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Growth Performance and Value Addition of Rice Industry in India: Potential Opportunities and Challenges

Aldas Janaiah*

Professor and University Head, Dept. of Agricultural Economics
College of Agriculture, PJTSAU, Hyderabad-500030, India

*Corresponding author

ABSTRACT

Rice is an important component of agri-value chain, and a life-line for the livelihood of billion rural Indians. India's rice sector has been transformed significantly with the increase of rice production by 250% and yield by 230% between 1971 and 2015. There is a wide variation in the growth of rice sector across ecosystems as well as states. India became a leading rice exporter in the world with the worth of US \$ 9 Billion-an increase in export of basmati rice by four time and non-basmati rice by 3 folds in 2015 over 2005. About 80 to 85% of rice farmers are small and marginal. Nearly 75% of India's rice production is marketable surplus-largely generated by irrigated rice farmers in north and south Indian states as well as by the large farmers in other parts of the country. The marketing system for rice has huge network that purchase paddy from farmers. Nearly 85-90% of total rice production is domestically consumed in the form of cooked and steamed rice. Thus, rice value chain is largely confined to drying at farmers' level and milling and bagging at millers and traders' level. Total value of rice value chain in India is estimated at only US \$ 71 Billion, which is only 7.4% of gross agri-value chain. In case of basmati rice, value chain has been developed considerably during the past one decade. However, there is a huge potential to promote rice-based products through modern value chain in view of rising demand for processed and packaged foods, driven by rapid urbanisation, feminisation, diet diversification and increase in incomes of middle class consumers in urban areas. Thus, promotion of rice value addition on large scale will generate huge employment opportunities for youth besides increasing farmers' income. This paper discusses three key issues with empirical evidences, (a) pathways to transformation of rice sector, (b) nature and future of rice farming, and (c) marketing channels and value chain.

Keywords

Rice, India, value chain, marketing

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Introduction

Rice is a life-line for food and nutritional security for majority of 1.35 billion Indians. It is also a vital source of livelihood, directly or indirectly, for a majority of the 0.86 billion rural Indians. In particular, rice is the principal crop and the staple grain in the eastern, north-eastern and the southern states of India, and it is an important commercial

crop in the north-western states of Punjab and Haryana where wheat is the staple grain. Rice farming is still considered as subsistence activity in about 60% of India's rice area, dominated by rainfed ecosystem (eastern, north-eastern, and central regions).

About half of the small and marginal farmers of eastern and north-eastern states produce rice mainly for their household consumption

with little marketable surplus. At national level, nearly 75% of rice production is considered as marketable surplus, largely generated in north and southern regions as well as by large farmers in other parts of the country (Government of India, 2016). Increasing productivity and profitability of the whole rice value chain is always a priority in India's development policy in order to improve rural livelihood, ensure an adequate supply of rice at affordable prices, and earn foreign exchange from rice exports.

India's paddy rice production increased from 63 to 158 million tons between 1970 and 2015—an increase of over 150%. Yield improvement contributed 84% to this increase while area expansion contributed only 16% (Janaiah and Faming, 2010). The rice production and productivity increased tremendously since the early 1970s, after the introduction of genetically improved high yielding varieties (HYV) during mid-1960s.

The widespread adoption of high-yielding varieties (HYVs) as well as improved crop and farm management practices; policy support to improve irrigation facilities, market infrastructure, and the supply of chemical fertilizers and agricultural credit; subsidies on farm inputs; and farmers' enthusiasm to adopt HYVs were the major drivers of the impressive growth in production and productivity of rice in India (Janaiah *et al.*, 2005; 2006).

Within rice, the biggest success has been in the improvement of total factor productivity, the development and adoption of climate-smart varieties, vertical integration of value chain actors, and transformation of the *basmati* rice industry. As a result, India became one of the leading rice exporters in the world market today. Although the Indian agriculture sector achieved astounding success over the past four decades, agri-value

chain and agribusiness in India is yet to be transformed from primary stage to a modern industry level. Agri-processing and value addition is expanding recently in high-value food items such as fruits, vegetables, fish, etc. India's rice sector has a huge potential to generate high value products through modern value chain in view of its large size in terms of area and production. Further rapid urbanisation, industrialisation, feminisation, and diet diversification towards high value processed foods due to increase in income levels are creating substantial consumer demand for value added rice products.

In this context, this paper attempts to discuss with empirical evidences in four parts, (a) an overview of performance of rice sector, (b) brief description on nature of rice farming, (c) marketing channels and value chain, and (d) conclusion.

Materials and Methods

This study used huge data sets from multiple sources to carry out temporal and spatial analysis of rice sector in India from industry perspective. Mostly secondary and time series data (state wise) for the period 1971-2015, on key indicators of rice-industry such as area, production, yield, irrigated area, area planted to high yielding varieties, prices, marketable surplus, processes products, exports, value-added products, etc were collected from published and unpublished reports of Ministry of Agriculture and Farmers' Welfare, Ministry of Food Processing, Agro-Processing and Export Development Authority, Central Statistical Organisation, etc.. In addition, some key indicators were from published papers were cited.

A semi-log linear regression is employed to estimate annual compound growth rates for three decadal period for major rice-producing states over the past forty five years.

Results and Discussion

Results were discussed with respect to four key issues, viz., analysis of nature of rice farming, growth performance of rice sector, marketing and value addition, and rice exports.

