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ICRIER

Working Paper 225

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Lessons for smallholder production systems

ISSN 1864-6638 Bonn, September 2023

PARI

ZEF Working Paper Series, ISSN 1864-6638
Center for Development Research, University of Bonn
Editors: Christian Borgemeister, Joachim von Braun, Manfred Denich, Till Stellmacher and Eva Youkhana

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Poultry Revolution in India

Lessons for smallholder production systems

Ashok Gulati and Ritika Juneja

Abstract

Poultry has been the fastest growing sector of Indian agriculture over the last two decades. Between 2000 and 2020, India's poultry meat and egg production grew at an annual average rate of growth of 9.2 percent and 7.2 percent, respectively. For comparison, cereal production grew just 1.5 percent over the same period. This is nothing short of a revolutionary change in India's poultry sector. In fact, this is even higher than the rate of growth achieved in wheat production (8.4 percent per annum) and rice (5 percent per annum) during the heydays of the Green Revolution (1967-1986) and the White Revolution in milk (1970-1997) which saw growth of 4.5 percent. Yet, this poultry revolution has not been as well studied and is not as well-known as the Green and White Revolutions have been. This paper makes a modest attempt in this direction with a view to uncover the sector's key drivers and explore whether there are any lessons to be learned for smallholder economies around the developing world.

Our research on India's poultry sector reveals that as a result of this fast increase in poultry production, India is now the third largest producer of eggs in the world (producing 122 billion eggs in 2020-2021) after China and the USA, and the fifth largest producer of broilers (producing 4.4 million metric tonnes (MMT) in 2020-2021) after China, the USA, Brazil and the Russian Federation. Two factors acted as catalysts of change: (1) the government policy of liberalizing imports of grandparent poultry stock; and (2) the emergence of a vertical integration model between large integrators/hatcheries and small farmers through a contract farming approach, purely driven by the private sector. It is this "double engine" of policy change by the government and institutional innovation of large integrators linking with small farmers that transformed the Indian poultry sector from a mere backyard activity into a major organized commercial one. In 2020, almost 80 percent of India's poultry production (in value terms) came from this organized contract farming segment, far more than any other commodity in Indian agriculture.

In this study, we also explore the inclusivity of the contract farming model with large integrators. Interestingly, we find that almost 70 percent of poultry farmers engaged through contract farming are smallholders with a flock size of 3,000-10,000 birds; 20 percent are medium scale farmers with 10,000-50,000 birds, and only 10 percent are large scale farmers with 50,000-400,000 birds. This reality has a number of lessons for many smallholder economies of the developing world, where they can find opportunities for augmenting incomes of smallholders by linking with large integrators who have the capacity to infuse credit and insurance while bearing market risks in the poultry value chain. This allows smallholders to have dependable and regular income at equal intervals. Being a good source of protein, poultry can potentially also help improve the nutrition status of all Indians with some education and awareness about the nutritional value of eggs and poultry meat.

However, despite this remarkable growth in poultry production, the sector also faces many challenges. The retailing of poultry meat is largely a wet market phenomenon in the informal sector, raising concerns about hygiene and food safety. Also, the infrastructure for freezing poultry meat all along the value chain is negligible and often absent. This limits India's participation in global trade of poultry meat. Occasional outbreaks of avian flu add to these challenges. India still has low levels of per capita consumption of poultry meat, partly because of relatively low levels of incomes of the masses and partly due to a "vegetarian" culture in some pockets of the country. Nevertheless, the potential for poultry seems large in the years to come as India's per capita incomes rise. However, the environmental footprint of rapidly increasing poultry farms, such as waste generated from slaughtering, rendering material from processing units, improper management of litter and excreta of the birds, needs to be tackled in a manner that ensures sustainable growth of this sector. This would be done as better infrastructure is built, and food safety, environment and animal welfare concerns get their due attention. We conclude that this institutional innovation of integrating large hatcheries with thousands of small poultry farmers, a unique hallmark of this sector, could pave the path towards shared prosperity and better nutrition for all.

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Acknowledgement

We are grateful to Balram Yadav, CEO and MD of Godrej Agrovet, for sharing his insights into the issues of contract farming in poultry. We also thank Joachim von Braun, Heike Baumüller and Thomas Daum for their comments on a draft version of this study and to Andrew Aziz for his editorial support.

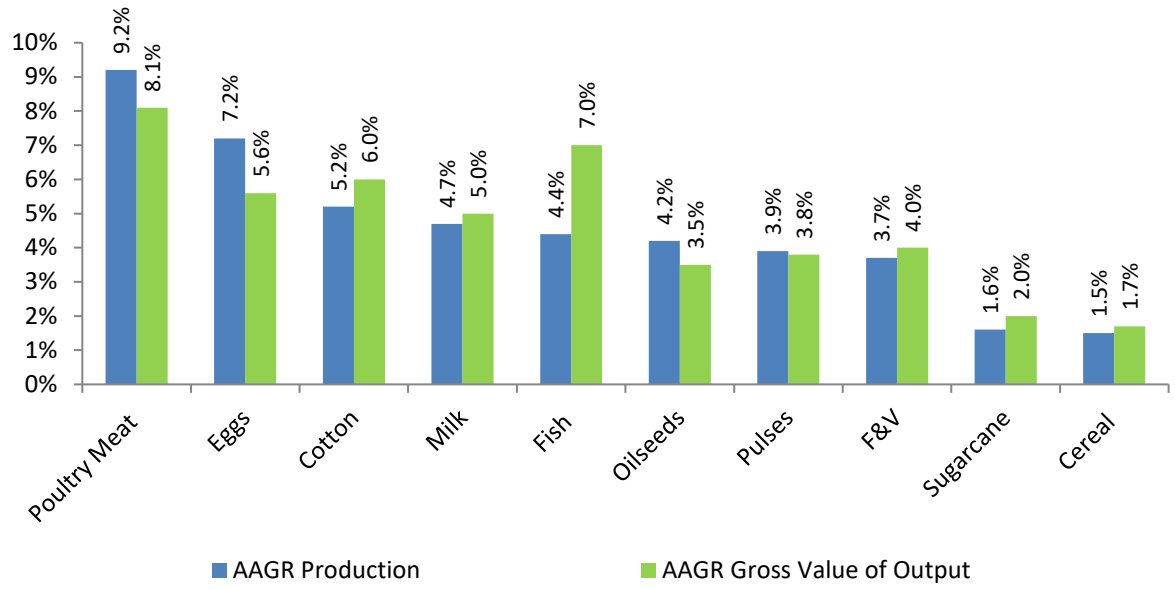
We would also like to express our deep appreciation to the "Program of Accompanying Research for Agricultural Innovation" (PARI) and the German Federal Ministry of Economic Cooperation and Development (BMZ) for supporting this study.

1 Introduction

Poultry has been the fastest growing sector of Indian agriculture over the last two decades. Poultry meat production (in tonnage terms) has grown at an annual average rate of 9.2 percent and egg production by 7.2 percent during the financial years 2000-2001 to 2019-2020 (FY2001 to FY2020). For comparison, cereal production grew at a rate of just 1.5 percent over the same period (see Figure 1). Even in value terms (at constant prices), poultry meat registered the highest rate of annual growth at 8.1 percent, surpassing all other segments of Indian agriculture over the same period (see Figure 1).

The growth rate in poultry meat has been even higher than that of wheat (8.4 percent) and rice (5 percent) during the heydays of Green Revolution (1968-1986) and of milk (4.5 percent) during the White Revolution (1971-1997) (Gulati & Juneja, 2021).

Figure 1: Average Annual Growth Rates (AAGR) in percentage from 2000-01 to 2019-20[1]



Source: Government of India, 2019b

The Green Revolution in India was brought about by the import of a high-yielding variety of wheat seeds from Mexico and of rice from Philippines, intensive use of irrigation and fertilizers and the minimum support price policy for wheat and rice (paddy), all steered by the government. The White Revolution was achieved through "Operation Flood", under the framework of "milk cooperatives" (or the so-called Anand model), which was also supported by the government (Gulati and Juneja, 2023). But the story of India's Poultry Revolution is far less well known. It is this which we want to explore in this paper to see if it holds any lessons for smallholder economies in Sub-Saharan Africa, and South and Southeast Asia.

Unlike the Green and White Revolutions, the Poultry Revolution in India has been largely driven by the private sector. The institutional innovation of 'contract farming' for vertical integration has significantly helped farmers, particularly the smallholders, to overcome land, capital and credit constraints and minimize market price risks. Interviews with several poultry industry participants, especially Suguna Foods (Hatcheries) and Venkateshwara Hatcheries (Venky's) which are amongst the biggest hatcheries, revealed that the model not only assures higher returns (at least 4-5 times higher than irrigated land), but also insures the farmers against risk of production failure due to natural calamity, disease, etc. But the poultry sector received a fillip and subsequent revolutionary changes only when government policy

[1] Horticulture includes Fruits, Vegetables, Spices, and Floriculture

related to import of grandparent stock of poultry was liberalized and import duties slashed. Thus, it is this combination of liberal import policies related to grandparent stock and institutional innovations of the private sector linking smallholders with large integrators which acted as a catalyst to accelerate growth in poultry production. The private sector also invested in vaccines and feed research to come up with very efficient feed conversion ratios (FCR about 1.5 to 1.6 in large players like Venky's and Suguna). While the government tried to assist backyard poultry for very marginal households, their share in overall poultry production remains below 20 percent.

In this study, we scan the historical evolution of this sector with special focus on the role of government policy, institutions and the private sector as drivers of growth. But we also look at how efficient the poultry sector has been in scaling-up and whether the vertical integration and contract farming model is inclusive of smallholder poultry farmers (i.e., those with less than 10,000 birds). How sustainable is the model in terms of financial and environmental outcomes? This paper also highlights potential areas of development for the sector, such as contributions in improving human nutrition, optimising costs, and producing hygienic processed products. Thus, the experience of Indian poultry in recent decades could present several important lessons for other smallholder economies in Sub-Saharan Africa, as well as South and Southeast Asia.

This paper is structured as follows: This brief introductory section is followed by an overview of the Indian poultry sector using secondary information on poultry population, domestic production and consumption, regional variation, and India's position in global poultry production and trade. Section 3 examines the revolution in the poultry sector and drivers of structural change. This section gives an account of the role of technology, government policy, institutions and investment in driving poultry growth in India. Section 4 presents a review of the major players in the Indian poultry industry. The next section critically evaluates the sector's performance on three basic parameters – competitiveness, inclusiveness and sustainability. It also discusses the outbreak of Avian Influenza in India and its economic impact on the poultry sector. In the last section, we discuss unique challenges and opportunities that the sector can tap in the years to come with respect to providing reasonably good source of nutrition to larger population. It can be done by improving the segment of processed products in light of better hygiene and safety, and optimising the feed costs by using futures markets to minimise market risks of feed material. Finally, Section 6 offers concluding remarks on the way forward for India's poultry sector.

2 An overview of Indian poultry

The Indian poultry sector is broadly divided into two sub-sectors – one is a highly organized commercial sector that accounts for 80 percent of the total market share and the other is an unorganized backyard sector with 20 percent of the total market share (Government of India, 2017). In terms of the size of the poultry population, there were 851.8 million poultry birds in the country in 2019, of which 807.8 million were fowls, 33.5 million were ducks and 10.4 million were turkeys and other poultry birds (Government of India, 2019a). Of the total poultry birds, 534.7 million are reared in commercial farms, while 317 million are reared in the backyard sector. Based on the number of handling of birds, poultry farms are classified into three categories, namely, small (with 5,000-25,000 birds); medium (above 25,000-100,000 birds); and large (more than 100,000 birds) (Ministry of Environment, Forest and Climate Change, 2020).

