Indian Journal of Agricultural Sciences **84** (8): 907–13, August 2014/Review Article
https://doi.org/10.56093/ijas.v84i8.43036

Research Papers

Supply of rice (*Oryza sativa*) commodity in India: Insights on domestic production performance

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Received: 5 July 2012; Revised accepted: 4 June 2014

ABSTRACT

Food security is a critical issue in the developing world. India is the second largest producer of rice (*Oryza sativa* L.) next to China and rice accounts for larger proportion of human caloric intake in India. The price rise of rice commodity and conversion of rice lands for non agriculture purposes necessitate examining the existing status of rice production and suggesting measures to prevent any sort of disturbances in food security in India. This paper aims at analyzing the present production performance of rice in the country by examining the trends and shifts in production growth, delineating the sources of production growth as well as assessing the instability in rice production. In addition, some other critical issues of spatial differentials and price escalation are also discussed. The study reveals that there has been deceleration in growth rate of rice production and productivity not only in India but also in all the top five major rice producing countries in the world. There exists a spatial variation among Indian states, where northern and southern region registered higher rice productivity and the rest of the regions witnessed less productivity. Yield effect contributed more towards the decline in production growth in eastern states like West Bengal, Odisha and Asom and therefore it is required to have adequate measures to improve upon the yield growth. Besides, higher instability in rice production is also noticed in Odisha and Bihar. It is therefore important to have technology breakthrough in rice which could push the production trajectory path upwards and achieve a higher and sustainable growth rate in rice as well as sustaining food security status in India.

Key words*:* Area effect, Decomposition, Instability index, Production growth, Rice, Yield effect

India is a major producer and consumer of rice (*Oryza sativa* L.), a staple commodity vital to the food security and welfare of many in the country. India is the world's second largest rice producer and is now self-sufficient with substantial stock, which transitioned itself from a nation dependent on imports to feed its population. Green Revolution and the introduction of modern high-yielding rice varieties in India helped in achieving better yield potential, which benefited both producers and consumers in the country. With the adoption of new technology package for rice and adequate policy and infrastructure support, rice producers benefited. Consumers also got benefited due to reduction in prices for rice. But in recent years, soaring price of rice impacts the consumers in their food budget. Besides these rising prices, there are some problems in production point of view also. Although, there has been significant increase in rice production in the previous years, the rate of growth of rice production in the country does not seem to be encouraging. This could be because of fatigue of technology. Technology is the prime mover of change and thus, technology fatigue and technology gap should be avoided (Chaudhary *et al*. 2008). The average yield level of rice in India is currently less as compared to major rice producing countries. It is in this context, the paper aims at examining the growth rates of area, production and productivity of rice in the country while comparing the performances in different phases of time ie pre-economic and post economic periods. The possibility for expanding the area under rice crop will remain very limited as the competition for land has been growing in the face of urbanization and industrialization. Water has also become scarce and in such situations, sustaining production growth is an arduous task. Besides the limited possibility for expanding harvested area, few other challenges are, increasing demand for rice due to population growth and keeping rice growers engaged in farming.

In this backdrop, the present study attempts to analyze the productivity growth, sources and instability in subsequent sections with the help of data collected from various secondary sources. Growth trends and shifts in rice production in India in comparison to major rice producing countries are discussed followed by delineating sources of rice production growth, examining spatial differentials in rice production and productivity, analyzing instability in production and price rise, estimating rice production and

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exploring the possibilities of higher production growth in rice.

TRENDS AND SHIFTS IN RICE PRODUCTION IN INDIA AND MAJOR RICE PRODUCING COUNTRIES

Production and yield growth of rice in India attained its peak during 80's and the trend exhibited an inverse 'U' shape during 1950-2010 (Table 1). The production growth rate increased to 3.65 percent per annum during 80s, from 1.9 percent during 70s, which has again fallen to nearly 1.5 per cent during 2000-10. Recent estimates have shown that neighboring countries such as Bangladesh (3%), Indonesia (2.35%) and Vietnam (1.99%) registered a better growth rate than that of India. Yield growth rate also showed similar pattern and it has shown declining trend in recent years. At the beginning of 60s, the total rice production was barely 34 million tonnes and the harvested area was 35 million hectares. Now the rice production increased nearly thrice, which has reached more than 90 million tonnes in a span of five decades. Thus India witnessed stupendous achievement in rice production even though horizontal expansion of area under rice was marginal. It is therefore evident that such increase in rice production must have been through increase in productivity of rice.