Nature of rice farming

Although the present paper primarily focused on temporal and spatial analysis of growth in rice sector over the past four decades from rice-based industry perspective, it is ideal as prelude to understand the nature of rice farming under diverse production and socioeconomic environments in India

Rice is widely grown by nearly 120 million farmers in total cropped area of 43 million hectares. About 80-85% of rice farmers are small and marginal whose average farm size is less than one hectare. Rice farming for these small and marginal farmers is subsistence in nature in rainfed areas who produce rice mainly for domestic consumption with little marketable surplus. However, rice is emerged as a commercial crop under irrigated areas of north and south Indian where farmers produce paddy mainly for market. In India, about 85 to 90% of total rice production is consumed domestically, largely in the form of cooked and steam rice.

Rice is cultivated under diverse production environments i.e. irrigated ecosystem, rainfed ecosystem and deep-water condition, which accounts for 56%, 38% and 6% of riceland area in India. Rice is mainly grown in wet season (June to Nov) accounting for about 70% of rice area while dry season (Dec - April) occupies remaining 30% where assured irrigation is available. Farmers harvest an average of about 5 to 5.5 tonnes/ha of paddy yields during wet season under irrigated ecosystem (Fig. 1). In dry season under irrigated condition, paddy yield is about 20-

25% higher than in wet season. Under rainfed and deep-water conditions, farmers get average paddy yield of only 3 to 4.5 tonnes/ha. It is noticed from long term growth trend during 1967 to 2015 that growth in paddy has been nearly stagnant under irrigated ecosystem which it is increasing under rainfed lowland and upland ecosystems after 1990s (Fig 1).

Farmers follow transplantation method of crop establishment mainly under irrigated ecosystem, where farmers use 20-25 days old seedlings from paddy nursery for transplantation. In general, farmers follow zig-zag method of transplantation (not line row method). Broadcasting of 3 to 4 days old sprouted paddy seeds is a common method under rainfed upland areas where paddy yields are low. Farmers use 100 to 120 kg of nitrogen, 40-60 kg of phosphorus and 40 to 50 kg of potassium per hectare in three to four splits in different form. The use of organic manures and fertilizers have declined over the period due to substantial reduction in livestock population in rural India. Nearly 85 to 90% of India's rice is now covered with high yielding varieties (HYVs). Hybrid rice coverage in the farmers' fields is very meagre, i.e. less than 3% of total rice area. In India, total of about 1200 HYVs and hybrids were developed and released by various R&D institutions over the past five decades. However, thirty most popular HYVs covered in 75% of rice area in India (Janaiah and Hossain, 2005). On an average, farmers replace paddy seeds with newly purchased certified seeds once in three to four years; i.e. seed replacement rate is about 25 to 33% in India (Janaiah and Debduita, 2016). Paddy farmers adopt integrated pest and disease management practices against major insect pests such as stem borer, brown plant hopper, leaf folder, gall midge, etc and major diseases such as blast, bacterial leaf blight, sheath blight, tungro, etc. Rice farming in India

including under rainfed areas is largely mechanized as farmers use modern machinery for ploughing and puddling (tractors, power tillers), irrigation (pump-sets), transplantation (transplanters only in some areas), and harvesting, threshing and winnowing (mini and combine harvesters and threshers). In many rice areas, farmers follow chemical weeding. Increasing labour shortage for farming and decreasing livestock in rural India are two key reasons for increased mechanisation and chemicalization of rice farming in India. At present, cost of producing one metric tonne of paddy rice under irrigated input intensive areas is about US \$ 200 to 250, while it is about 150 to 180 in rainfed regions.

Growth performance of rice sector

Rice accounts for 35% of the total cropped area and 42% of the total production of food grains in India (Table 1). Between triennium ending (TE) 1971-73 and 2013-15, rice's share in the total area of food grains slightly increased but remained virtually same in production. The national aggregate values, however, disguise a large variation in production environments across Indian states and regions. The state and region-wise analysis however show that the contribution of rice to total food grains production varies enormously across regions and states (provinces) of the country depending on the agroecological conditions. In the humid tropics of the northeast (e.g., Assam and West Bengal) and the coastal regions of the south (e.g., Kerala), rice accounts for over 90% of the total area and production of food grains. Rice is also the principal crop in the humid subtropics of southern Bihar, Odisha and eastern Madhya Pradesh (MP), and in the sub-humid subtropics of northern Bihar and eastern Uttar Pradesh (UP). In these regions, farmers have little choice but to grow rice during the hot and humid monsoon season.

The top three rice producing states are West Bengal, UP and AP (including Telangana), which together contribute 40% to India's rice production (Table 1).

Paddy rice production at the national level increased from 63 to 160 million tons between TE 1971-73 and 2013-15—an increase of 2.3% per year (Figure 3), which is higher than the growth rate of population during the same period. Yield improvement was the major contributor to this production growth. The yield growth contributed 84%, while the area growth contributed only 16% to this production growth (Figure 2). The paddy rice yield increased from 1.7 to 3.6 t/ha over the last four decades. The higher growth rate of rice production than population led to substantial increase in per capita rice production. Per capita paddy rice production increased from 108 kg to 126 kg from the early 1970s to the late 1990s, despite 70% increase in the country's population in the same period. It decreased in the early 2000s, but again started rising since the late 2000s reaching 128 kg in TE 2013-15. The substantial increase in per capita rice production resulted in an adequate supply of rice at affordable prices, which was instrumental to improve national food security, reduce poverty, and uplift rural livelihoods.