Total meat production in India was accounted as 8.8 million metric tonnes (MMT) in 2020-2021, wherein poultry contributes the highest share of 50.8 percent (4.47 MMT), followed by bovine (buffalo and cattle) meat at 21.28 percent (1.87 MMT), goat meat at 13.78 percent (1.21 MMT), sheep at 10.04 percent (0.88 MMT) and others (Government of India, 2020). In terms of gross value, poultry meat contributes 52 percent to the total value of meat in India, followed by mutton (30 percent), beef (largely buffalo meat) (10 percent) and pork (2 percent) (Government of India, 2019b). Also, chickens account for some 98 percent of total egg production, followed by ducks and other poultry (Government of India, 2020).

2.1 Poultry production in India

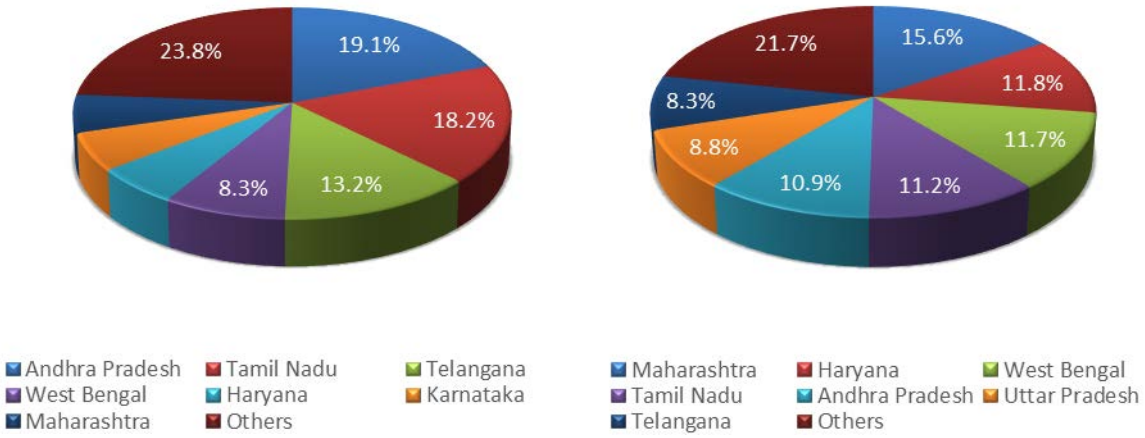
Poultry production in India has increased significantly over the last three decades. Egg production in the country has increased from around 1.83 billion in 1950-1951 to around 83 billion in 2015-2016 and reached 122.05 billion in 2020-2021 (Government of India, 2020). Meanwhile, poultry meat production in the country has increased from 0.06 MMT in 1961 to around 4.47 MMT in FY2020 (Government of India, 2020). However, one of the most peculiar features of the poultry industry in India is that it is highly fragmented. There are several thousand independent poultry producers (Mehta, 2002).

There is very little promotion of any particular brands either in the layer or the broiler segment. Also, there exists wide regional variation in its development. As can be seen in Figure 2, the three southern states – Andhra Pradesh, Tamil Nadu and Telangana – are the top producers of egg in India and they accounted for half of India's total egg production in 2018-2019. Egg production is also expanding in states such as West Bengal and Haryana, contributing 13.2 percent and 8.3 percent to the country's total egg production, respectively (Government of India, 2020). These eggs are mostly sold in large quantities without branding in most cases (USDA, 2016).

It is worth noting that a district in Tamil Nadu called Namakkal currently has more than a thousand egg farms and produces around 30.5 million eggs per day on average, of which 5 million (i.e., roughly 16 percent) is consumed in Tamil Nadu itself. The remainder is supplied to the neighbouring states, such as Kerala and Karnataka, and trade has recently started to expand to some northern states (Kumaravel, Rajkumar, & Gowthaman, 2020). This is one of the most concentrated districts in India (Mehta & Nambiar, 2013). According to industry sources, the abundance of production in the southern region is due to a number of factors, including reduced capital and variable costs of production (South India has the lowest feed conversion ratio), less disparity in weather conditions; readily available day-old chicks at lower prices due to location of hatcheries; and the presence of a relatively large number of integrators and poultry processing plants (Mehta, Narrod, & Tiongco, 2008). Further, a state-focused analysis of poultry meat production shows an interesting rise of Maharashtra as the largest poultry meat producer in India during 2018-2019 with a 15.6 percent share, followed by Haryana (11.8 percent), West Bengal (11.7 percent), Tamil Nadu (11.2 percent), and Andhra Pradesh (10.9 percent).

In India, small market sales of live birds still constitute a majority of total sales volumes (around 90 percent) because consumers mostly prefer to buy freshly slaughtered meat from open or "wet" markets. The processed chicken meat segment, however, is slow to be adopted and constitutes just 7-10 percent of total production. (USDA, 2016).

Figure 2: State-wise egg and poultry meat production in India



Source: Government of India, 2020

2.2 Poultry consumption in India

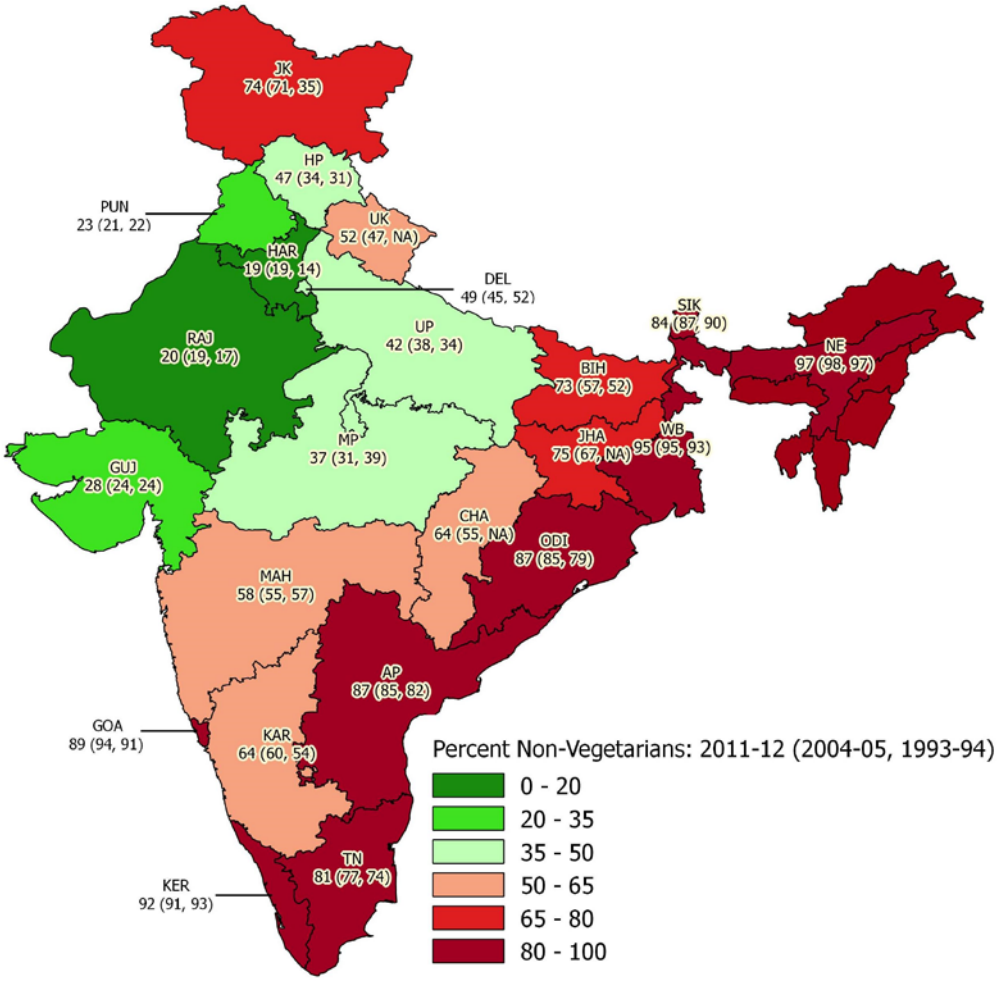
With regard to consumption, poultry is the major source of meat in India. Its share in total meat consumption was 65 percent in 2020, up from 23 percent around two decades ago. It has outpaced its two competitors – beef and veal, and buffalo meat (OECD, 2021). High mutton prices as well as religious restrictions on beef and pork have contributed to poultry's primacy in India. Expanding domestic production and increasing integration have pushed poultry meat prices downward and stimulated its consumption. It is further projected that poultry meat consumption will increase globally to 145 MMT between 2020 and 2029, accounting for 50 percent of the additional meat consumed (OECD/FAO, 2020).

Gulati and Verma (2016) also observed a growing number of non-vegetarians in the country. Data published by the Government of India shows that there has been a rise in the percentage of non-vegetarians[2] from 56.7 percent in 1993-1994 to 58.2 percent in 2004-2005, 62.3 percent in 2011-12 and 71 percent in 2014-15 (Government of India, 2017; Gualit & Verma, 2016). State-wide analysis of the NSSO data further shows that seven states in the northeast of the country had the highest proportion (97 percent) of non-vegetarians in 2011-2012, followed by West Bengal (95 percent) and Kerala (92 per cent) (see Figure 3). At the other end of the spectrum, non-vegetarians in Gujarat make up 28 percent of the population, followed by Punjab (23 percent), Rajasthan (20 percent) and Haryana (19 percent). There has been a sharp increase in the proportion of non-vegetarians in Jammu and Kashmir — from 35 percent in 1993-1994 to 74 percent in 2011-12 (Figure 3). According to experts, the clear trend toward non-vegetarianism in India has been marked by a "chicken revolution" in India (Gulati & Verma, From plate to plough: A clear trend towards non-vegetarianism in India, 2016). The proportion of Indian households consuming chicken shot up from 8 percent in 1993-1994 to 38 percent in 2011-2012, while that of the fish-eating households increased marginally from 30 percent to 32 percent over the same period. But the proportion of goat-meat/mutton-eaters has fallen significantly from 30 percent in 1993-1994 to 15 percent in 2011-2012. The population of beef and buffalo meat-eaters has remained more or less constant at about six percent over this period. Interestingly, the

[2] Those who either consume or fish or meat or any combination of these. Data before 2014-2015 refers to all age groups while data for 2014-15 covers people over 15 years of age.

proportion of those consuming only eggs has fallen drastically from about 24 percent in 1993-1994 to merely 3.5 percent in 2011-2012.

