PME notes

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Raising Wheat Production by Addressing Supply-Side Constraints in India

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Global wheat production has declined substantially in past few years. In 2007-08, the global wheat production was 604 million tonnes, down by 20 million tonnes in comparison to 2004-05, due to poor crop in the major producing countries, probably caused by the prevalence of hot and dry weather. The low production induced an upward surge in the prices of wheat and other staple foods in this period. However, with record production of wheat in India of 78 million tonnes in 2007-08, and having good prospects of wheat crop in the major producing countries, prices of wheat have declined in the past few months. For example, the price of red winter wheat in the USA declined from US$ 449 per tonne in February 2008 to US$ 349 per tonne in May 2008. However, this price is still high considering the past yearly trend and may remain so in the coming years too, due to diversion of food to bio-fuel production. The higher food prices would also mean additional cost on feed in livestock-rearing. Therefore, it is extremely important to sustain growth in wheat production by addressing supply-side constraints. Such a strategy is essential to avoid the food-deficit situation witnessed in recent past in countries like India.

Managing Demand for Wheat

Demand for wheat in India is categorized as food and for non-food uses. To meet food demand, wheat is used to make chapatti, bread, pasta and some other food items; while non-food uses (12.5 per cent of production) include seed, feed, and others. Government of India builds buffer stocks of wheat and rice for ensuring food security, feeding public distribution system and meeting its requirement for direct poverty reduction programmes. The government could not build buffer stock of wheat during the recent years, which can be attributed to a shortfall in output of wheat from the targeted level, lower market arrivals, high ruling market prices, and negative market sentiments due to low stocks of wheat. In order to encourage farmers to increase production of wheat as well as to enhance procurement during *rabi* marketing season (RMS) 2007-08, the government announced the minimum support price (MSP) of Rs 1000 per quintal, which is Rs 250 per quintal more than last year's MSP. The above market incentive has resulted in record high production in 2007-08. Moreover, higher offtake of wheat under different government programmes alongwith stagnation in its production in the past few years, has created shortage in the country. How can such a situation be avoided in future and what are the technological, institutional and policy options to accelerate growth in production of wheat? This note covers all these aspects.

Wheat supply under stress

Wheat production in the year 2006-07 was 75.81 million tonnes. The production of wheat increased significantly during the past years, from 33 million tonnes in TE 1980 to a peak of 74 million tonnes in TE 2007 (Figure 1). A part of this increase could be due to its spread to non-traditional areas like eastern Uttar Pradesh, Orissa, West Bengal, Gujarat, and Maharashtra. But, most of the increase in production came from improvement in yield. The wheat yield during this period increased from 1.5 t/ha in TE 1980 to 2.7 t/ha in TE 2007, while the area expanded by 5 million hectares, from 22 million hectares to 27 million hectares. The improvement in yield was possible because of increased use of modern inputs, particularly of high-yielding variety seeds, fertilizers, and irrigation.

The growth in wheat production however decelerated during 1990s over 1980s, and even became negative during 2001-06. In fact, during the later period, there was a decline in both the area and yield. How to bring additional area under wheat cultivation and improve its yield is a challenge?

Figure 1: Wheat production in India : 1980-2007

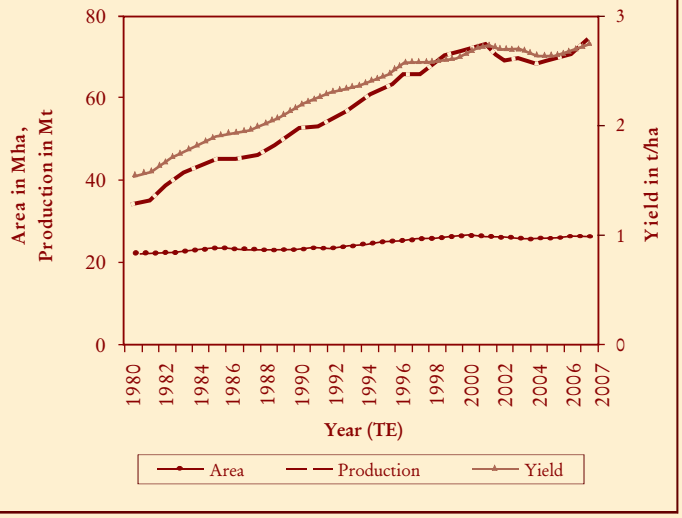

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Table 1: Share of area, production and yield of wheat in the major producing states of India, 2006