The national level aggregate values mask a large heterogeneity in rice area, yield, and production across the Indian states. Rice yield has increased significantly in all states over the past four decades, although the magnitudes of increase vary considerably. In the early 1970s. Paddy rice yield across states ranged from 1.1 to 3.2 t/ha (Figure 4) during the early 1970s. The northern states of Punjab and Haryana and southern states of Andhra Pradesh (AP), Karnataka, Kerala and Tamil Nadu had relatively better irrigation infrastructure and quickly started adopting the

green revolution technologies (Table 2). As a result, these states achieved a substantially high yield (over 2.0 t/ha) even in the early 1970s. After four decades in 2013-15, paddy rice yield across states ranged from 2.2 to 5.9 t/ha. Paddy yield is about 4.0 t/ha or above in West Bengal, Punjab, Haryana, and all major rice growing southern states. But the yield is still considerably lower in many other states, especially the eastern Indian states (Figure 4).

During the first decade of GR (i.e. 1960s), rice production growth was limited to regions with already developed irrigation infrastructure, such as AP, Haryana, Karnataka, Kerala, Punjab, and Tamil Nadu, where farmers quickly adopted HYV suitable for the irrigated ecosystem (Janaiah *et al.*, 2006). In the early 1970s, rice yield had been already high, exceeding 2.3 t/ha in these states (Figure 4). In Punjab and Haryana, both rice area and yield increased spectacularly that led to a production increase of 250% in Punjab and 180% in Haryana from the early 1960s to the early 1970s. In the traditional rice bowls of eastern India, the diffusion of new technologies started only in the 1980s with (a) the expansion of small-scale groundwater irrigation that allowed farmers to grow HYVs during the dry season (*boro* rice) and manage monsoon failures during the wet season with supplementary irrigation, (b) the availability of intermediate height HYVs that are suitable for the shallow and medium flooded, poorly drained land that constitute an important sub-ecosystem in these states. As HYVs started spreading in eastern India, the regional aggregate rice yield growth rate jumped from virtually 0 to 4.1% per year and rice production growth rate jumped from 0.1 to 4.7% per year from the 1970s to the 1980s. Across states in eastern India, the rice yield growth rate was negative in all states except West Bengal in the 1970s, but rice yield picked up and maintained in the order of 0.6 to 5.5% per year in the 1980s (Table 3).

The additional rice production over the past four decades came mostly from the non-traditional rice growing states and the irrigated ecosystem in the traditional belt. During 1970–2013, India's paddy area increased by 6.1 million ha and paddy yield increased by 2.0 t/ha, which together lead to a production increase of 95.4 million tons (Table 4). The share of different states to the national rice production changed considerably during that period. It decreased from 40 to 35% in the eastern zone, increased from 20 to 26% in the northern zone, increased from 4 to 16% in the western zone, and decreased from 33 to 21% in the southern zone. Of the incremental rice production over the past four decades, the eastern states contributed 31%, the northern states contributed 30%, the western states contributed 23%, and the southern states contributed 14%. Punjab's share in the national rice production was only 2% in the early 1970s, but this increased to 10% in the early 2010s. Punjab contributed 16% to the incremental rice production over the past four decades (Table 4). Punjab benefitted the most from the green revolution in rice farming as it had developed reliable irrigation infrastructure and enterprising farmers with a relatively large size of farm holdings (Table 2).

Rice exports

India is a traditional exporter of a special quality rice, *basmati* to Middle East, Europe and USA. However, with the substantial increases in production of rice-both *basmati* and non-*basmati* rice- after mid-1990s, India became a leading rice exporter in the world during the recent past. At present, rice accounts for about 20% of total India's agriculture exports in terms of value. India is mainly exporting rice into two categories such as *basmati* rice and non-*basmati* rice. Sella Rice, Steamed Rice, and Pusa Rice are the different types of rice that are exported under

basmati rice category. While Parboiled Rice, Broken Rice, Sella Rice, Swarna Rice and Sona Masoori Rice are the types that are exported under non-*basmati* Rice category. The export of *basmati* rice has significantly increased from about one million tonnes to about 4 million tonnes during the past ten years (Table 5). Similar quantum jump was registered in the export of non-*basmati* rice by 2.5 to 3 times increase during the same period. Total rice export from India during 2014-15 was all-time record, i.e. about 12 million metric tonnes, which is about 30% of global rice exports. The total value of rice exports during 2014-15 was approximately US 9 Billion, of which the share of *basmati* rice was about 56%. In 2015-16 and 2016-17, *basmati* rice exports have increased by about 10% over previous years, but non-*basmati* rice exports have declined after 2014-15 (Table 5). The Indian *basmati* rice and non-*basmati* rices have fetched price of US \$ 1010 and 413 per metric tonne respectively in the world rice market during 2016-17.

Up until the early 1990s, Pakistan dominated the world *basmati* rice market, but significant increases in production due to improved technologies and farm management practices, upgrading of postharvest systems (drying, storage, milling, and processing), improved value addition (packaging and branding), and wider marketing brought success to the Indian *basmati* industry and has made India the leader in the world *basmati* rice market today. Favourable trade policy and licensing procedures for agricultural exports, private-sector efforts to promote rice exports, and the zeal of *basmati* rice exporters to establish themselves as reliable suppliers contributed to the success of the Indian *basmati* industry. Like-wise, surplus production of high-quality non-*basmati* rice varieties such as Samba Masuri and Jyothi made India to increase overall rice exports during the past one decade. However, there has been a wide

fluctuation in the export quantity of non-*basmati* rice over the period (Table 5) due to fluctuations in domestic supply, and uncertain government trade policy on food grains exports.