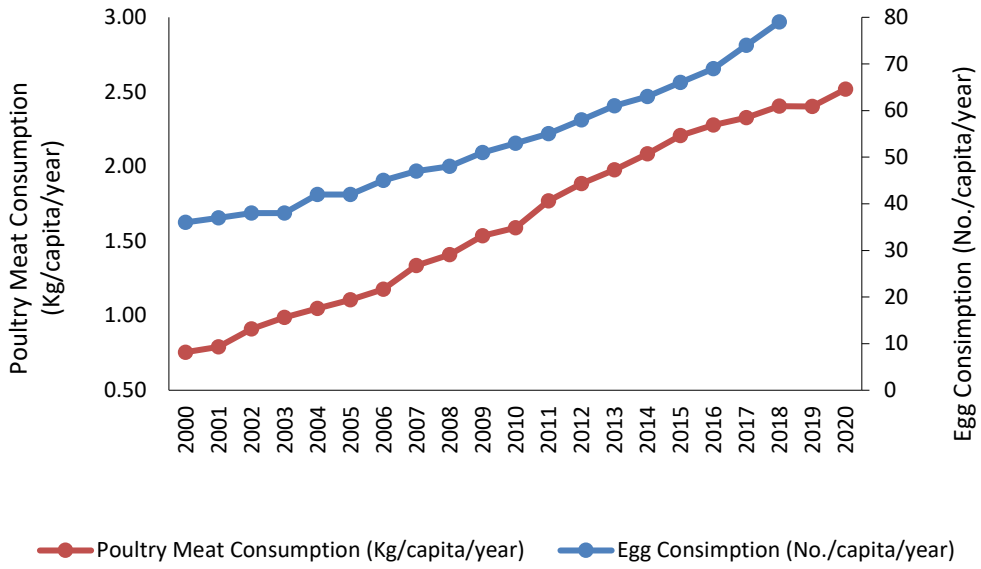
Figure 3: Percentage of non-vegetarians: 2011-12 (2004-05, 1993-94)



Source: Gulati & Verma, 2016

On a per capita basis, India's consumption of broiler meat has increased significantly from less than 1 kg per person per year in 2000 to 2.5 kg per person per year in 2020 (Figure 4). While this is marked increase, it is far less than per capita consumption in other countries such as Brazil (41 kg), Australia (44 kg), Malaysia (49 kg), the USA (51 kg), Israel (64 kg), China (14 kg), and Thailand and Indonesia (8 kg). Global per capita broiler meat consumption sits at 15 kg (OECD, 2021). There has also been remarkable growth in the per capita consumption of eggs, rising from 36 eggs per person in 2000 to 79 eggs per person in 2018-19 (Government of India, 2020). However, this level of consumption continues to lag behind the recommended requirement of 180 eggs per person, as suggested by the National Institute of Nutrition, India (Government of India, 2017).

Figure 4: Per capita consumption of poultry meat and eggs in India

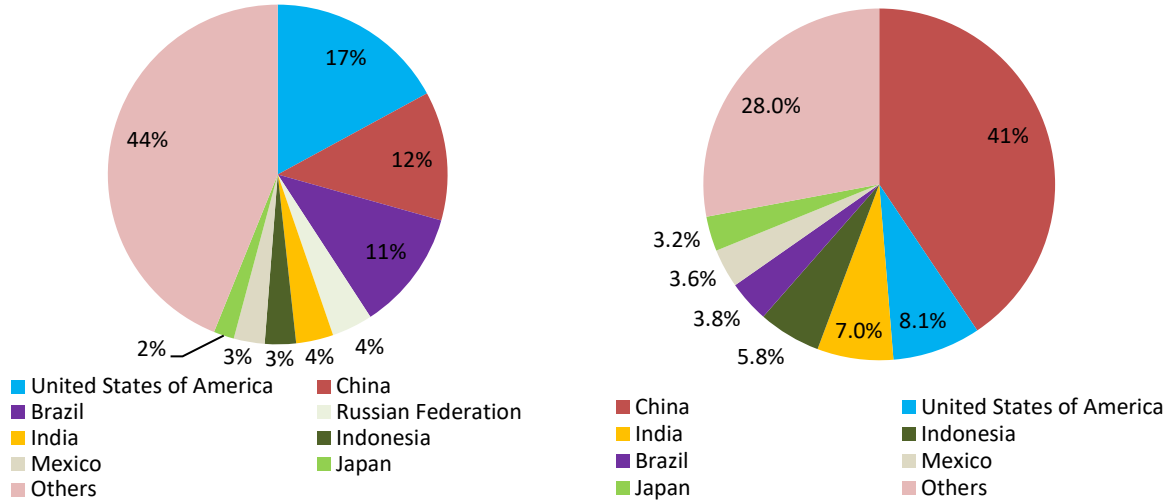


Sources: Government of India, 2020; OECD, 2021

2.3 Global scenario

World egg production in 2019-2020 was recorded as 82.3 MMT, with China being the largest producer (contributing 41 percent), followed by the USA (8.1 percent) and India (7 percent). Other leading producers include Indonesia, Brazil, Mexico and Japan (see Figure 5). For comparison, global production of poultry meat was reported as 118 MMT in 2019-2020 (FAOSTAT, 2020). Of the world's major poultry producers, the USA is the largest producer (17 percent) followed by China (12 percent). India is the fifth largest poultry producer, contributing only 4 percent to the total. Other notable producers include Brazil (11 percent) and the Russian Federation (4 percent) (see Figure 5). According to the OECD-FAO Agricultural Outlook 2020-2029, globally poultry is expected to be the fastest growing meat with a projected increase in production of 16 percent over the 2020s. Similarly, egg production is projected to increase by 13 percent between 2020 and 2029, with China and India accounting for 45 percent of this global increase (OECD/FAO, 2020).

Figure 5: National share in global poultry meat and egg production



Source: FAOSTAT, 2020

Of all the leading private players in the global poultry meat business, Brazil's JBS is the world's largest producer. Its chicken business is now more than twice the size of the world's second-largest chicken producer: USA-based Tyson Foods (WATTPoultry, 2020). Other top players include Brazil's BRF, China's New Hope Liuhe and Wen's Food Group, and Thailand's CP Group. It is interesting to note that India's Suguna Foods takes the 17th spot in the list of the top 25 chicken meat producers in the world (WATTPoultry, 2020). The ranking of these top companies in terms of number of head slaughtered annually is illustrated in Table 1. In the layer segment, although China is the largest egg producer in the world, none of its companies are accounted for on the list of the world's top 25 egg producers (WATTPoultry, 2020). Rather, the list is dominated by USA-based companies. Of the total 400 million laying hens owned by the 25 largest egg producing companies, about 184 million are managed by 10 leading US companies, namely, Cal-Maine Foods, Rose Acre Farms, Versova Holdings, Hillandale Farms, Daybreak Foods, and Michael Foods (WATTPoultry, 2020). See Table 2 for complete list of the rankings.

Table 1: World's top 25 broiler producers

Company		**Broilers Slaughtered Annually (millions)**
JBS	Brazil	4,036
Tyson Foods, Arkansas	USA	1,991.6
BRF	Brazil	1,554
New Hope Liuhe	China	1300
Wen's Food Group	China	748
CP Group	Thailand	685
Koch Foods Inc.	USA	681.2
Perdue Farms	USA	667.7
Sanderson Farms Inc	USA	622.4
Industrias Bachoco	Mexico	622
LDC	France	578.5
Arab Company for Livestock Development (ACOLID)	Saudi Arabia	562
Cargill	USA	545
MHP (Myronivsky Hliboproduct)	Ukraine	478
Fujian Sunner Development Co. Ltd	China	450
Plukon Food Group	Netherlands	426.4
Doyoo Group	China	400
Suguna Foods	India	400
Wayne Farms LLC	USA	395.2
Mountaire Farms Inc.	USA	394.7
Harim Group	South Korea	392.6
George's Inc.	USA	357.8
San Miguel Pure Foods	Philippines	352
Gruppo Veronesi	Italy	350
PHW Group	Germany	350

Source: WATTPoultry, 2020

Table 2: World's top 25 layer producers

Company	Country	Layers (millions)
Cal-Maine Foods	USA	45
Proteína Animal (PROAN)	Mexico	34
Rose Acre Farms	USA	26.5
CP Group	Thailand	22
Versova Holdings LLC	USA	21
Hillandale Farms	USA	20
Ise Inc.	Japan	20
Arab Company for Livestock Development (ACOLID)	Saudi Arabia	14.4
Daybreak Foods	USA	14
Michael Foods	USA	13.3
Kazi Farms Group	Bangladesh	12.7
Industrias Bachoco	Mexico	12.2
Empresas Guadalupe	Mexico	12
Rembrandt Enterprises	USA	11.9
CP Standart Gida Sanayi Ve Ticaret (CP Turkey)	Turkey	11
MPS Egg Farms	USA	10.9
Center Fresh Group	USA	10.8
Prairie Star Farms	USA	10.8
Avangardco	Ukraine	10.5
Granja Mantiqueira	Brazil	10.5
Avril Group	France	10
El Calvario	Mexico	10
Gena Agropecuaria	Mexico	10
Granja Yabuta	Brazil	10
Wadi Group	Egypt	10

Source: WATTPoultry, 2020

Gobal exports of frozen chicken[3] accounted for USD 16.4 billion in 2019 (Workman, Chicken Exports by Country, 2020). As of 2019, Brazil was the largest exporter of frozen chicken in the world in terms of value, with its industry valued at USD 6.3 billion (38.6 percent of the global share). The second largest global exporter is the USA, with a value of USD 2.7 billion, 16.4 percent of the gobal share. This is followed by the Netherlands (7.4 percent), Poland (4.9 percent) and Turkey (3.3 percent) (Workman, Chicken Exports by Country, 2020). India's export value of meat and edible poultry offal (fresh, chilled or frozen) in 2019 totalled USD 6.68 million, constituting negligible share in the global exports (TrendEconomy, 2021). With regard to imports of frozen chicken, China takes top spot (accounting for 12 percent of total imported frozen chicken), followed by Saudi Arabia (7.8 percent), Japan (7.5 percent), Hong Kong (5.7 percent) and the United Arab Emirates (UAE) (4 percent) (Workman, 2022).

Globally, eggs are one of the fastest growing proteins in human diets. In 2019, the total value of exported of in-shell fresh eggs from domestic fowls (excluding those fertilized for incubation) (HTS code 047021) was USD 1.9 billion. Countries that exported the highest dollar value worth of fresh eggs in 2019 were the Netherlands at USD 470.7 million (24.5 percent of the global share), Poland at USD 247.8 million (13 percent), Turkey at USD 215.8 million (11.2 percent) and Malaysia at USD 139.3 million (7.2 percent share) (Workman, 2022). In 2018-2019, India's total egg exports amounted to USD 48.1 million, of which in-shell fresh eggs from domestic fowls (excluding those fertilized for incubation) accounted for the majority (USD 27.5 million), followed by fertilized eggs for incubation from domestic fowls (USD 16.4 million) (APEDA, 2019). However, when compared to other egg producers, India is a small global player when it comes to egg exports.

[3] Six-digit Harmonized Tariff System (HTS) code prefixes used for the analysis are 020712 for whole frozen chicken and 020714 for frozen chicken cuts and offal.

3 The Poultry Revolution in India: Role of policies, institutions and incentives

The poultry industry in India represents a major success story within agriculture. This section seeks to capture the evolutionary story of industry's growth over the past 70 years and identify innovations in technology, policy and institutions that drove the growth over time. This section also sheds some light on the role of private players in the industry's spectacular transformation and the economics of the contract farming model.