Despite absolute increase in rice production, the decline in growth rate of production and yield has started after 90's, and therefore increasing efforts are required to enhance the productivity growth. Keeping in view such decline in growth rates and rising population and demand, it is important to make interventions in technology and policy fronts. Enhancing R&D investments can generate technologies which can break the yield barrier and boost the productivity in rice. The current rice production technologies seem to be yield stabilizing types and it is essential to have productivity enhancement technologies, which would provide safety net against any eventualities in future. Besides this low growth rate, there are spatial differences in rice productivity across the country. It is as low as 1 232 kg per hectare in Bihar state and as high as 3 942 kg per hectare in Punjab state. Odisha and Bihar are poor performing states as far as yield of rice varieties are concerned. The spatial disparities in rice production are discussed in detail in the ensuing section.

Table 1 presents the annual compound growth rate of rice production and yield of top five rice producing countries in the world. China's rice production growth was very impressive (7.58%) during 60's and declined since then. Rice production growth in Bangladesh now reached all time highest (3%). As per the latest estimates, Indonesia and Vietnam also have exhibited declining trends (2-2.4%) after reaching a higher growth rate of 4-4.5 per cent during 80's as witnessed in India. Despite having the largest area under rice, India produces less rice compared to China which is mainly attributed to lower productivity level. The average yield of paddy rice for the last ten years have revealed that other countries like China (6.3 tonnes/ha), Indonesia (4.6 tonnes/ha), Vietnam (4.8 tonnes/ha), and Bangladesh (3.8 tonnes/ha) surpassed the rice yield level of India (3.1 tonnes/ha).

Despite the rice productivity is higher in these countries, production and yield growth rates have declined in recent years. Such decline in all the top five rice producing countries is looking gloomy due to the fact that these countries supply a lion's share to the world rice pool. Any disturbance in these countries can induce supply shock, which decides the price in the international market.

More specifically, in recent years, China registering growth rates in rice production and yield of less than 1 per cent implies that current technologies are stabilizing ones and amply suggests the need for yield breaking technologies. Same is true for all the major rice producing countries world over. If the current trend continues and adequate steps are not taken timely, there may be a shortage for rice consumption in future assuming all other factors are constant. Change in preference towards high value commodities, changes in food habits, and changes in income growth all matter while considering future demand for rice. Any erosion in world rice supply will push up the international price, which is one of the reasons quoted for the recent price rise of rice in the country. The middle income group will be impacted more in a country like India as low income group are safeguarded by the safety net of fairly good public distribution system. Though, we have solid policies in place in protecting the poor and low income class, we need to reorient our policies in production, investment and infrastructure in order to push positively

Table 1 Area, production and yield growths of rice in top five rice producing countries

CAGR in %

Time period	India			China			Indonesia			Bangladesh			Vietnam		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
1950-60	1.54	4.44	2.84	–0.05	–2.04	–1.98	2.25	2.69	0.43	0.04	1.91	1.87	6.80	12.21	5.45
1960-70	0.83	1.19	0.35	2.12	7.58	5.44	1.62	3.80	2.20	1.87	2.42	0.56	0.48	–0.95	–1.43
1970-80	0.87	1.90	1.04	0.29	2.63	2.35	0.96	3.48	2.54	0.66	2.74	2.07	1.84	0.36	–1.49
1980-90	0.41	3.65	3.25	–0.56	2.22	2.80	1.69	4.11	2.42	0.05	2.33	2.27	0.35	4.41	4.05
1990-00	0.68	2.02	1.34	–0.45	1.00	1.46	1.43	1.28	–0.13	0.24	1.96	1.76	2.48	5.54	3.09
2000-10	–0.22	1.57	1.78	0.23	0.93	0.71	0.97	2.35	1.36	0.46	3.00	2.54	0.39	1.99	2.38

Note: A, P & Y denote area, production and yield of rice respectively.

towards a much higher growth rate.