Marketing channels and value chain

An efficient marketing with value chain is crucial for transforming rice sector into an industry mode. Rice farming is a subsistence activity for half of the small and small farmers under rainfed rice areas whose marketable surplus is small portion of their rice production. Large quantity of marketable surplus of rice is generated in the southern and north Indian states. At national level, 75% of paddy production is marketable surplus, largely generated in the irrigated regions of south and north Indian states as well as by large farmers in other parts of the country (Government of India, 2016). Most of the marketable paddy surplus is sold out by farmers in the form of paddy after drying and bagging. Small and marginal farmers sell their produce after retaining required quantity for their home consumption to local village traders at relatively lower price right at the threshing yard. Large and medium sized farmers whose marketable surplus is substantially more sell paddy to rice millers or supply formal public agencies at higher price. In either case including *basmati* rice farmers (except contract farmers of few big companies), paddy farmers sell only paddy after very little value addition except drying and bagging.

About 90% of paddy marketable surplus is marketed through the various channels. There is a huge public sector managed marketing network in India with many agencies and institutions, which were set up in the 1960s and 70s. There are four forms of marketing channels through which paddy farmers sell their surplus paddy in India.

Public sector marketing agencies

The State Civil Supplies Corporation (SCSC) at state level and Food Corporation of India-FCI at national level are two major public-sector agencies that procure paddy rice through direct purchase centres mainly in surplus regions of north-west and southern states. These agencies also procure rice (milled) through rice millers to maintain central buffer stocks. An important issue is that most of these agencies are old and not modernized in lines with demand. Nearly 25 to 30% of total marketable surplus of paddy rice is procured through these agencies. Farmers get paid government's fixed minimum support price (MSP) for their produce from agencies. However, the operation of these agencies is very limited or even absent in the eastern, north-eastern and some central Indian states.

Regulated markets (argil. market committees)

There are about 8000 regulated markets and 32000 rural and wholesale markets with government-controlled committees are functioning in the country. These markets are managed by farmers' representatives and financially self-sustained because; these markets collect 1% of farm produce values as a cess from purchasers and use this income for market development. All transactions between farmers and licensed traders in these markets are monitored and regulated by respective State Department Officials in order to avoid malpractices and to facilitate fair trade through open auction method. All types of farmers especially medium and large farmers who were out of reach of FCI and SCSCs purchase centres bring their paddy to these markets for selling. Farmers may get competitive price in these markets as open auction method is followed by licensed traders to buy paddy from farmers. This price

may less or more than MSP depends upon supply-demand situation on day to day basis. These markets purchase 30 to 35% of total marketable surplus of paddy in the country.

Women self-help groups

There are 12 million Women Self-Help Groups (WSHGs) in India, formed by village women themselves with the support of government and rural financial institutions over the past two decades. They are functioning as grass root level institutions especially for empowerment of rural women. Recently, these WSHGs are permitted in southern states to buy paddy directly from the farmers on behalf of State Civil Supplies Corporation, and millers for which Rs 1 per bag of 70 kg will be paid to WSHGs as a commission. About 3 to 4 million tons of paddy procured by WSHGs mainly in south Indian states.

Open market (village traders)

In addition to above channels, a large number of traders are buying farm produce from farmers and sell it to the millers. Most of these traders are village level business people, money lenders, etc who often lend loans to the small and marginal farmers with a condition that farmers sell their produce to these traders. Most of small farmers usually sell their produce to the village traders, which accounts for 30 to 35% of total marketed surplus. Generally, farmers get paid relatively lower price by the local traders.

Value addition

The value addition in rice sector is largely confined to drying and bagging of paddy at farmers' level, milling, cleaning and separation at millers' point, and bagging with different sizes of quantity at wholesale point. In case of exportable *basmati* rice, some

registered companies have contracts with farmers and provide required technical advises and quality seeds to farmers to produce quality basmati rice. These companies involved in grading, cleaning, packing and branding in order to meet requirements of global rice markets.

There are about 100 different registered companies engage in rice trading of in India-both for export and domestic markets. These companies also started grading, packing and branding of quality non-basmati rice for providing to the high-income consumers through different super markets and big retailers.

Unlike earlier, rice in small packages of various sizes, varying from one to 25 kg are now available with brand names in some big retailing malls in urban areas. But the share of packaged and branded rice in the total rice sales to consumers is meagre, i.e. less than 10%. However, demand for branded and packaged rice is increasing in urban India. Historically, the Indian consumers eat rice in the form of cooked and steamed rice. Rice-based processing industry is very small in India and confined to only few rice-based products for occasional consumption.

At present, only 5 to 6% of total farm output is passing through modern value chain and processing in India. Thus, the gross value of Agri-value chain (both inputs and outputs are estimated at only US\$ 960 Billion, although the value of raw farm output is about US\$ 400 Billion. Rice is an important component of agri-value chain in India.

The value of paddy rice accounts for about 8% of total value of raw agriculture output in India. Nearly 85-90% of rice production is consumed domestically, largely in the form of cooked/steamed rice. Therefore, the share of rice-based products in the dietary system is

negligible; however it is increasing in recent years. Thus, gross value of rice value chain is only about US\$ 71 Billion, of which share of value addition is only 28% (wholesale and retail traders' share), and -54% is for farmers' share (farm-gate price) and by-product value is 18%. The share of rice value chain in the India's agri-value chain is only 7.4%.