1950s to 1970s

In the 1950s and 1960s, the Indian poultry industry was largely a backyard venture. Domestic producers at this time were using local breeds with low feed conversion ratios (FCRs) relative to commercial hybrids in several other developed nations (Mehta, Narrod, & Tiongco, 2008). According to industry sources, transformation of the Indian poultry industry began with the introduction of high yielding hybrid strains of layers in 1955 and broilers in 1961 (Mehta & Nambiar, 2013). At this time, commercial broiler farms constituted a few hundred birds on average (200-500 chicks) per cycle (Mehta, Narrod, & Tiongco, 2008). Even the production of poultry meat was just 60,000 tonnes and eggs were 2.8 billion units. Up until 1961, the share of the hybrid population in the total poultry population was approximately 2 percent (Mehta & Nambiar, 2013). Against this backdrop, the Indian Council of Agricultural Research (ICAR) initiated production of high yielding hybrids acclimatized to Indian weather conditions through pure line breeding of genetic stocks in India itself (Government of India, 2011). In the late 1960s, some private players also began to enter the industry. Keggfarms Pvt. Ltd., based out of Haryana, began commercial production of table eggs in 1967 and pioneered the genetic breeding of poultry stocks in India in 1972 through purelines (germplasm) imported from Parks Poultry in the USA (Keggfarms Pvt. Ltd., 2019). In 1971, Dr. B.V. Rao, also known as "the father of the Indian Poultry Industry", established Venkateshwara Hatcheries (VH) Pvt. Ltd. in Pune. In 1974, the VH Group joined hands with USA-based Cobb Ventress Inc. and initiated imports of grandparent stock of foreign breeds ("Cobb-strains") that kick-started the development of indigenous pure-line breeding in the country (Mehta, Narrod, & Tiongco, 2008). As a result of these technological innovations, egg production went up from 2.8 billion in 1961 to 10 billion in 1980, and that of poultry meat production from 60,000 tonnes in 1961 to 113,000 tonnes in 1980 (see Figure 6). This started the revolutionization of the poultry industry in India.[4]

1980s and 1990s

Prior to 1982, egg prices in India were determined by market forces, where traders had an upper edge in the bargaining power vis-à-vis producers. Change came about when the egg industry was hit by an unprecedented crisis in 1981 (Frontline, 2003). The cost of inputs, particularly chicken feed, went up by about 250 percent as a result of a severe drought in 1979-80 while selling prices of chicken remained more or less stagnant, affecting the profitability of farmers by huge margins (Mehta & Nambiar, 2013). Due to this, over 40 percent of poultry farms across the country were forced to close down and survival of the industry was under severe threat. At this time, Dr. Rao of Venkateshwara Hatcheries felt that farmers engaged in egg production and poultry farming should fetch a guaranteed income, price stability and be free from any exploitative trade practices. So, in 1982, he mobilized thousands of farmers across the country into a unified platform under the National Egg Co-ordination Committee (NECC)[5] umbrella and gave a clarion call, declaring "my egg, my price, my life". The

[4] Today, practically all multi-national poultry breeding companies in the world like Balecock, Shavers, Ross, H. & N., Hylina, Cobbs, Hubbhard, Indian River, Hisex, Tegel, Lahmann, Keystone, Dekelk etc. have collaborations with Indian entrepreneurs, producing parent line, grandparent lines and commercial chickens.

[5] NECC has a membership of more than 25,000 farmers as of now.

innovative institutional change helped in reviving the egg industry and put it back on the path of orderly progress (Frontline, 2003). The NECC also focussed on improving egg consumption in India as an important source of protein through on-air advertisements.

During the 1980s, the entry of private players in the poultry industry accelerated. Venkateshwara Hatcheries initiated vertically integrated poultry operations in layers in South and North India (during the mid-1980s), wherein they integrated different aspects of the poultry value chain from raising grandparent and parent flocks, rearing day-old chicks, compounding feed, providing veterinary services and marketing. According to industry experts, the model did not succeed in most areas at that time (Mehta & Nambiar, 2013).

In 1984, Suguna Poultry Farm Ltd. based out of Coimbatore entered the industry and with the help of thousands of small- and medium-sized farmers they pioneered the efforts towards institutionalizing the concept of 'contract farming'" in broilers within the framework of vertical integration. By the mid-1990s, integration and contract farming models increased in popularity in the south and then slowly in the west (Mehta, Narrod, & Tiongco, 2008). In the north, this model was not popular. Under a Suguna contract farming model, all the inputs required for poultry production – such as day-old chicks, feed, medicines, credit, extension services and information – were supplied to the contract farmer. In turn, farmers took care of the daily management of the poultry birds until they reach the slaughter weight and the stage of marketability. Under this model, the contract farmer owns the shed and puts in his labour and other variable costs for which he gets paid an agreed upon price. The broilers are usually reared for 35 to 40 days until they reach a market weight of 1.8-2.2 kg (Government of India, 2017). After that, Suguna collects the live birds from farmers' gate for either slaughter or further processing (Mehta, Narrod, & Tiongco, 2008).

In the Suguna scenario, there was negligible risk for a contract farmer of both input and output price volatility as well as assurance of a regular income. The institutional innovation of integrated producers and contract farming significantly contributed in revolutionizing the role and the structure of poultry industry in India. It not only improved farmers' profitability through economies of scale, higher productivity, reduced risks and transaction costs, but also, spurred the overall growth of poultry production in India (Government of India, 2017). Thereby, providing a competitive source of low-priced animal protein to consumers. As a result, a large number of poultry farmers switched from being independent to being integrated into a more dynamic private sector business[6]; however, they remain confined to some pockets of the country like Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra (Mehta & Nambiar, 2013).

In addition to the institutional innovation of vertical integration and contract farming, the Government of India lifted the ban on grandparent poultry stock imports from abroad in April 1993. This major policy decision, upending a ban that was in place since mid-1980s, further supplemented poultry growth in India. To encourage overseas support in Indian breeding operations, the government also slashed the import duty on grandparent stock from 105 percent to 40 percent in 1994 (Murty, 1996). In the subsequent year, the government further reduced the import duty to 20 percent.[7] This policy change on the liberalization of grandparent imports resulted in a massive increase in private investment in breeding operations in India. According to Mehta and Nambiar (2013), most of the imported high-yielding breeds present in India now have entered only since 1995.

According to data published by US Department of Agriculture (USDA), India's poultry meat production grew at 6 percent annually during the 1980s, accelerating to 11 percent annually in the 1990s. As a result, in 2000-2001, India produced some 37 billion eggs and 0.86 MMT of poultry meat compared to only 10 billion eggs and 0.1 MMT of poultry meat in 1980-81 (see Figure 6).

[6] Currently, there are more than 60 thousand poultry farms in India that function under a modern integrated management system (Hellin, Vijesh, Erenstein, & Boeber, 2015)

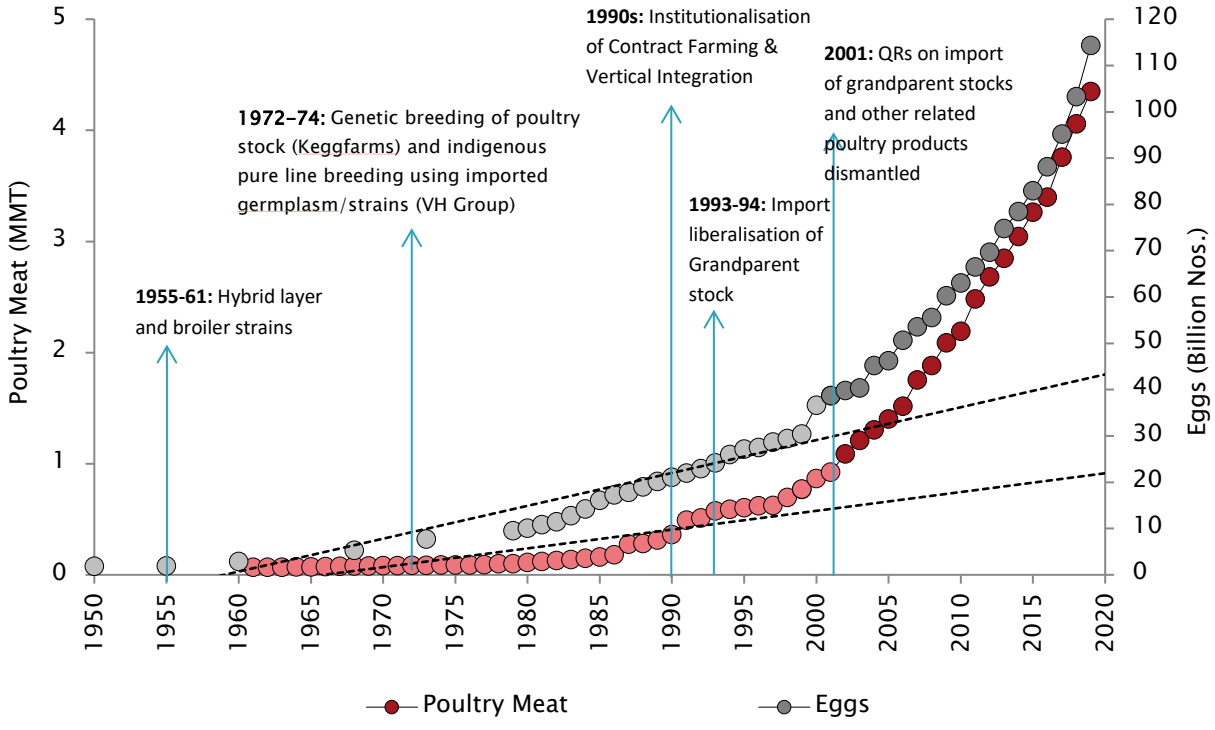
[7] Budget (1995-96). Speech by Shri Manmohan Singh Minister of Finance on 15th March, 1995. Accessed on April 15, 2018 (https://www.indiabudget.gov.in/bspeech/bs199596.pdf)

2000s to the present

A structural break in poultry production came in 2001, when all quantitative restrictions on India's imports of poultry items were dismantled and grandparent breeding stock was able to be imported without any barriers (The World Food Prize, 1996). However, from then on, these imports were subject to tariff-quotas. Thus, proactive pure line breeding programmes coupled with the development of vertical integration, liberalization of grandparent stock and sizeable investments from the private sector transformed the structure of poultry farming in India into a commercial, growth-oriented venture.

Concomitantly, the development of other inputs, such as feed, also contributed to the growth of the Indian poultry sector. It is worth noting that feed represents up to 70 percent of the total cost of poultry production (Government of India, 2017). Moreover, of total feed cost, 95 percent is for energy and protein requirements, about 3-4 percent for major minerals, trace mineral and vitamin requirements, and 1-2 percent for other feed additives. Maize and soybean meal constitute the major share of the poultry feed across countries (Government of India, 2017). According to industry sources, competitive prices of feed is key to improving feed conversion ratios as well as for competitive poultry and egg production. However, in Southern India, where most of the poultry integrators are located, feed is not available locally and must be purchased from suppliers in central and northern India (Landes, Persaud, & Dyck, India's Poultry Sector: Development and Prospects, 2004). These added transportation and handling costs show how both feed prices and feed use efficiency are critical factors that determine India's poultry competitiveness and growth.

Figure 6: Production of poultry meat and eggs in India



Source: Government of India, 2020

In India, the introduction of high-yielding hybrid maize varieties and high-quality protein maize,[8] along with other plant protection measures, have certainly played a key role in improving yields and feed efficiency. However, current production levels of maize may not be sufficient to meet the growing needs of the poultry sector in the coming years. Thus, there is an urgent need to increase domestic feed production at a higher rate. Other innovations – such as palletization, automated feeding and improvements in feed purchasing and logistics – have also contributed to improving feed use efficiency in the Indian poultry industry over the years.