States	Per cent share		Average yield (t/ha)
	Area	Production	
Bihar	7.8	7.1	1.7
Haryana	8.7	12.7	3.9
Madhya Pradesh	15.1	9.7	1.6
Punjab	13.1	20.8	4.2
Rajasthan	7.8	8.3	2.8
Uttar Pradesh	34.4	34.7	2.7
All-India	100.0	100.0	2.6

Production niches and performance

Wheat is cultivated mainly in six states of northern India, viz. Uttar Pradesh, Punjab, Haryana, Rajasthan, Madhya Pradesh and Bihar. These states together accounted for 87 per cent of area and 93 per cent of production of wheat in the country in 2006 (Table 1). Besides, wheat is also grown in some pockets of Maharashtra, Gujarat, Karnataka and West Bengal, but their area and production shares fluctuate widely.

In 2006, Uttar Pradesh contributed above 34 per cent to total wheat production in the country, followed by Punjab (21 per cent), and Haryana (13 per cent). These three states together accounted for about 68 per cent of total wheat production. The states of Madhya Pradesh and Bihar though occupied 23 per cent of total wheat area, their share in production was only 17 per cent. The average yield of wheat in these two states is lower by 35 - 40 per cent as compared to the national average. Wheat yield in Punjab and Haryana is more than double of that in Bihar and Madhya Pradesh. By increasing wheat yield in Madhya Pradesh and Bihar to the level of national average, nearly 5 million tonnes of wheat can be added to total production. Apart from bio-physical factors such as fluctuations in temperature, lack of access to assured irrigation, timely availability of inputs, especially seeds and fertilizers, and low seed replacement rate are the main causes of low yield in Madhya Pradesh and Bihar.

A striking difference in the growth performance of wheat has been observed between the decades of 1990s and beyond (Table 2). The production growth during 1990s was positive across states and at the national level. It was achieved through growth in both area and yield. During 1990s, wheat production increased at a much higher rate (6 - 7 per cent) in Madhya Pradesh and Rajasthan than other states (2-3 per cent). Also, area and yield equally contributed to the growth in wheat production in Madhya Pradesh, while in Rajasthan, production increased mainly due to growth in area (above 5 per cent).

Table 2: Annual compound growth rates of wheat in major wheat-producing states of India

(per cent)

States	1991-00			2001-06		
	Area	Production	Yield	Area	Production	Yield
Bihar	1.1	3.2	2.1	-0.2	-5.3	-5.1
Haryana	1.8	3.4	1.5	neg	-0.9	-0.9
Madhya Pradesh	2.9	6.3	3.4	-0.6	-0.4	0.4
Punjab	0.1	1.8	1.6	0.5	-1.4	-1.9
Rajasthan	5.2	7.0	1.7	-4.8	-2.3	2.6
Uttar Pradesh	0.8	3.1	2.3	-1.0	-1.1	-0.1
All-India	1.6	3.5	1.9	-0.4	-1.0	-0.6

Note: neg = negligible

However, a more worrisome trend is the universal decline in wheat production in all the states in recent years. The decline has been caused by negative growth in both yield and area of wheat. In Punjab and Haryana which contribute over one-third to total wheat production in the country, growth in yield has been negative (-1.9 per cent and -0.9 per cent, respectively) during 2001-06. The decline in yield has been much more in Bihar than Punjab. The negative growth in area of wheat has been due to its diversion towards other crops like sugarcane, potato and vegetables in Uttar Pradesh; winter maize, onion and chillies in Madhya Pradesh; and tomato, garlic, and coriander in Rajasthan. The negative growth in yield has been due to low quantity and injudicious use of nutrients, poor seed replacement, delay in sowing, particularly the rising temperatures during flowering and grain setting, and scanty winter rainfall, etc. Evidence has shown that delay in sowing by 25-30 days leads to a grain yield loss of 25 per cent (DWR 2003)