SOURCES OF RICE PRODUCTION GROWTH

The influence of drivers of production growth may differ at spatial scale. While disaggregating the production growth into area and yield effects, it is possible to examine the individual effect on overall production growth and how it varies in magnitude in different states across the country. In this paper, an attempt is made to disaggregate these effects in major rice producing states in the country. Minhas (1964) component analysis model is used to decompose and measure the relative contribution of area and yield to the total output change for rice crop. The form is expressed as $DQ = DYA_0 + DAY_0 + DADY$ whereas DQ is change in rice production; DYA_0 is yield effect; DAY_0 is area effect; and DADY is interaction effect. In this additive form, the total change in production is decomposed into three effects, viz. yield effect, area effect and the interaction effect due to change in yield and area. This decomposition exercise is undertaken separately for both pre and post Economic Reform era, i e 1965-91 and 1992-2010 respectively and the results are presented in Table 2.

As discussed earlier, the rate of production growth of rice in major rice producing states in India was above 3.5 per cent during eighties, which was impressive after the Green Revolution period. However, there has been a deceleration in production growth rate of around 2 per cent during 90's and 1.5 per cent after 2000. While several factors are responsible for the decline in production growth after 80s, it is important to examine the changing pattern of yield and area effects over a period of time. When the higher growth occurred in the first period, one factor seems to be common in majority of states, which is yield effect contributing overall to the production growth. During post Economic Reform era, it is observed that both area and yield effects contributed to the declined production growth, which varies from state to state. Karnataka, Tamil Nadu, Punjab, Haryana, and Bihar states registered more area effect and in rest of the major rice growing states, the yield effect is found to be more. One striking feature is that yield effect is very high in eastern states like West Bengal, Odisha and Asom. As the significance of yield effect is more pronounced for the decline in growth rate, more efforts are required in these states to promote high yielding varieties of rice for large scale adoption while removing the production constraints. Yield effect is more in Uttar Pradesh and Andhra Pradesh also in post Economic Reform period. A typical case is in Punjab and Haryana states, where interaction effect was more during Green Revolution period; however, during Economic Reform period there was a clear delineation and pronouncement of yield and area effects.

Table 2 Area and yield effects in major rice producing states in India

States	Pre-economic reform era (1965 - 91)			Post-economic reform era (1992- 2010)		
	Area effect (%)	Yield effect (%)	Inter-action effect (%)	Area effect (%)	Yield effect (%)	Inter-action effect (%)
Andhra Pradesh	18.02	67.67	14.32	24.55	69.12	6.32
Tamil Nadu	15.84	67.51	16.65	56.21	39.14	4.65
Karnataka	19.24	71.40	9.36	60.19	36.12	3.70
Uttar Pradesh	9.08	72.50	18.42	16.96	80.62	2.42
Punjab	31.53	10.05	58.41	53.78	36.99	9.24
Haryana	33.81	20.65	45.54	76.43	15.17	8.40
Bihar	4.60	92.52	2.89	56.04	34.70	9.26
West Bengal	18.16	66.89	14.95	1.58	98.05	0.37
Osisha	5.48	91.04	3.49	7.52	91.18	1.30
Asom	36.19	51.73	12.07	34.25	60.88	4.87
India	14.93	71.60	13.47	3.62	96.01	0.37

Major technology breakthrough came in mid sixties and the technologies that came during and after eighties were of yield stabilizing type, which has not provided any quantum jump in yield and thus lowered the production growth. Since the introduction of IR8 in 1966, no major technological breakthrough was evident even though some early maturing varieties were developed. Intensive rice cultivation, mono-rice cropping or rice based cereal cropping practices might be another reason for decline in yield. For example, reports in the early 1980s revealed a yield decline in the intensively cultivated rice plots within research stations in the Philippines. Increased salinity resulting from long-term rice production in irrigated areas worldwide was reported by Pingali and Rosegrant (1996). Extreme weather conditions such as drought and flood are often experienced in some parts of the country may also be responsible for overall reduction in yield growth rate. In addition, biotic stresses can also cause modern rice varieties not to realize its full yield potential. It is estimated that diseases and insects cause yield losses of up to 25% annually. Apart from biotic and abiotic stresses, prices would have had an influence on yield growth. Output and relative input prices are not moving on par. Though international rice prices have declined since 1995 (Calpe 2003), the reversal of price trend after 2008 and increase in oil prices have increased the prices of all commodities including prices of agricultural inputs. All these factors erode the profit level of farmers which is considered as disincentive to the farmers to invest in production inputs, which could eventually impact the yield growth.

