http://www.ibef.org/industry/retail.aspx.

Khare, S.P. (2003-04), "Estimation of Production and Marketing Parameters of Indian Poultry Industry", Poultry Year Book.

Landes, M., S. Persuad, and J. Dyek (2004), "India's Poultry Sector; Development and Prospects", Market and Trade Economics Division, Economic Research Unit, US Dept. of Agriculture, Agriculture and Trade Report, WRS 04-03, January.

Lohmann (http://www.nicholas-turkey.com/docs/Lohmann%20Me), visited on 12/27/2006

Mehta, R. (2005), "Non-Tariff Barriers Affecting India's Exports", RIS DP #97.

Mehta, R. (2006), "Indian Poultry Industry in Global Context", World Agro Trade Scanner, Vol. 1, No. 1, pp. 7-11.

Mehta,R. et al. (2002), "Livestock Industrialization, Trade and Social-Health-Environment Issues for the Indian Poultry Sector", Livestock Industrialization Project; Phase I, IFPRI, June.

Mehta, R. et al. (2003), "Policy, Technical, and Environmental Determinants and Implications of the Scaling up of Broiler and Egg Production in India" Livestock Industrialization Project, Phase II IFPRI- FAO Project.

Mehta, R. et al. (2005), Food Safety Standards and Indian Food Exports, Workshop on "International Food Safety Regulations and Processed Food Exports: A Comparative Study of India and Thailand", RIS, New Delhi, August 13, 2005.

Mehta, R. and J. George (2005), "Institutional and Legal Framework of Food Safety Regulation in India", in Mehta, R. and J. George (Eds.), Food Safety Regulation Concerns and Trade: The Developing Country Perspective, Macmillan India Ltd., pp 141-186.

Mehta, R. and P. Mathur (2004), "India's Export by Countries and Commodities: On the Estimation of a Forecasting Model Using Panel Data", RIS DP # 84 .

Mehta, R. &R. Nambiar. (2008), "The poultry industry in India", Poultry in the 21st Century: avian influenza and beyond, Proceedings of the International Poultry Conference, FAO Animal Production and Health Proceedings, No. 9, FAO Rome.

Mehta, R., R. Nambiar and S. Ray (2005), "WTO and Poultry Industry in India", South Asian Journal, Vol 9, July-September, pp.69-87.

Mohanty, S. and K. Rajendran (2003), "2010 Vision for Indian Poultry", International Journal of Poultry Science, 2(2) 139-143.

Panchamukhi, V.R., et al. (1995), Complementarity in Trade and Production: Intra South Potential, Sage Publications, New Delhi/Thousand Oaks/London, 1995, pp.1 179

Poultry Times of India, (2007), "Enormous Poultry Expansion Possible in India", a special interview with Mr. Wiebe Van Der Sluis, Vol. 11, November 2007, pp. 6-8.

Rajan, B.S. (2007), "Integrated Broiler Production - A Process of Transformation", Hind Poultry, Vol VI, No. 6, pp. 25-33

Ramaswami, B., P. Birthal and P.K.Joshi (2006), "Efficiency and Distribution and Contract Farming: The Case of Indian Poultry Growth", MTID Discussion Paper No.91, International Food Policy Research Institute, Washington, January.

Reddy, C.V. (2001), "Sustainable Poultry Production for Poverty Alleviation and Human Development in South Asian countries", paper presented at the South Asian Regional Conference and Exhibition, Pune, September 24-26.

Tiongco, M., Narrod, C. & Delgado, C. 2006. Equitable intensification of market-oriented smallholder dairy and poultry production in India through contract farming: a synthesis. Final Report of IFPRI-FAO Contract Farming of Milk and Poultry in India Project. Washington DC, International Food Policy Research Institute.

Suguna Group (2006), "Poultry Market - opportunities for Farmers", presented by P.K. Bharadwaj, G.M., Corporate Finance Suguna Poultry Farm Ltd., Coimbatoire, 2006.