The opportunities for promotion of modern value chain rice are plenty in view of growing consumer demand for processed and value-added rice products. Some key challenges that confronting to expand rice value chain are (a) small farm size of rice farmers, (b) inadequate institutional and infrastructure, (c) lack of modern milling and processing methods, (d) low yields, (e) weak quality regulation, and (f) traditional food habits of rice consumers-preferences.

Rice is a life line for India's food and nutritional security, and source of rural livelihood for half billion people. With the introduction of green revolution led high yielding varieties coupled with input uses and government's policy support, rice production has increased by 250% and yield by 230% between 1971 and 2015.

The irrigated regions of north and south Indian performed better in rice sector during the 1970 and 80s while the rainfed areas in eastern, north-eastern and central Indian states have picked up to increase rice yields after mid-1980s.

As a result, about 10 to 12 million tonnes of exportable surplus-both *basmati* (4 million tonnes) and non-*basmati* (8 million tonnes) rice- was generated after meeting domestic consumption requirements. India became leading rice exporter in the world today worth of US \$ 9 Billion-an increase in export of *basmati* rice by four time and non-*basmati* rice by 3 folds in 2015 over 2005.

Table.1 The relative importance of rice in total food grains area and production, by state, India, 1971-73 and 2013-15

		Rice's share in total food grains			
		1971-73		2013-15	
		Area	Prod.	Area	Prod.
Zone/State		(%)	(%)	(%)	(%)
East zone					
	Assam	92	94	92	96
	Bihar	52	53	51	52
	Odisha	77	83	81	92
	W. Bengal	82	84	87	89
North zone					
	M. Pradesh	27	32	29	28
	Maharashtra	11	25	14	26
	U. Pradesh	23	21	30	30
West zone					
	Gujarat	9	11	21	23
	Haryana	7	12	29	25
	Punjab	12	13	44	40
South zone					
	A. Pradesh	35	65	56	66
	Karnataka	16	35	17	30
	Kerala	95	98	99	99
	Tamilnadu	53	77	51	62
All zones					
	Others	8	17	10	14
	India	31	41	35	41

Source: Data from Ministry of Agriculture, GOI (2017 and previous years).

Notes: Food grains include milled rice, wheat, maize, coarse grains, and pulses.

Andhra Pradesh includes Telangana; Bihar includes Jharkhand; Madhya Pradesh includes Chattisgarh; and Uttar Pradesh includes Uttarakhand.

Table.2 Input use intensification in rice farming, by state, India, 1970-2013

Zone/State	Rice irrigated area (%)		Rice area under high yielding varieties (%)		Fertilizers use per hectare of gross cropped area (NPK, Kg/ha)	
	1985-87	2012-14	1970-72	2008-10	1975-76	2013-14
East zone						
Assam	23	11	10	65	2	65
Bihar	36	46	8	66	13	165
Odisha	33	33	6	79	7	98
W. Bengal	24	47	13	94	17	131
North zone						
M. Pradesh	20	34	9	45	5	84
Maharashtra	30	26	17	94	14	127
U. Pradesh	37	85	19	79	21	149
West zone						
Gujarat	53	65	14	87	15	120
Haryana	99	100	23	50	19	179
Punjab	98	100	63	99	52	217
South zone						
A. Pradesh	95	97	26	98	31	227
Karnataka	59	74	16	87	20	136
Kerala	43	76	31	91	22	121
Tamil Nadu	90	93	77	87	39	154
All zones						
Others	45	55	21	54	9	85
India	44	60	19	79	17	131

Source: Data from Ministry of Agriculture, GOI (2017 and previous years).

Notes: Andhra Pradesh includes Telangana, Bihar includes Jharkhand, M. Pradesh includes Chhattisgarh, and U. Pradesh includes Uttarakhand.

Table.3 The decadal growth rate of area, yield, and production of rice, by state, India, 1970-2015 (% per year)

		1970-79			1980-89			1990-99			2000-15		
Zone/State		A	Y	P	A	Y	P	A	Y	P	A	Y	P
East zone													
	Assam	1.5	-0.9	0.6	0.5	0.6	1.1	0.1	1.0	1.1	-0.1	2.7	2.6
	Bihar	0.5	-0.2	0.3	0.3	3.8	4.1	0.1	4.3	4.4	4.1	6.6	10.7
	Odisha	-0.9	-0.5	-1.4	0.4	3.5	3.9	0.2	-1.5	-1.3	-0.7	2.9	2.2
	W. Bengal	-0.1	0.8	0.8	1.1	5.5	6.6	0.5	1.9	2.5	-0.6	1.1	0.5
North zone													
	M. Pradesh	0.9	-4.0	-3.1	0.4	1.7	2.0	0.7	-0.9	-0.1	0.4	5.0	5.4
	Maharashtra	1.7	5.0	6.7	-0.1	-0.6	-0.7	-0.7	2.1	1.4	0.1	1.9	2.0
	U. Pradesh	1.3	0.3	1.6	0.0	5.5	5.5	0.9	2.2	3.1	0.1	1.2	1.3
West zone													
	Gujarat	0.3	3.8	4.1	0.4	-0.6	-0.2	2.0	1.7	3.7	2.1	4.3	6.4
	Haryana	6.4	4.3	10.7	2.4	-0.1	2.2	5.9	-1.7	4.3	2.1	1.1	3.2
	Punjab	11.7	5.2	17.0	5.3	1.3	6.5	2.5	0.0	2.5	1.0	0.7	1.7
South zone													
	A. Pradesh	1.9	2.2	4.1	0.5	1.9	2.5	0.5	1.1	1.7	0.7	0.6	1.3
	Karnataka	-0.1	1.5	1.4	0.4	-0.1	0.2	1.7	1.9	3.6	-0.2	0.8	0.6
	Kerala	-1.1	0.6	-0.5	-4.2	1.2	-3.0	-5.7	0.7	-5.1	-4.0	1.9	-2.1
	Tamil Nadu	0.2	0.2	0.5	-2.0	5.8	3.8	1.1	0.6	1.7	-0.1	1.2	1.1
All zones													
	Others	2.0	1.5	3.5	-0.1	0.8	0.7	0.5	0.7	1.2	0.7	1.6	2.3
	India	0.9	1.0	1.9	0.4	3.1	3.6	0.7	1.3	2.0	0.0	1.8	1.8