SPATIAL DIFFERENTIALS OF RICE PRODUCTION

In this paper, rice growing states have been grouped in five major rice growing zones and analyzed for its share in total rice pool at national level. Spatial and temporal changes in rice production across region are presented in Table 3 and are found to be differentials in rice production across regions in the country. Overall, rice productivity in northern and southern region is higher, which enhances the national rice productivity in the country. Major rice growing states in southern region are Andhra Pradesh, Karnataka, Kerala,

Table 3 Spatial disparities of rice production in India

(%)

Year	Shares by region				
	South	North	West	East	Northeast
1960-70	31.6	2.7	4.9	54.9	5.8
1971-80	31.7	7.0	5.0	50.7	5.6
1981-90	28.0	12.0	4.6	50.4	5.0
1991-00	26.6	13.2	4.1	51.1	5.0
2000-08	25.2	16.8	4.7	48.3	5.0

Table 4 Spatial distribution of rice productivity in India

Year	Rice productivity by region (tonnes/ha)					
	South	North	West	East	Northeast	India
1960-70	2.18	1.89	1.35	1.28	1.37	1.50
1971-80	2.63	3.19	1.68	1.39	1.60	1.77
1981-90	3.16	3.88	1.99	1.80	1.97	2.27
1991-00	3.82	3.92	2.23	2.30	2.51	2.30
2000-08	3.99	4.36	2.55	2.43	2.85	3.07

and Tamil Nadu. Rice is grown in the southern region as more than one crop in a year and is an important crop of the region. Irrigated rice is largely grown in deltaic tracts of Godavari, Krishna and Cauvery rivers. Rainfed rice farming is also practiced in non-deltaic rainfed area of Tamil Nadu and Andhra Pradesh. The temporal analysis over the last five decades has shown that rice production from this region to the overall national rice pool has reduced from nearly 32 per cent to 25 percent. Productivity wise, this region is still the second best in the country next to northern region.

Northern region comprises Haryana, Punjab, Jammu and Kashmir states is single rice crop in *kharif* season followed by wheat in *rabi*. The average productivity of rice in this region is the highest in the country. The share of rice production from this region has significantly increased to 16.8 per cent from a meager 2.7 per cent during 50's. The reasons for such significant increase in northern region could be due to assured irrigation water supply in Punjab and Haryana, increase in irrigation intensity, widespread adoption of HYV/modern technologies, appropriate policy and adequate infrastructure support in relation to minimum support price and procurement. In the western region (Gujarat and Maharashtra states), rice is largely grown under rainfed condition. The share of western region in total production of rice is the lowest (5.48%). The method of cultivation and less geographical proportion compared to other regions are the main causal factor for the lowest share.

Bihar, Madhya Pradesh, Odisha, Uttar Pradesh and West Bengal constitute the eastern region, wherein more than one crop of rice is cultivated annually in states like Bihar, West Bengal and Odisha. Rice is grown in the basins of Ganga and Mahanadi rivers and has the highest intensity of rice cultivation in the country. As the region receives heavy rainfall, rice is grown under rainfed conditions also. Eastern region contributes the highest (48.3%) to the overall production in the country. West Bengal and Uttar Pradesh states are in the top three largest rice growing states in the country contributing an average of 14.78 and 11.59 million tonnes respectively to the total production of rice in India in the last five years. Though area influences the total production in this region, productivity of rice in the eastern region is less than national average productivity and much below the productivity level of northern and southern regions (Table 4).

Overall, the share of eastern region is looming large, which is nearing 50 per cent; however this region showed a marginal decline in share to the total rice production from 55 per cent to 48 per cent in the last five decades. Despite the lion share of this region, the average yield of rice (2.43 tonnes/ha) continues to remain at lower level when compared to other regions of the country. If the yield level of this region is enhanced, a quantum jump in rice production in the country as a whole can be expected. To enhance the production in the region, water management needs to be given adequate attention. Watershed development and, water conservation by the community are needed under water management. Ground water can be exploited in a big way in Eastern region (Dev 2012). It is therefore important to identify the production constraints in the eastern region and steps must be taken to either minimize the constraints or eradicate them.