RIS Discussion Papers

Available at http://www.ris.org.in/risdiscussion_papers.html

DP#145-2008 *South-South and Triangular Cooperation in Asia-Pacific: Towards a New Paradigm in Development Cooperation* by Nagesh Kumar

DP#144-2008 *Exchange Rate Pass-through in India's Exports to Developed and Emerging Markets* by Sushanta Mallick and Helena Marques

DP#143-2008 *Changing Economic Power in the World Economy* by Manmohan Agarwal

DP#142-2008 *Transportation Cost and Trade Competitiveness: Empirical Evidence from India* by Prabir De and Bhisma Rout

DP#141-2008 *Re-Discovering the Role of Developing Countries in the GATT before the Doha Round* by Faizel Ismail

DP#140-2008 *Internationalization of Indian Enterprises: Patterns, Strategies, Ownership Advantages and Implications* by Nagesh Kumar

DP#139-2008 *Emerging Patterns in Architecture for Management of Economic Assistance and Development Cooperation: Implications and Challenges for India* by Sachin Chaturvedi

DP#138-2008 *Emerging Countries and the World Economy: Implications of India's Recent Expansion on Developing Countries* by S.K. Mohanty

DP#137-2008 *Emerging Countries as Sources of Investment and Appropriate Technology: Case Study of India* by Sachin Chaurvedi

DP#136-2008 *Potential of Asian Economic Integration: A Perspective from the Strategy of Japanese Enterprises* by Tetsuji Kawamura

DP#135-2008 East *Asian Infrastructure Development in a Comparative Global Perspective: An Analysis of RIS Infrastructure Index* by Nagesh Kumar and Prabir De

DP#134-2008 *India-Africa Economic Partnership: Trends and Prospects* by S. K. Mohanty and Sachin Chaturvedi

DP#133-2008 *Towards An Asian "Bretton Woods" for Restructuring of the Regional Financial Architecture* by Ramgopal Agarwala

DP#132-2008 *The WTO's Doha Negotiations: An Assessment* by Bhagirath Lal Das

DP#131-2007 *Regional Cooperation and Integration Prospects in Asia* by Rajat Nag

DP#130-2007 *Deepening India–Bangladesh Economic Cooperation: Challenges and Opportunities* by Prabir De and Biswa N. Bhattacharyay

DP#129-2007 *Intellectual Property Regime, Indigenous Knowledge System and Access and Benefit Sharing: Drawing Lessons from Kani Case* by Sachin Chaturvedi

DP#128-2007 *WTO and Trade in Electronically Delivered Software (EDS): Emerging Challenges and Policy Options - An Indian Perspective* by Sachin Chaturvedi and S. K. Mohanty

DP#127-2007 *Economy: Recent Evolution and New Perspectives for South-South Cooperation* by Maria Lúcia L.M. Pádua Lima

DP#126-2007 *Welfare Gains from Regional Economic Integration in Asia: ASEAN+3 or EAS* by S.K. Mohanty and Sanjib Pohit

DP#125-2007 *Investment Provisions in Regional Trading Arrangements in Asia: Relevance, Emerging Trends, and Policy Implications* by Nagesh Kumar

DP#124-2007 *Indian Innovation Systems and Emergence of Biopharmaceutical Sector: Issues and Prospects* by Sachin Chaturvedi

DP#123-2007 *Regional Economic Integration, Foreign Direct Investment and Efficiency-Seeking Industrial Restructuring in Asia: The Case of India* by Nagesh Kumar

DP# 122-2007 *Community-based Rights and IPR Regime: Revisiting the Debate* by Srividhya Ragavan and Jamie Mayer

DP#121-2007 *India's Rising Role in Asia* by Mukul G. Asher

DP#120-2007 *Relevance of 'Policy Space' for Development: Implications for Multilateral Trade Negotiations* by Nagesh Kumar and Kevin P. Gallagher

DP#119-2007 *India-Sri Lanka Bilateral Free Trade Agreement: Six Years Performance and Beyond* by Saman Kelegama and Indra Nath Mukherji

DP#118-2007 *Trade Facilitation Measures in South Asian FTAs: An Overview of Initiatives and Policy Approaches* by Sachin Chaturvedi

DP#117-2006 *Emerging Multinationals: Trends, Patterns and Determinants of Outward Investment by Indian Enterprises* by Nagesh Kumar

DP#116-2006 *Addressing Global Growth Asymmetries through Regional Trade Integration: Some Explorations* by Ram Upendra Das and Ramaa Sambamurty.