Source: Data from Ministry of Agriculture, GOI (2017 and previous years).

Notes: Abbreviations: A-area, Y-yield, and P-production.

Andhra Pradesh; Bihar includes Jharkhand, M. Pradesh includes Chhattisgarh, and U. Pradesh includes Uttarakhand

Table.4 Changes in area and production of rice, by state, India, 1971-73 and 2011-13

Zone/State	Rice area and production				Share of states to all India				
	1971-73		2013-15		1971-73		2013-15		
	A	P	A	P	A	P	A	P	
	(Mh)	(M)	(Mh)	(Mt)	(%)	(%)	(%)	(%)	
East zone									
Assam	2.0	3.1	2.5	7.6	5	5	6	5	
Bihar	5.1	6.9	4.7	13.9	14	11	11	9	
Odisha	4.6	6.0	4.1	10.9	12	10	9	7	
W. Bengal	5.1	9.0	5.5	23.0	14	14	12	15	
North zone									
M. Pradesh	4.5	5.2	5.8	14.4	12	8	13	9	
Maharashtra	1.3	1.9	1.6	4.3	4	3	4	3	
U. Pradesh	4.5	5.5	6.2	31.1	12	9	14	20	
West zone									
Gujarat	0.4	0.6	0.8	2.6	1	1	2	2	
Haryana	0.3	0.8	1.3	6.1	1	1	3	4	
Punjab	0.5	1.5	2.9	17.1	1	2	7	11	
South zone									
A. Pradesh	3.1	7.3	3.8	17.5	8	12	9	11	
Karnataka	1.1	3.0	1.3	5.1	3	5	3	3	
Kerala	0.9	2.0	0.2	0.8	2	3	0	1	
Tamil Nadu	2.7	8.2	1.8	9.3	7	13	4	6	
All zones									
Others	1.3	2.3	1.6	5.2	3	4	4	3	
India	37.6	63.2	43.9	158.3	100	100	100	100	

Source: Data from Ministry of Agriculture, GOI (2017 and previous years).

Notes: Rice production value refers to rice quantity measured in paddy form.

Abbreviations: A—area, P—production, Mha—million hectares, and Mt—million tons.

A. Pradesh includes Telangana, Bihar includes Jharkhand, M. Pradesh includes Chattisgarh, and U. Pradesh includes Uttarakhand.

Table.5 Rice exports from India during 2004 - 05 to 2014 -15
(Quantity in million metric tonnes)

<i>Year</i>	<i>Basmati</i>	<i>Non-Basmati</i>	<i>Total</i>
2004-2005	1.163	3.615	4.778
2005-2006	1.167	2.922	4.089
2006-2007	1.046	3.702	4.748
2007-2008	1.183	5.286	6.469
2008-2009	1.556	0.932	2.488
2009-2010	1.217	0.140	1.357
2010-2011	2.371	0.101	2.472
2011-2012	3.178	3.998	7.176
2012-2013	3.460	6.688	10.148
2013-2014	3.757	7.019	10.776
2014-2015	3.702	8.274	11.976
2015-2016	4.047	6.373	10.420
2016-2017	4.104	6.815	10.915

Source: Government of India (2010, 2018)