In North-Eastern region, rice is largely grown in Asom and Tripura states. This region receives very heavy rainfall and rice is predominantly grown under rainfed condition. More than one crop is grown in Asom state in a year. The productivity of rice in this region is also comparatively lower (2.85 tonnes/ha) as compared to the northern region (4.36 tonnes/ha) and the national average rice productivity (3.07 tonnes/ha). These spatial variations in rice productivity are supported by a study conducted by Chand *et al*. 2011 on total factor productivity, which revealed that there have been variations in total factor productivity in rice among different regions of the country. The northern region has shown the highest growth in TFP (1.43%) and eastern region with a growth of 0.78%.

Since there is scope to step up the yield level in these regions, identification and removal of rice production constraints would pave a way for enhancing the rice economy in these regions. Particularly in eastern region, where the contribution is large, it is important to accelerate efforts to enhance rice productivity to a significant level so that overall rice production in the country will improve further to match the growing demand of rice in future. If spatial disparity is removed and productivity is enhanced to match with the highest productivity level of north region, it is expected to get an additional 43.18 million tonnes from the eastern region alone. Similarly there is scope to increase the rice production to an additional 4.33 million tonnes in north eastern region from the existing level if adequate

steps are taken to enhance the productivity level of rice in this region.

INSTABILITY IN RICE PRODUCTION

Though rice commodity is considered expenditure inelastic, recent price hikes can impact the poor badly and it can have an impact on rice production across states in India. Area under rice cultivation remains more or less same over a long period of time, though there are spatial and temporal variations in yield across the country. There seems to be yield instability and hence the risk in rice crop can have varied impacts. In this paper, an analysis on instability has been undertaken while comparing two distinct periods from the post Green Revolution period to Economic Reforms period.

To examine the stability of rice crop production in India, an indexing method proposed by Ray (1983) was used. The instability index was constructed as the standard deviation of natural logarithm of ratio of a variable (Y) between t^{th} and $t+1^{th}$ year. Y_t is the rice crop area/production/ yield in the current (t^{th}) year whereas Y_{t+1} is in subsequent year. This index is unit free and very robust, it measures deviations from the underlying trend (log linear in this case).When Y_t and Y_{t+1} are approaching same value, the ratio tends toward unity implying standard deviation is less. In other words, whenever the ratio is much deviated from unity, standard deviation is bigger showing high variability in the data.

The instability analysis was undertaken with the time series data on yield, area, and production of rice crop in India for the period 1966 to 2010. The results (Table 5) have shown that instability in rice production varies from state to state. In Bihar, the stability in rice crop production has improved in the Reform period than that of post Green Revolution period. The instability in rice production has declined from 38 percent to 30 percent and such decline is mainly due to the decline in yield instability of rice in Bihar.

In agriculturally advanced states like Punjab and Haryana, the instability in rice crop production has improved in the Economic Reform period. More particularly in Haryana, where the instability of rice production has improved overall with a reduction in instability index from 20% to 10% in post Green Revolution and Economic Reform periods respectively. Risk in rice production in Punjab state improved, which is largely attributed to the relatively stable yield of rice crop in the liberalization period. In Uttar Pradesh, the instability was more during post green revolution period, it reduced greatly from 28 per cent to 16 per cent. Though Uttar Pradesh state showed higher instability in yield (26%) during the Green Revolution period, it improved during liberalization period (10%). It is the lesser risk in yield, which has led to more stable rice production in Uttar Pradesh. In West Bengal, Rice is the staple food crop, wherein the instability has improved to a greater extent in productivity as well as production. Yield risk reduced to 4 percent in reform period from 13 per cent in Green Revolution period, which could be responsible for the reduction in instability of rice production from 15 per cent to 6 per cent respectively from the Green Revolution to Reform period. Temporally, there exist marked differences in instability between Green Revolution and Economic Reform period.