As a result, India's poultry meat production has increased at an average rate of 10 percent annually from 2001 onwards to 2010, reaching 2.2 MMT in 2010. It subsequently increased at an average annual rate of 7.3 percent between 2011 and 2020, reaching 4.47 MMT in 2020/2021 (see Figure 6). In the case of egg production, the industry witnessed an average annual growth of 6 percent between 2001 and 2010, rising from 36.6 billion in 2000 to 63 billion in 2010. It further increased substantially at a rate of 7 percent per annum from 2011 onwards and reached more than 122 billion in 2020 (see Figure 6). The feed conversion ratio, in the case of broilers, has also improved significantly over the years from 2.2 in the 1990s to 1.65. Furthermore, laying capacity of layer birds improved to more than 320 eggs per bird (Government of India, 2017).

Another parameter to measure the growth of the poultry sector in India is the increase in the size of poultry farms. In earlier years, an average of a few hundred birds (200 to 500 chicks) per cycle were produced by broiler farm units. Recently, farm units with less than 5,000 birds are rare, while farm units with 5,000 to 50,000 birds per cycle are common (Mehta, Narrod, & Tiongco, 2008). Similarly, layer farms with a size of 10,000 to 50,000 birds have become common. Most of these units are open sheds and just a few are large poultry integrators with environment-controlled housing, and automatic feeding and drinking systems (Government of India, 2017).

Most of the private players in the Indian poultry industry are proactively investing in R&D of poultry parent stock (both indigenous and international breeds) to produce improved meat broilers and egg layers. Some of them have also entered into franchisee agreements with pureline/grandparent stock providers to develop breeds that are acclimatized to Indian environmental conditions. At the moment, there are a number of hybrids that are reared for rapid growth, feed efficiency and higher profits such as Cobb, Ross, Marshall, Hubbard, Hybro Avian, and Anak in case broilers. Of these, the Cobb 100 (or Vencobb) breed accounts for the majority share (65-70 percent) in the broiler market (Government of India, 2017). In the layer segment of the poultry industry, common breeds include Babcock, CARI Gold layer, Bovans, Hyline and Lohmann. Of these, BV 300 (or Babcock) is the most preferred layer breed and constitutes about 85 percent of the layer market share (Government of India, 2017). Venkateshwara Hatcheries or Venky's continue to play a pivotal role in the growth and development of the Indian poultry industry. They are the only commercial producer of Specific Pathogen Free (SPF) eggs in India. In simpler words, SPF eggs are those that are free from specific antibodies in their yolks. SPF eggs have been used in developing lifesaving vaccines against diseases like Rabies, Swine Influenza, Measles, Mumps, Rubella and yellow fever (Venky's, 2020). Besides producing vaccines for humans, SPF eggs are also used in the production of Avian Biologicals of International standards as well as for the development of primary cell cultures and cell lines for research and diagnosis (Venky's, 2020).

Thus, the evolutionary growth of the poultry industry in India over the years has been a result of changes in the institution of production and marketing, government policies toward trade of poultry and feeds, technological advancements, and continuous R&D investment for breeding improved quality breeds.

[8] Biological value of normal maize is just half as compared to that of high-quality protein varieties (ICAR, 2015).

4 Major players in the Indian poultry industry

Major players that constitute the majority of the poultry market share in India are Suguna in Coimbatore, Venky's in Pune, Godrej Agrovet Limited in Gujarat, Skylark Hatcheries Pvt. Ltd. in Haryana and Sneha Farms Pvt. Ltd. in Hyderabad. According to government sources, around two thirds of the total broiler meat production in India is contributed by contract farmers (or integrated farmers) and the remaining share is contributed by independent farmers (Government of India, 2017). Meanwhile, in the case of layer production, commercial farms contribute an approximately 80 percent share and the remaining comes from household/backyard poultry (Singh, 2019).

Among several companies in the Indian poultry industry, Venky's (Venkateshwara Hatcheries) is one of the oldest and leading names in the history of poultry farming. The company's major business segment is poultry and poultry products which consists of production and sales of day-old broiler and layer chicks, SPF eggs, processed chicken and egg products, poultry feed, poultry vaccine and diagnostic services, among others. In the FY 2019-2020, turnover of this segment was USD 221 million. Other segments include animal health products (registering a turnover of USD 32.75 million) and oilseeds (with turnover of USD 224 million). It is also the first company in India that started selling processed chickens under their brand name. While the company has operations in all parts of India, it is mainly concentrated in the south and west (Mehta & Nambiar, 2013).

Suguna Foods, the largest broiler producer in India, is the pioneer of contract farming in India. Founded by two brothers – B. Soundararajan and G. B. Sundararajan – the company ranks among the top 10 poultry enterprises in the world. Over a period of more than 35 years, the company's turnover had grown to USD 1.3 billion (Suguna Foods, 2020). The company has its operations in more than 8000 villages across 19 states employing about 42,000 poultry farmers. Their operations cover broiler and layer farming, hatcheries, feed mills, processing plants, vaccines and exports. The company has 84 hatcheries and 66 feed mills in production at present. Suguna markets live broiler chicken, value added eggs and frozen chicken. They have also set up a chain of modern retail outlets (Suguna Daily Fressh) to provide fresh, clean and hygienically packed chicken to its consumers. Through their branded products like Suguna Home Bites (ready-to-eat), Suguna Anytime (processed chicken) and Suguna value added eggs, the company has become a household name in India (Suguna Foods, 2020).

Godrej Agrovet Limited, a part of the Godrej Group, was incorporated in November 1991 in Gujarat (Business Standard, 2018). Today, it is one of the leading Indian conglomerates in the integrated poultry business (Mehta & Nambiar, 2013). The company operates across five business verticals including animal feed, crop protection, palm oil, dairy and poultry and processed foods (IBEF, 2020). It is the largest organized player in the Compound Feed market in India, contributing just over half of its revenues in FY 2019-2020 (IBEF, 2020). In the poultry segment, its integrated operations range from breeding, hatching and rearing of broilers to processing and marketing of its branded chicken "Godrej Real Good Chicken" (Mehta & Nambiar, 2013). According to industry sources, Godrej is the first company in India to market fresh chilled chicken. The company has a joint venture with USA-based Tyson Foods Inc. in the processed poultry segment, called Godrej Tyson Foods, which is the second largest player in the processed poultry segment in India (Godrej Group, 2020).

Skylark Hatcheries Pvt. Ltd. was established in Haryana by Jagbir Singh Dhull and Jasbir Singh Deswal in 1985. They had started a breeder business with a flock of 1000 Parent Stock and by 2020 had become one of the largest vertically integrated poultry businesses in India (Skylark Hatcheries, 2020). Their integrated operations cover a diverse portfolio, ranging from breeding of grandparent stock, parent stock, hatcheries, commercial bird farming (both layers and broilers), contract farming, feed production, poultry processing, large-scale mechanized farming and equipment fabrication. The company recently innovated a feed saving parent stock under the name "Skylark F-15". This new breed grows with feed consumption of only 10.5 kg and laying feed consumption of 39.5 kg, much less

compared to other breeds (with a feed consumption ratio of 14 kg and 48 kg, respectively).[9] Also, the company is the sole supplier of Hubbard and Bovans, which are pure line breeds of broilers and layers, respectively. The company's annual turnover was over USD 177 million in FY 2018-2019 (CRISIL, 2018).

Sneha Farms Pvt. Ltd. was established in 1982 in Hyderabad by D. Ram Reddy. They followed an integrated approach covering operations including broiler breeding farms, hatcheries, commercial broiler farms, feed plants, processing plants, distribution networks, and retail and wholesale outlets (Sneha, 2020). The company is also involved in manufacturing feeds, feed supplements and solvent extraction, as well as refining of edible oils. In FY 2019-2020, the company reported an annual turnover of USD 370 million (CRISIL, 2020)**.** Through their poultry contract farming network, the company is connected with thousands of farmers in South India. In 2014, the hatchery operations of the company reached an egg capacity of 1.8 million per week. Their chicken retail brand has a wider reach in southern and central parts of India (Sneha, 2020). As a step towards clean energy, Sneha Farms has installed a solar power plant at the hatchery.

These companies, along with others, are investing continuously in new technologies in poultry biological and feed analytics and disease diagnostics to improve the quality of breeds along with marketing and processing. Future expansion of the industry depends on the pace at which integrated poultry operations spread to other parts of the country. Investments in modern mechanized poultry and egg processing plants and vertical and horizontal integration have the potential to strengthen the competitiveness of the industry in India.

Box 1: The economics of contract farming: The case of the Indian poultry industry

In the Indian poultry business, farmers face high production and market risks, which are beyond the bearing capacity of most small-scale farmers. Therefore, in the early 1990s, some leading poultry companies began contract farming in India. Under the framework, companies provide chicks and feed to farmers at no cost, an assured off-take of output, and guaranteed returns for their contribution to production cost. In turn, farmers get assured income at regular intervals. However, the contract farming model is binding on the company as well as growers as per the agreement signed by both parties on a non-judicial stamp paper. The model has become popular across the industry. It is therefore interesting to examine the empirical evidence on the true costs and benefits of contract farming in India.

Birthal et al. (2005) use the case of contract farming model by Venkateshwara Hatcheries Limited in Andhra Pradesh to compare (i) the transaction costs and profits, (ii) scale of operations and (iii) output prices and risk sharing of contract farmers versus non-contract farmers through a sample-based study. The results show that contract farmers obtain 13 percent higher net profits per tonne compared to non-contract farmers, mainly on account of lower transaction and marketing costs (58 percent). Contract farmers also enjoy a better feed conversion ratio (1.88) compared to non-contract farmers (2.15). Second, the contract farming model is inclusive of smallholders because of their low costs of production (exclusive of family labour) compared to non-contract farming. Third, because the model guarantees assured procurement at an agreed price, the price risk is shared between integrators and contract farmers. Also, with insurance of up to a 5 percent mortality rate, the production risk for farmers is covered to some extent (Birthal, Joshi, & Gulati, 2005).

In a comparative study of contract and non-contract broiler poultry farming in Nagpur, Maharashtra, Kalpande (2013) reports that the average total cost for poultry per kg was USD 0.04 for contract farmers and USD 0.68 for non-contract farmers. Meanwhile, the total return obtained per kg was USD 0.06 and USD 0.73 by the farmer in contract and non-contract broiler poultry farming, respectively. The data also revealed that the average benefit-cost ratio of contract farmers with a capacity of 9,074 chicks was 1.52, whereas it was only 1.08 in case of non-contract farmers who reared average chicks of 7,624 per batch (Kalpande, 2013). Thus, contract farming is win-win model for both contract farmers (particularly smallholders) and integrators.

[9] https://www.skylarkhatcheries.com/img/f1.pdf

5 A critical assessment of the performance of Indian poultry industry

In order to assess the impact of structural change in the Indian poultry industry, this section first examines the industry's competitiveness in terms of fulfilling export demand at competitive costs and prices, as well as ensuring investments and growth of the sector. Second, we assess the inclusiveness quotient (i.e., the industry's reach among different classes of farmers, based on holding size). Third, by examining the ease of credit availability and carbon footprint of the poultry sector, respectively, we explore and assess the financial and environmental sustainability in the sector.