Ecosystem-wise rice yield: India, 1967-2015

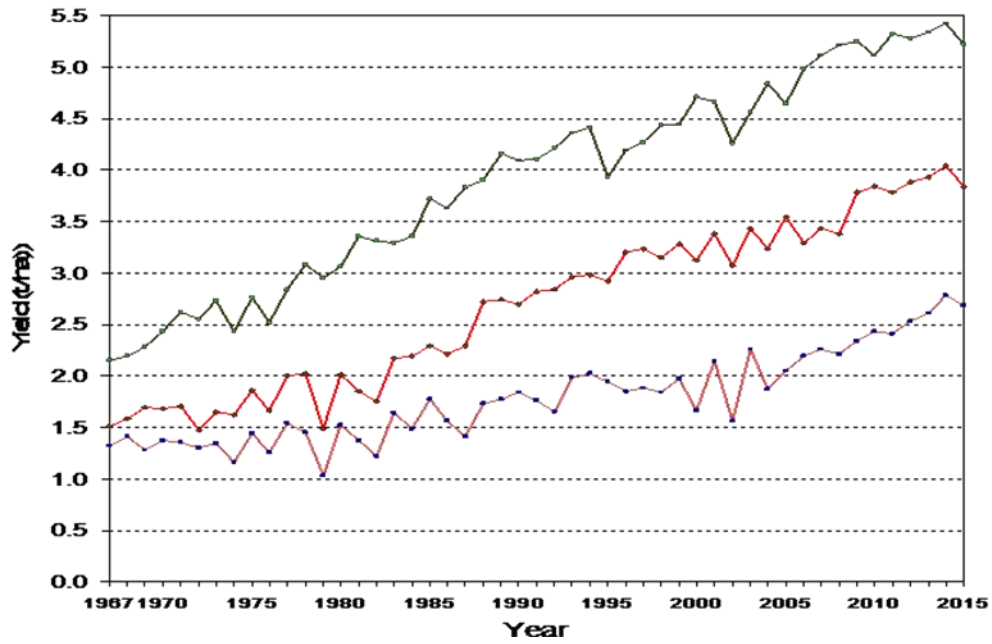


Figure.1 Trends in the yield of paddy in different ecosystems in India, 1967-2015

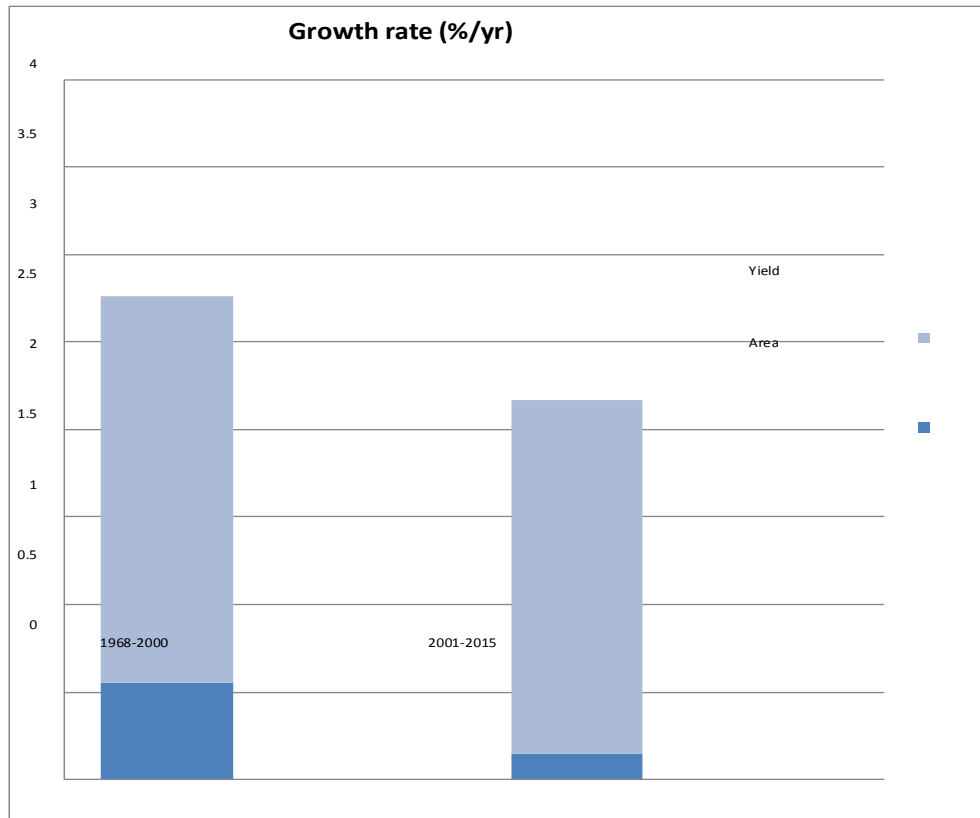
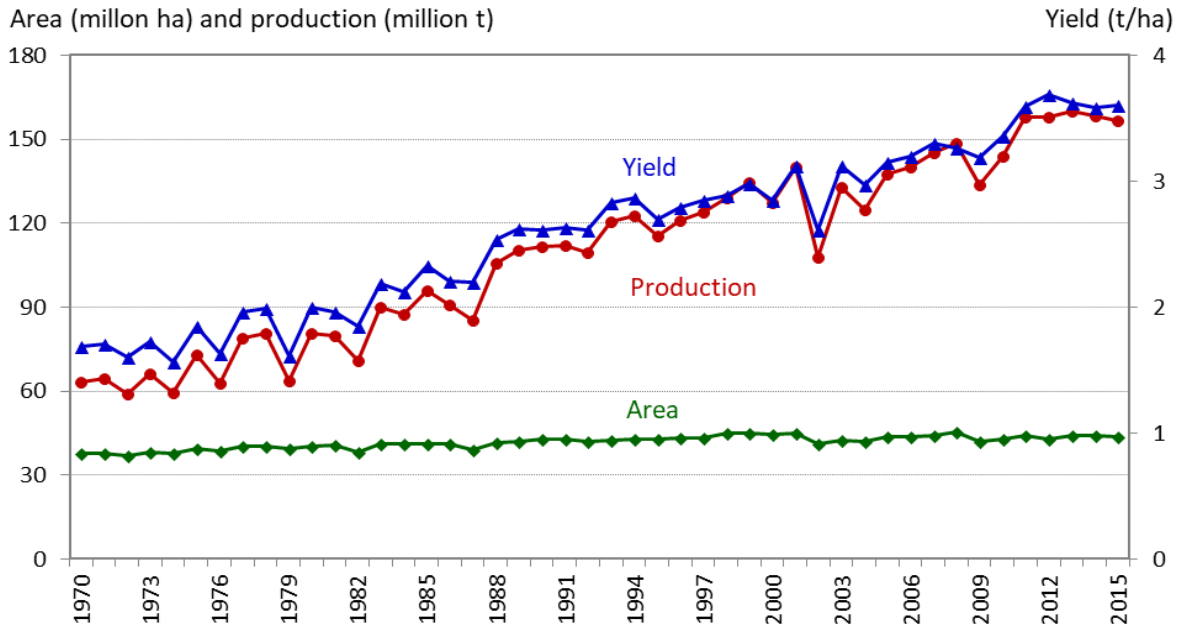
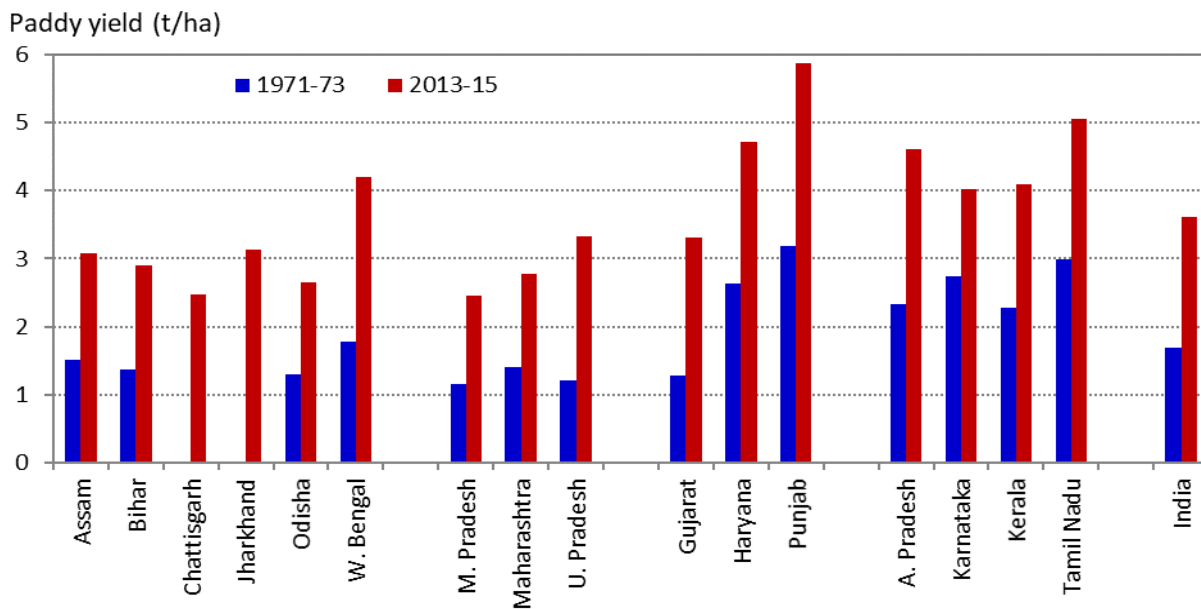