Table 5 State-wise instability indices of rice production in India

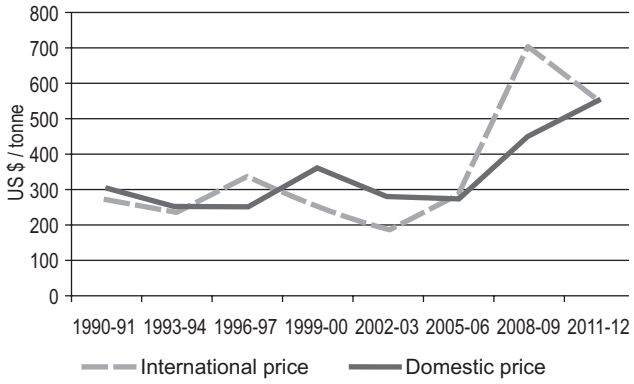
States	Area		Production		Yield	
	1966-91	1992-2010	1966-91	1992-2010	1966-91	1992-2010
Andhra Pradesh	0.11	0.14	0.16	0.19	0.09	0.08
Tamil Nadu	0.12	0.12	0.21	0.23	0.11	0.15
Karnataka	0.09	0.09	0.19	0.21	0.12	0.15
Uttar Pradesh	0.05	0.07	0.28	0.16	0.26	0.10
Punjab	0.07	0.04	0.12	0.06	0.10	0.05
Haryana	0.10	0.07	0.20	0.10	0.16	0.13
Bihar	0.08	0.09	0.38	0.30	0.32	0.26
West Bengal	0.05	0.05	0.15	0.06	0.13	0.04
Odisha	0.04	0.03	0.26	0.32	0.23	0.30
Asom	0.05	0.08	0.11	0.13	0.09	0.07

Notes: Two time frames (1966-91 & 1992-2010) are pre and post Economic Reform era respectively.

More specifically states like Punjab and West Bengal have shown far more stable rice crop production, which is greatly attributed to stability in yield. The instability in yield of rice crop reduced to a greater extent in these states between these two periods. All southern states, where rice is predominantly grown have showed higher instability more particularly in the Economic Reform period. Odisha also has shown the same pattern with higher instability of rice production largely due to more instability in yield. The highest level of instability in rice production and yield is found in Odisha state followed by Bihar. Uttar Pradesh is one of the states, wherein the instability in rice production has greatly reduced, however, low level of rice productivity in the state still a concern. In Asom, there seems to be fairly stable rice production, however the yield is quite low, which needs to be improved.

RICE SUPPLY AND PRICE RISE

As far as rice production is concerned, India is in fairly a comfortable position to meet out the domestic demand despite increasing population. Stocks are maintained at sufficient level to meet needs and eventualities if any, which is mainly attributed to the price policy adopted by the Government of India. The minimum support price while providing support to the rice producers it also helps in minimizing the risk. It helps indirectly to increase the whole sale price of rice to a certain extent and therefore the farmers get benefited. Along with this favourable price policy, infrastructure support in irrigation and advent of high yielding varieties helped in boosting the rice production. The result is we are not only feeding our population and building our stock but also exporting rice and we are now the net exporter of rice. Though we are self reliant in rice



Source: The World Bank 2013

Fig 1 Domestic and international price of rice (US $/tonne)

production, of late the price rise of rice has impacted the consumers. When the domestic and international price of rise is analysed, it is evident that there has been more or less a similar trend in both prices. However, the international price of rice peaked in 2008-09 as presented in the Fig 1. The domestic price is also on a rising trend ever since 2008-09. The swift rise in the price of rice in general is due to the confluence of a number of short- and long-term factors (Pandey *et al.* 2010). The major contributing factors are deceleration in rice yield growth rate, reduction in the stock level, demand growth, reduced public investment in agricultural research, development, and infrastructure, rapid rise in oil prices, and exchange rate movements (IRRI 2008). It is important to understand such high global prices because supply response is expected from price transmission to farmers of farmgate level (Acharya *et al.* 2012). There is a strong network of public distribution system in the country which helps very poor by providing them with rice at subsidy prices.

China, India and Indonesia occupied nearly 70 percent of world rice production in 2009-2010. Any disturbance in these countries will certainly have ramifications in world rice supply and price. India witnessed drought that reduced its 2009 *kharif* production and also there were major floods in southern states of India, Andhra Pradesh and Karnataka. Andhra Pradesh being one of the major rice production states, it was affected by drought and followed by flood. Such setbacks have repercussions on domestic as well as international markets. Thus supply and demand mismatch is linked with price rise both domestic as well as global. However, stock remains substantial in the country and hence there is no immediate threat in terms of availability. Rice stock position in the central pool as on January 2012 was 29.72 million tonnes, which is adequate for meeting the requirements under the public distribution system and welfare schemes during the current year (Economic Survey, 2011-12, GOI). India's policy pertinent to rice commodity is more of a protectionist's policy and hence Indian stocks are currently not necessarily to be linked with international market. It provides buffer to the Indian domestic rice market and hence it is perceived that it would remain stable unless otherwise some unusual event which impacts production sector.