5.1 Assessing on the competitiveness front

First and foremost, the way to assess competitiveness in the commercial poultry sector is to explore whether it is able to satisfy the demand for poultry products at competitive prices. The second parameter is to look at the cost at which it produces poultry products. Basing our analysis of efficiency on these two parameters, we find that India is not only the third largest producer of eggs and the fifth largest producer of poultry meat in the world, it also produces these at internationally competitive prices. This is due to the availability of local supplies of feed, such as corn and soybean meal. Kumar et. al (2022) evaluated the competitiveness of India's eggs and poultry meat exports. The authors find that India has been traditionally competitive in egg production and has exported large volumes of egg products to the markets in Japan and the Gulf. However, with the onset of Avian Flu outbreaks and certain tariffs on Indian egg exports by Japan, the competitiveness has decreased since 2010. In the case of poultry meat, India has been competitive since 2003–04, but has been able to find only a small place in the global market, mainly due to a lack of proper infrastructure in the value chains (cold chain) for exports (Kuman, Samantara, & Gulati, 2022)

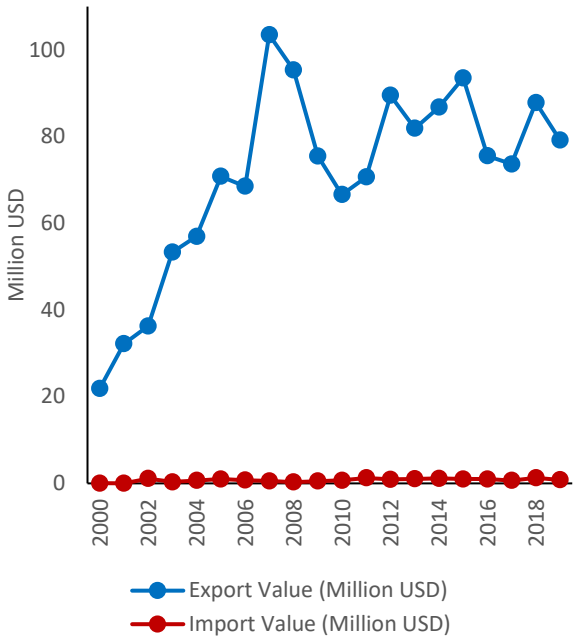
Thus, overall India's participation in the global poultry trade has so far been negligible. During the year 2019-2020, India exported poultry products mainly to Indonesia, Maldives, Oman, Russia and Vietnam (APEDA, 2021). Major items exported from India included table eggs, egg powder and whole frozen chicken (Government of India, 2017). The relative strength of India's poultry exports is in eggs, rather than poultry meat. A small amount of export revenue is earned from canned poultry meat exports (see Figures 6 and 7). India's export of canned chicken was a meagre USD 400,000 in 2000, rising to USD 4.8 million in 2003 and peaking at USD 14.6 million 2011 (FAOSTAT, 2020). Thereafter, annual canned exports fell and increased again to settle at USD 7.3 million in 2019 (see Figure 7). However, egg and egg-based products constitute a significant net export. Exports of eggs (dried, liquid, and in shell), increased dramatically from USD 21.8 million in 2000 – due to a higher demand from the Middle East countries – to more than USD 103 million in 2007 (FAOSTAT, 2020). In subsequent years, exports declined to USD 66.6 million in 2010. In 2019, these exports amounted to USD 79.2 million (see Figure 7). The top export markets for India's egg exports are Kuwait, Oman, Saudi Arabia, UAE and Yemen. Indian egg powder also enjoys demand from Japan and the European Union (Government of India, 2017). According to industry sources, plausible reasons of low trade in poultry products are the high mortality of birds, low processing capacity and low prices offered by importing countries (Kumar, Prasad, & Kumar, 2018). At the same time, India also cannot export poultry products to major trading partners on the grounds of non-adherence to important food safety standards (Mehta, 2002).

Indian imports of poultry products have also been limited, as can be seen in Figures 7 and 8, due to a web of import restrictions. Until early 2000, only hotels and restaurants were permitted to import poultry meat under import licensing (Mehta, 2002). However, from April 2001 onwards, all quantitative restrictions on India's imports have been dismantled and poultry items can be freely imported. However, these restrictions were replaced by high tariffs. Thus, while chicken may be imported without a license, it was subject to an import duty of 35 percent for whole chicken

(fresh/chilled/frozen) and 100 percent for cuts and offal (fresh/chilled/frozen).[10] Also, imports of grandparent breeding stock were placed without any barriers, but were subject to 30 percent import duty. Notwithstanding the import policy changes, India also imposed phytosanitary regulations and clearance procedures on poultry meat imports (Landes, Persaud, & Dyck, 2004). In 2010-2011, import duties on whole chicken (fresh/chilled/frozen) were reduced to 30 percent and on poultry cuts and offal (fresh/chilled/frozen), was increased to 110 percent. This import policy has continued and the rates in the year 2019 were 30 percent for whole chickens (fresh/chilled/frozen) and 100 percent for cuts and offal (fresh/chilled/frozen) (Goyal, various issues).

Figure 7: Export-import of poultry meat (chicken canned), India

Figure 8: Export-import of eggs (dried, liquid and in shell), India



Source: FAOSTAT, 2020

Chicken breast versus chicken legs

In the USA, poultry processors are said to earn profits by selling chicken breasts – which are preferred by domestic consumers for their lean, white meat that is highly rich in protein – at premium price in their domestic markets. Processors then sell the leg quarter – which domestic consumers view as less flavoured dark meat – to Asian markets at throwaway prices (Landes, Persaud, & Dyck, 2004). In the Indian market, the thigh and leg quarter, on the other hand, is considered a delicacy and is preferred over chicken breast. In a fear that imported leg quarters at throwaway prices would lead to significant imports and un-remunerative prices to domestic producers, India banned imports of US chicken under the Indian Livestock Importation Act, 1898, as a safeguard measure against the spread of low pathogenic strains of avian influenza. The ban has been opposed by the USA on the grounds that India's measures are more trade restrictive than required to achieve India's appropriate level of protection and not in line with provisions of WTO's agreement on sanitary and phytosanitary standards (Venkatesh, 2015). In reality, removal of India's import restrictions could give US poultry exports a boost of USD 300 million, as estimated by a US study in 2012. Thus, to tap this potential, on March 6, 2012, the USA appealed against India's import ban in the WTO. In October 2014, the WTO panel ruled

[10] Meat and edible offal, of the poultry of heading: Cuts and offal, fresh or chilled and Meat and edible offal, of the poultry: Cuts and offal, frozen

in favour of the USA, saying the Indian restrictions lack sufficient supporting evidence. However, India's Commerce Ministry appealed the ruling in January 2015. Nevertheless, India ultimately lost the case to the USA due to inconsistencies with the National Treatment Principle under the General Agreements on Tariffs and Trade (GATT). Still, India has implemented non-tariff barriers, such as not allowing imports if chicken meat is older than 6 months (US chickens are often frozen for 4-5 years); chickens that are fed with genetically modified feed; chickens that are given growth hormones and antibiotics; chickens that are given feed of meat, bone and blood; and chickens that are slaughtered or processed in the same unit as bovine meat (as suggested by FSSAI in consultation with Ministry of Commerce and Ministry of Animal Husbandry, Government of India).

5.2 Assessing on the inclusiveness front

One of the important questions that arises with the commercialization of the Indian poultry industry is whether the smallholders would be able to participate in such a fast-changing commercial sector. It is often argued that high-value commodities like poultry products are often perishable in nature and generally feed the local markets that are usually thin and fragmented (Birthal, Joshi, & Gulati, 2005). Whereas in the case of smallholders, the marketable surplus is too small to be bargained and traded remuneratively in distant markets due to high marketing and transaction costs (Birthal, Joshi, & Gulati, 2005). Thus, it is important to evaluate the impact of contract farming on farmers' income.

Against this backdrop, a review of some studies indicates that the contract farming model in poultry has played an important role in improving marketing efficiency (Birthal, 2008). Since most of the poultry meat in India is marketed in the form of live birds to consumers (almost 90 percent), the costs associated with moving live birds to markets (including transport, shrinkage and mortality) is beyond the bearing capacity of small-scale producers. Also, small-scale producers lack investments to cater to dynamic market demands. Thus, in a co-ordinated market approach, integrators on one hand cover market risks for small producers and ensure remunerative income (by keeping producer-retail margins relatively low), while on the other hand they help in compressing the average cost of production through improved technology and management practices. Besides this, integrators also perform key functions of banking and insurance against production risks (Birthal, 2008). Ramaswami et al. (2006) found that the contract farming model in poultry has benefited small-scale producers substantially. The study also compared production costs of contract producers relative to non-contract producers in Andhra Pradesh, India and observed that simulated costs for contract producers was USD 0.34 to produce 1 kg of bird, while for the non-contract producer it was USD 0.36 for 1 kg of bird produced. The study also showed that with contract farming, as much as 88 percent of the risk can be shifted to the integrators (Ramaswami, Birthal, & Joshi, 2006). Birthal et al. (2005) studied the institutional mechanisms adopted by different firms to integrate smallscale producers of milk, broilers and vegetables into the supply chain and their effects on producers' transaction costs and farm profitability. The study found that in broilers transaction costs as a result of contract farming had been reduced by over 58 percent. Moreover, the net revenue realized by contract producers has been 1.1 times higher in broilers (Birthal, Joshi, & Gulati, 2005).

According to the recent report of Agricultural Skill Council of India on Poultry Sector, there are around 100,000 layer farmers in India and an equal number of broiler farmers. Of these, 70 percent are small-scale farmers (3,000-10,000 birds) and 20 percent are medium scale farmers (10,000-50,000 birds). Only 10 percent are large-scale farmers with units varying from 50,000 to 400,000 birds (LMIS, 2019). This shows that there is significant involvement of small-scale producers in the Indian poultry industry and they account for most of the production. Thus, for small-scale producers to stay involved in this fast-growing segment of the market, it is profitable to integrate into high-value chains through contract farming (FAO, 2008). This not only covers their market and production risks and provides higher than expected returns, but also improves their productivity through modern technology, high quality feed and other management practices.

5.3 Assessing on the sustainability front

The question of sustainability is critically examined by looking at both the financial aspects of sustainability (i.e., the role of institutional credit system in the commercialization of poultry sector) and the environmental aspects of sustainability (i.e., the environmental concerns emanating from the rapid scaling up of the poultry sector).

5.3.1 Financial sustainability

Access to capital and credit plays a major role in scaling-up a production unit. While some segments of livestock (e.g., dairy) can be kick-started or scaled-up with a small amount of capital, others (e.g., poultry) are capital-intensive (Mehta, Narrod, & Tiongco, 2008). In particular, the small producers in the business who lack private investment require a regular flow of finance to meet their working capital needs, bear high transaction and market costs, and protect their flock from vagaries of nature and diseases (Landes, Persaud, & Dyck, 2004). Mehta et al. (2008) observed through a primary study on poultry in Andhra Pradesh and Haryana that the efficiency of poultry farms is significantly influenced by the availability of credit – particularly with regard to small poultry farms (Mehta, Narrod, & Tiongco, 2008).

However, the income of poultry producers in India is taxed under the Income Tax Act of 1961, at the same rate as any other industry (Mehta & Nambiar, 2013). Meanwhile, unlike the agricultural sector, they receive no subsidies for key inputs (e.g., feed, power, water, etc.). Also, unlike the industrial sector, poultry producers receive no fiscal or regulatory benefits or concessions. The rate of interest at which poultry loans can be obtained from institutional banks starts at 10-12 percent and depends on business requirements as well as flock size per batch. However, most banks require collateral or security to be deposited against the loan.

With vast commercialization and the emergence of organized contract farming in the Indian poultry sector, there is an increase in availability of credit and insurance (in terms of risk sharing), subject to a mutual agreement between the producers and contracting firms. This has not only eased the capital constraints of producers, particularly smaller ones, but also has improved production efficiency and provided them protection against price risk and uncertainty. Birthal et al. (2005) reported in a study that in the case of broilers, the contracted producers hardly incur any costs on extension, information and transportation for acquiring inputs, which account for 80 percent of the total transaction cost in broiler production. Moreover, in a contractual arrangement, they receive key inputs such as chicks, medicines and feed from the contracting firm, where these inputs account for about 75 percent of the total cost of broiler production (Birthal, Joshi, & Gulati, 2005). This has been the principal attraction to these farmers for participating in the contractual agreement.