Figure.2 Growth rate in area, production and yield during early and late green revolution periods in India



Source: Data from Ministry of Agriculture, GOI (2017 and previous years)

Figure.3 Trends in rice (paddy) area, production, and yield in India, 1970-2015



Source: Data from Ministry of Agriculture, GOI (2017 and previous years) (2015)

Figure.4 Trends in paddy rice yield in major rice growing states, India, 1971-73 and 2013-15

Rice is grown by about 120 million farmers under diverse ecosystems across India, of which 80 to 85% are small and marginal. Farmers follow different methods of crop establishment with improved seeds of HYVs and other inputs, varying from one ecosystem

to other. Nearly 75% of India's rice production is marketable surplus-largely generated by irrigated rice farmers in north and south Indian states as well as large farmers in other parts of the country. The marketing system for rice has huge network-

both under public and private sector-that purchase paddy from farmers. Nearly 85-90% of total rice production is domestically consumed in the form of cooked and steamed rice. Thus, rice value chain is largely confined to drying at farmers' level and milling and bagging at millers and traders' level. Total value of rice value chain in India is estimated at only US \$ 71 Billion (58% of it is raw paddy value), which is only 7.4% of gross agri-value chain. In case of *basmati* rice, registered companies provide considerable services to contracted farmers for maintain quality of produce through various value addition activities.

However, there is a huge potential to promote rice-based products through modern value chain in view of rising demand for processed and packaged foods, driven by rapid urbanisation, feminisation, diet diversification and increase in incomes of middle class consumers in urban areas. Rice farmers' income cannot be increased in future without promotion of value addition and rice-based processing.

At present, farmers' get market price of only US \$ 200 to 250 per tonne of raw paddy without any value addition. If C-3 category cost of production is considered (includes all operational costs, imputed value of own family labour and rental value of land, interest on fixed capital and depreciation on farm equipment's), farm-gate price of paddy is nearly same as C3 costs (Government of India, 2017).

Further, promotion of rice value addition on large scale will generate huge employment opportunities for youth besides increasing farmers' income. The key challenges constraining rice value chain are traditional food habits, lack of modern infrastructure, presence of large number of small and marginal farmers in rice sector, etc.

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