India is one of the countries whose imports have been on the rise, which has an indirect effect on price escalation of all food commodities including rice in the country. International oil prices increase and the rising production cost through increases in the price of inputs, such as fertilizer and diesel and also transportation costs, which have indirectly driven commodity price increases in general and rice commodity in particular. Globally again the price hike was mainly due to stock use ratio. Shocks in major rice producing countries tend to adopt protectionist policies which ban the export of rice which impacts the stock use ratio globally. When stocks are relatively high, shocks can be easily absorbed with little price change, but when stocks are low, even modest supply shocks can have major impacts on price. Shortfall in rice production due to unforeseen events in some countries also shoots up the price. Apart from production related issues, speculation in rice commodity market would have also led to increase in price of rice commodity. This indicates that the total impacts come from the combination of all these factors, and it is often difficult to separate out the share of any one cause. As far as variability in rice prices are concerned, International rice prices have notoriously been prone to large swings and volatility in last five decades. However, rice price variation since the 1990s has fallen (Calpe 2004). Despite less variability, price hike in relation to rice is more. To minimize its impact on poor consumers, in India, efficient public distribution system is in place supplying rice at reduced/zero price to the consumers below poverty line.

ESTIMATED RICE PRODUCTION AND GAP

Rice production area and yield were estimated using annual compound growth rates, value at beginning for which figures are estimated and length of time interval in years for which figures are estimated. It is predicted that rice production in 2020 would be 124.6 million tonnes and in 2030 it would be 150.4 million tonnes (Table 6), which implies that in another 20 years, rice production in India should be increased around 2.5 million tonnes every year. Rice area already reached a plateau and horizontal expansion of area under rice will be limited. As seen from Table 5 that there would be a marginal decline in area under rice in India in future. The yield of rice crop is predicted to be around 3.5 tonnes per hectare in 2030, which is quite possible with the current state of technology however, spatial yield gap needs

Table 6 Estimated rice production in India

Year	Rice production (mt)	Rice yield (kg/ha)	Rice area (mha)
2011	105.2	2398	43.8
2015	113.4	2597	43.6
2020	124.6	2869	43.3
2025	136.9	3169	43.0
2030	150.4	3500	42.8

to be plugged in order to achieve the higher national average productivity level of rice. It is also important to make further investments in rice research to develop high yielding variety of rice to aim for surplus in future.

Based on this estimated production of 124.6 million tonnes and the demand projection made by Kumar (1998), there would be a marginal surplus of 2.5 million tonnes in 2020. We would be relatively in better position however, to have substantial stock to meet out the contingencies and eventualities, it is important to step up rice production, which could be possible by increasing the yield since horizontal expansion is limited.

CONCLUSIONS

The deceleration in growth rate of rice productivity of late is evident from the foregoing discussion. Such decline in yield growth rate can have far reaching impact on food security and further price rise in future. Domestic price of rice and international price have been on the same trend overall. As the domestic and global demands are rising in light of increasing population growth, efforts are therefore required to step up the yield growth rate focusing more on developing yield increasing technologies.

It is evident that spatial productivity differentials across states are wider and so are the production levels. Eastern states need more focus because the productivity level of rice is quite low. Delineating the low rice productivity districts across the region and identifying the location specific rice production constraints and taking steps to eliminate those constraints would help to improve the productivity of rice. Thereby the total supply of rice production in the region could be enhanced. The disadvantaged and low productivity regions need to be accorded higher priority. In addition to spatial variability in rice productivity, there are variations in instability in rice production also. Micro level diagnostic analysis would pave way for identifying exact needs and focused and targeted efforts in production.

While area expansion has very limited scope in the region, much of the production increase has to come from yield growth increase. While reducing the spatial disparity to achieve equitable growth, technology push is important to sustain growth level of rice crop production in the country. A right policy mix for technology development, uptake and dissemination aiming to achieve inclusive growth can improve the overall performance at national level. Concerted efforts are therefore required to work consciously and consistently on technology domain to push the production frontier significantly upwards.

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