The contracting firms incentivise the producers to reduce mortality rates (below 5 percent) by paying extra. Mortality risks up to 5 percent is covered by the firm, with the remainder to be borne by the producer. This implies that broiler contract producers enjoy built-in insurance and indirect credit for important inputs without any interest and at the same time transfer some risks to the contracting firm (Birthal, Joshi, & Gulati, 2005). This contract farming model is also in the best interest of firms, as they receive an assured and timely supply of the desired output (Birthal, Joshi, & Gulati, 2005). The contract farming model also helps firms establish better control over operational and fixed costs, and minimizes risk because capacity is underutilized. Thus, the cost of processing is eventually decreased. Such a win-win model is found to be financially sustainable, even with very little or no support or investments from the government. Development has been largely based on private domestic or foreign investment. Also, a noticeable expansion of contract farmers indicates that they are gaining from the innovative institution curated for efficient production and marketing of poultry products. However, there is still substantial need for investing in adequate infrastructure for transportation of birds to the domestic markets (cold chains), processing of poultry products and tapping export potential.

Some steps toward increased infrastructure investments have been taken by the government from time to time to support rural backyard poultry producers, but they have remained limited in reach and implementation. During the eighth five-year plan (1992-1997), the Government of India announced that they would support the development of backyard poultry farming on a co-operative basis in order to help very small rural farmers in the unorganized sector (Birthal, Joshi, & Gulati, 2005). Further, to ensure easy access to critical inputs (e.g., feed, credit and marketing), infrastructure and related facilities poultry estates were set up for rural backyard poultry in collaboration with agencies such as the National Co-operative Development Corporation (NCDC), National Bank for Agricultural and Rural Development (NABARD), state governments, and non-governmental institutions (Mehta & Nambiar, 2013). The central government also introduced a bankable programme called the Poultry Venture Capital Fund (PVCF) under the National Livestock Mission's "Entrepreneurship Development and Employment Generation" (EDEG) program. Under the scheme the central government, subsidies are provided through NABARD to those beneficiaries taking loans under PVCF for promoting poultry farming activity in India (Ministry of Fisheries, Animal Husbandry & Dairying, 2020). The scheme envisages strengthening of the poultry industry by improving production and productivity of processing units through technology upgrades and also encouraging introduction of innovative technologies. To avail the capital subsidy, farmers need to take on a bank loan and pay installments in due time. For example, if the capital cost of the project is, USD 14,104 the bank loan component must be at least USD 5,642 (i.e., a minimum of 40 percent of the cost) (Government of India, 2013).

Also, in view of the setback to the poultry industry due to natural calamities or disease outbreaks, such as bird flu, the General Insurance Corporation (GIC) of India introduced livestock and poultry insurance under the Indian Rural Development Act 2000 (IRDA), wherein insurance is provided for crossbred and exotic breeds only. Under the scheme, insurance coverage is provided against deaths of birds due to accidents (including fire, lightning, flood, cyclones, storms, tempests, earthquakes, strikes, riots, or acts of terrorism) or diseases contracted or occurring during the period of insurance subject to certain exclusions. The premium rates are fixed per bird according to market conditions, mortality experience, and veterinary service promptness.

Even the Reserve Bank of India in their timely revisions of guidelines, instructions and directives to banks on Priority Sector Lending has included poultry as a part of allied agricultural activities for extending 18 percent credit to agriculture and allied sectors. Within the 18 percent target, a target of 8 percent credit is prescribed for small and marginal farmers to supplement their credit needs. Further, as a consequence of the Union Budget 2020 announcement, the livestock sector has been included in the Kisan Credit Card (KCC) scheme. This gives benefits of crop loan and interest subvention, which has so far only been available to agriculture sector under KCC, for rearing of cattle, buffalo, goat, sheep, poultry, and fisheries (Singh, 2019). Also, in the most recent Union Budget 2021 speech, the NDA government has announced that there will be an increase in the agricultural credit target to USD 222.6 billion in the FY 2022, with a special focus on better formal credit flow to animal husbandry, dairy and fisheries (Ministry of Finance, 2021). It is expected that these public investments will help to generate improved returns in the near future.

5.3.2 Environmental sustainability

Poultry production is growing each day and so is the waste generated (i.e., slaughter waste, hatchery waste, poultry droppings and litter manure) (Shakya & Agarwal, 2017). Poultry farming contributes to environmental degradation due to the generation of ammonia (NH_3) and Hydrogen Sulphide (H_2S) gases from the excreta of the birds (Central Pollution Control Board, 2022), waste generated during hatching operations, and from the death of the birds in poultry farms. Inappropriate management of poultry litter and waste as well as rendering material from processing units can cause serious long-term health implications (Mehta & Nambiar, 2013). Additionally, poultry manure can contain microorganisms and pharmaceuticals (such as antibiotics) used in poultry production, which can contaminate soil and water, leading to antimicrobial resistance, including multidrug resistance, in microbial pathogens.

Mehta et al. (2008) note that in India, most of the birds are kept in open houses or in cages and the excreta of birds is collected through a deep-litter system (Mehta, Narrod, & Tiongco, 2008). However, the mechanism gets tricky if the appropriate temperature is not maintained in the poultry house. This is because too much heat can lead to the coccidiosis disease from poultry litter and low humidity can cause dusty litter resulting in respiratory trouble and poor growth. The poultry litter is then used for composting, and converting to electricity (where chicken manure containing rice chaff is used as energy input), steam and biogas over the years. Other innovative poultry waste management methods include manure belt systems in egg production and palletization of dried manure that stabilizes the material and reduce dust. Some countries also use Black soldier fly (BSF) larvae as an alternative system for manure treatment (Government of India, 2017).

According to Shakya & Agarwal (2017), poultry litter is basically a mix of poultry excreta, feathers, spilled feed and material used as bedding, which mostly includes wood chips, sawdust, wheat straw, peanut hulls and rice hulls in poultry operations. Prabhu (2009) reported that India produces about 6.25 MMT of poultry manure annually and the most common use of the poultry litter is land application (Dunkley, Cunningham, & Harris, 2011). It can also be used as fish feed and livestock feed. However, there are several studies that regard direct use of poultry litter on agricultural lands as environmentally unsustainable due to concerns such as eutrophication and greenhouse gas emissions (GHG) from decaying and microbial contamination (Shakya & Agarwal, 2017). One of the innovative solutions to this problem is the thermochemical conversion of poultry litter into biochar, which is an environmentally sustainable approach. Under this technology, biochar (a processed solid state, which is obtained from the carbonization of biomass) is added to soils instead of direct poultry litter to improve soil functions and reduce GHG emissions from the decomposition of biomass (Shakya & Agarwal, 2017).

Thus, poultry intensification has potential environmental externalities, thus appropriate actions are required for handling waste and managing diseases (Hellin, Vijesh, Erenstein, & Boeber, 2015).

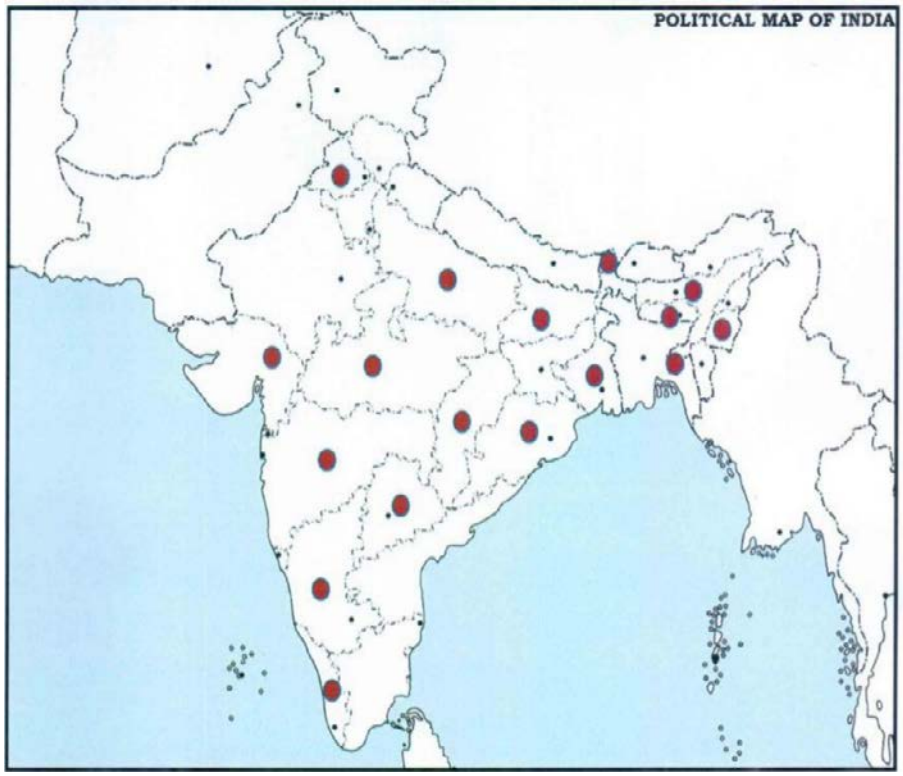
5.3.3 Outbreak of highly pathogenic avian influenza (H5N1) in India

Highly pathogenic avian influenza (H5N1) is an infectious disease of birds caused by the type A strain of influenza virus (FAO, 2008), which poses a high risk and at times threatens the sustainability of businesses. The first wave of avian influenza first emerged in Hong Kong in 1997. India, however, remained free of the disease until 2006. On February 18, 2006, the first outbreak emerged in Maharashtra (in Navapur and Jalgaon) and Gujarat, followed by an immediate second outbreak in Madhya Pradesh in March 2006 (Government of India, 2015). In the wake of global spread of the disease and apprehensions about a possible human pandemic, necessary control measures were taken, such as culling the entire poultry population and destruction of eggs, feeds, consumables, litter, and other potentially infected material within a radius of 10 km from the location of the outbreak (FAO, 2008). Restrictions were also placed on the movement of poultry, poultry products and personnel to and from the affected area, and cleaning and sanitation measures were implemented in the infected area (FAO, 2008).

After the first two outbreaks in India, more than 1 million birds were culled (Government of India, 2015). After the successful completion of control and containment operations, on August 11, 2006, the government declared that India is a notifiable avian influenza-free country, according to the regulations of the World Organisation for Animal Health (OIE) (FAO, 2008). However, a third outbreak occurred during July 2007 in a small poultry farm at Chingmeirong in the East Imphal district of Manipur. About 339,000 birds were destroyed. India achieved freedom from the disease on November 7, 2007. The fourth outbreak in the country was confirmed in West Bengal on January 15, 2008 and about 4.2 million birds were culled. A fifth outbreak was declared in Tripura on April 7 2008, where a total of 1.9 million birds had to be culled during control and containment operations. Thereafter, a sixth outbreak of Avian Influenza was reported in Assam and a total of 500,000 birds were culled. The disease re-emerged in the Malda District of West Bengal and spread to five more districts in the state. As a result, about 201,000 birds were culled. During an eighth outbreak in Sikkim and a ninth in West

Bengal in 2010, about 156,000 birds were culled and 18,000 eggs were destroyed. Between February and March, 2010, a tenth outbreak was notified in Tripura followed by an eleventh in Assam, and a twelfth in West Bengal (in September, 2011). Following this, the country was reported free from the disease on January 4, 2012. A series of avian influenza outbreaks have continued, but since 2011 occurrences of the disease shifted from the north-east to eastern and southern parts of the country (e.g., Odisha, Karnataka, Kerala, Telangana, and Bihar). By 2018, more than 8.3 million birds had been culled, causing huge losses in financial terms and loss of genetic stock.

Figure 9: States with avian influenza outbreaks in poultry 2006-2015



Source: Government of India, 2015

Episodes of avian influenza outbreaks were also reported in higher-income countries, including the USA, Germany and the UK, despite following higher levels of biosecurity and advanced husbandry practices. During 2014, 26 countries reported the avian influenza outbreaks to the OIE and during 2015, 39 countries reported an outbreak (Government of India, 2015). Since then, incidences of avian influenza cases have occurred, but of low-pathogenicity in small parts of the country.

Economic impact of avian influenza in India

Mehta et al. (2013) described that after the first outbreak of AI in India, when more than 1 million birds and over 1.5 million eggs were destroyed, the poultry industry was hit severely. While farmers were compensated for their losses, chicken prices dropped drastically when news of the influenza spread, from USD 0.85/kg to USD 0.37/kg (2006) in Mumbai and Pune. The poultry business in the two cities dropped by almost 40 percent. In response to this fall in demand, production was cut from 1.5 million birds to 1.2 million birds and egg production was reduced from 1.2 million to 800,000 (Mehta & Nambiar, 2013). Other states stopped imports of poultry from Maharashtra. Big integrators such as Venkateshwara Hatcheries and Godrej Agrovet also suffered substantial losses (Mehta & Nambiar, 2013). Exports to major markets had fallen massively, with the sharpest decline seen in exports to the UAE, Kuwait and Oman. The UAE even implemented a ban on egg imports from India in February 2006, which was later lifted in January 2007. According to industry sources, the poultry industry suffered an estimated loss of USD 2.84 billion (Mehta & Nambiar, 2013). After India was declared “avian influenza

free", the decline in poultry off-take slowed (Mehta & Nambiar, 2013). In October 2006, exports grew by 5.4 percent. The poultry industry even started a media campaign to regain consumer confidence in the safety of poultry meat and the government also announced a relief package for the poultry industry.

In the wake of the avian influenza crisis, an action plan on Preparedness, Control and Containment of Avian Influenza was implemented for early detection of viruses in high-risk areas and culling of birds in infected areas. According to government sources, until 2015, a total cost of USD 3.71 million had been provided for compensation of birds culled during avian influenza control and containment operations in the country (Government of India, 2015). However, the indirect costs on account of loss of livelihood, loss of assets and exposure to economic distress, market loss and impacts on international trade remain difficult to estimate and compensate.

6 Challenges and opportunities towards 2030 and beyond

Some opportunities that the Indian poultry sector should focus in the coming years include advancements in poultry nutrition, poultry processing and optimization of feed costs.

6.1 Poultry and nutrition

One of the critical issues that the world is going to face in the next two to three decades is how to feed a rapidly growing population with nutritious food. This is particularly true for a country like India, which became the most populous country of the world in 2023 and its population is expected to reach 1.5 billion by 2030 and 1.65 billion in 2050 (United Nations, 2019). At the same time, access to essential macronutrients remain constrained. This is a great opportunity for the poultry players to expand consumption and intensify awareness about the nutritive value of eggs and poultry. According to a government report, a chicken egg contains 6-7 grams of protein that contributes to 12 percent of the recommended daily intake of protein. It also contains a variety of other essential nutrients such as vitamins, amino acids and minerals such as vitamin A, D, E, K, B6, B12, folate, iron, phosphorus, selenium, choline, and zinc. Thus, eggs are a wholesome, nutritious food with a high nutrient density, which is crucial for good health and particularly for children's growth and development (Government of India, 2017). Recent studies have also reported that with the consumption of lutein and zeaxanthin (newly-recognized nutrients that have put eggs in the "functional foods" category) one can significantly lower risk of age-related macular degeneration (AMD), which is a leading cause of cataracts and blindness (Government of India, 2017).

Chicken meat is a rich and affordable source of protein (containing 22-24 percent more proteins than red meats), vitamins (B12) and minerals (e.g., iron, selenium, and zinc). It also contains omega-3 fats, which are an important provider of essential polyunsaturated fatty acids (PUFAs), especially the omega (n)-3 fatty acids (Government of India, 2017). Importantly, chicken meat does not contain trans-fats that contribute to coronary heart disease and is, thus, widely considered to be a healthy meat. According to experts, development of rural backyard poultry can contribute to improve a family's nutrition by supplementing income and providing food, particularly in the rural areas (Government of India, 2017). However, one of the most striking observations from the National Sample Survey (NSSO) data is that, on average, per capita calorie intake in India decreased from 2266 to 2099 kcal/ day in rural areas and from 2107 to 2058 kcal/ day in urban areas between 1973-1974 and 2011-2012 (Venkatesha et al., 2016). Intake of protein also declined in rural areas (from 62 to 57 g/day), but remained largely unchanged in urban areas (56 g/day) during that period. The next survey on consumption patterns is likely to come in 2024-25

In order to enhance the nutritive value of eggs, Suguna Foods has recently developed value-added fortified egg varieties, namely Active, Pro, Shakti and Heart. These varieties are rich in nutrients (omega 3 fatty acids, selenium, and vitamins) and are available at leading supermarkets and the company's outlets across the country at a price varying between USD 0.37-0.51 for half-a-dozen eggs (FnBnews, 2011). These new egg varieties aim to help maintain a balanced diet and healthy lifestyle for people of all age groups and health conditions. Concurrently, governments should make concentrated efforts to provide safe and healthy animal foods and proteins for the growing population. Thus, poultry *per se* has the potential to play the most important role in transforming the nutritional demography of India, with an ever-growing share of inexpensive protein-based human diets.

6.2 Poultry processing

At present, intensification of poultry production in India is constrained by a lack of capital investment in processing capacity and underdeveloped value chains. One of the major reasons for this is that the live market sales of broiler meat still constitutes more than 90-95 percent of the total volume of sales

and the processed chicken meat segment comprises only about 5 percent of total production because of consumer preferences. Small birds of 1.8-2.0 kg dressed weights are the norm in India (Government of India, 2017). In the case of eggs, the need for processing is even less and value-addition is miniscule. At present, barely 5 percent of eggs are processed into dehydrated or frozen products – and these are mainly destined for export or used in bakeries and other food and non-food sectors (Government of India, 2017). As a result, processing facilities for eggs are lagging far behind poultry production. Also, egg storage facilities, which could help conserve products without loss in quality, remain limited. There is currently a strong need for clean and hygienic processing machinery and waste treatment plants in the Indian poultry market (Duurzaam, 2017). In addition to processing and storage, India's poultry industry also lacks investments in cold chain and transport. Up until now, the major share of broiler birds in India are produced in five states: Maharashtra, Haryana, West Bengal, Tamil Nadu and Andhra Pradesh. Similarly, a major share of eggs produced in India are produced in five states: Andhra Pradesh, Tamil Nadu, Telangana, West Bengal and Haryana. Birds are currently transported alive between the states which causes them to be transported in unsafe and sometimes unhygienic conditions (Duurzaam, 2017). As a result, many birds are killed in transit. Lack of dry processing and cold chain facilities make it a logistical nightmare to be transporting good quality poultry produce within India. Thus, it is an opportunity for the poultry industry as a whole to create awareness about the safety and hygiene of processed products. This will help in improving consumption of healthy poultry products among Indian population.

6.3 Optimising feed costs

Feed (e.g., corn, soybean, pearl millets) accounts for about 70 percent of broiler and about 80 percent of layer production costs. Maize constitutes 60 to 65 percent of this feed while soybean paste represents another 20 percent. To produce poultry products at competitive prices, the availability of low-priced, high-quality feeds is critical. According to projections, the broiler industry will grow at a rate of 8-10 percent per annum during the next 5-10 years from now. It means the demand for maize and soya is likely to increase exponentially. If a feed conversion ratio is 1.65 – which implies 1 kg of corn is required to produce 1 kg of broiler (60 percent corn in feed) – an additional 1-3 MMT of corn would be required to cater to growing demand. Thus, a key factor underpinning India's poultry industry is the availability of maize. Maize production in India is expanding and changing rapidly in response to the growth in the poultry industry. During the last 15 years, maize production in India has more than doubled from 14.71 MMT to 30.16 MMT in 2020-21. But questions remain about whether it will be enough to meet domestic demand in the years to come. An increased use of hybrid seed technology in maize can contribute to increased yields. Thus, expansion of areas growing hybrid maize is the way forward. This would also provide a major boost to the maize seed industry.

FICCI (2015) in its report on "Maize in India" highlighted that due to growth in demand, maize prices have consistently gone up during the past few years. There is a lag between the increase in maize pricing and the transfer of increased price to the end user (poultry in this case). NCDEX futures trading, which was initiated in the last decade, provide a great opportunity to escape volatility. The innovative trading platform can help in developing the value chain and physical market for maize in India by giving advanced price signals and allowing risk management (FICCI, 2015). The platform can facilitate integration and expansion of markets across geographies and can improve warehousing infrastructure in the country, empowering maize farmers with "waiting power", which can lead to better price realization. On the other hand, futures trading is also beneficial for poultry producers operating with thin margins to lock in prices of their raw materials (i.e., feed). Thus, an appropriate institutional and policy environment is required that boosts India's poultry revolution to continue into the future – with due attention to feed market development and the environment.

7 Conclusion

The transformational success and challenges of the fast growing poultry sector in India can provide important lessons for smallholder economies, such as Sub-Saharan Africa, South Asia, Southeast Asia, and other developing countries. Because agriculture is often considered to be the backbone of the country in these economies, there is ample scope for replicating and scaling-up these innovations to achieve holistic and inclusive growth in agriculture. Countries in Africa face challenges such as diverse, rain-fed farming, far less irrigation potential and fertiliser consumption, poor infrastructure, low investment levels, limited access to markets and fragmented supply chains. Therefore, to augment farm incomes, ensure better nutrition and improve cost efficiencies, there is need to invest in the economic context that can facilitate vibrant, competitive and remunerative poultry sectors in these regions.

In countries where average land holding size is small (e.g., in India it is about one hectare), a crop sector growing basic staples cannot give enough income to the farmer families. But a poultry farm on one hectare of land can give an income that is multiple times more (3 to 5 times, roughly) than from basic staples. However, the risks of disease or market prices can be high. Getting critical inputs, such as day old chicks, vaccines, quality feed and insurance, can also pose a challenge. It is under such circumstances that the integrator model of contract farming has some important lessons. It provides quality chicks, quality feed, vaccines, insurance and even credit as well as buying arrangements for grown-up chicks after 35 to 40 days. This institutional innovation brings in the best technology and reduces the farmers' risk. This model can be an important innovation for smallholders to pilot in Africa or even other South and Southeast Asian countries.

It is worth reiterating that a major change in the Indian poultry sector came from liberalising the imports of grandparent stock which incentivised private sector investments to take advantage of the opportunity. Thus, the catalyst of change is access to the best technologies in the world (be it through imports or domestic R&D), adaptation of the technologies to local conditions and easy access to credit for investors (such as priority sector lending in India where all commercial banks have to give 18 percent of their credit to agriculture, including poultry and livestock).

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Working Paper Series

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Photo: Manish Prasad, ICRIER

Published by:
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