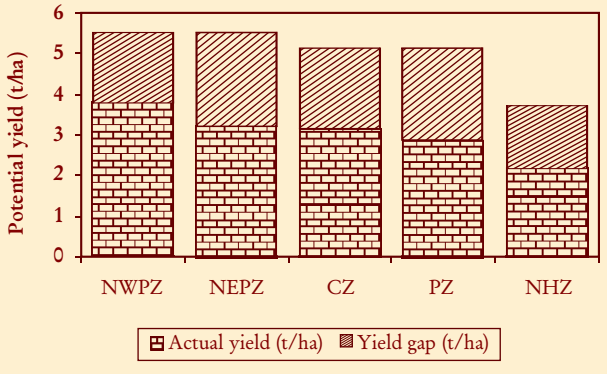
Impeding Factors

A number of supply-side factors affect wheat production, and a few of them are described below:

(a) Yield gap

Farmers are yet to achieve the yield levels obtained in local conditions in frontline demonstrations conducted by the State Department of Agriculture/ research institutions. At the national level, there is a yield difference of about 2 t/ha between the actual yield at farmers' field and frontline demonstration yield. It varies across wheat zones. The yield difference is also high (2 t/ha) in the North-Eastern Plains Zone (NEPZ), covering wheat growing areas of eastern parts of Uttar Pradesh, Bihar, Orissa, and West Bengal; and the Central Zone (CZ), covering areas of Madhya Pradesh and Gujarat. There is a considerable scope to increase wheat yield and bridge the yield gap of 1.7 t/ha in the North-Western Plains Zone (NWPZ), covering the states of Punjab, Haryana, Rajasthan and western parts of Uttar Pradesh, despite high yield levels (Figure 2). The considerable amount of yield gaps have also been observed in the Peninsular Zone (PZ) which includes Karnataka and Maharashtra, and Northern Hills Zone (NHZ) which wraps hills of Uttar Pradesh, Himachal Pradesh and Jammu & Kashmir.

Figure 2: Potential and actual wheat yields across zones, 2004



Source: Jha and Kumar (2005)

b) Imbalanced fertilization

Presently, the use of chemical fertilizers is highly imbalanced. The ratio of nitrogen, phosphorus and potash (N:P:K) application in the *rabi* season is 6.9:2.6:1 at the national level, against the recommended ratio of 4:2:1. The nutrient imbalance is a major concern in both low and high fertilizer-using states. In the states of Madhya Pradesh and Bihar, where the average fertilizer application is only about 105 kg/ha, the N:P:K ratio is 10.6:4.5:1. The nutrient imbalance is alarming in the north-western states of Punjab and Haryana, where fertilizer use is more than 200 kg/ha. The N:P:K ratio is as high as 60.9:23:1 in Haryana, and 38.2:2.8:1 in Punjab (FAI 2004). This highly imbalanced use of plant nutrients adversely affects the soil health and plant growth, delays the maturity period, and causes higher incidence of pests and diseases, all of which ultimately manifest in low yield. In addition, the role of micronutrients has become more significant today than before. The deficiency of micronutrients, particularly of zinc, across the Indo-Gangetic Plains and boron deficiency in the eastern regions are also limiting wheat yield.

c) Low rate of seed replacement

Seed replacement rate is low in wheat at the national level. It was only 13 per cent in wheat, against 19 per cent in paddy, 24 per cent in maize and 27 per cent in sorghum in 2003-04 (GoI 2005). Between 50 and 60 per cent of the farmers in Bihar and Madhya Pradesh use farm-saved seeds, as against 28-30 per cent in Punjab and Haryana (NSSO 2005). Use of quality seeds enhances wheat yield by 25-30 per cent (GoI 2006).

Strategies to Increase Wheat Production

Strategies to increase wheat production through area expansion and yield augmentation are described below:

Area expansion

It has been found that only 32 per cent of the net sown area is cultivated more than once, and a large portion of land remains fallow during *rabi*-season. Subbarao *et al*. (2001) have estimated that of 40 million hectares of *kharif* rice area in the country, 12 million hectares (30 per cent) remains fallow during *rabi*-season. It is equivalent to 85 per cent of the total cropped area of Punjab and Haryana. Most of the fallow land during *rabi*-season is in the eastern and central parts of India, covering the states of Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, West Bengal and Orissa. This fallow land can be used for the sowing of wheat during this season. However, there are some constraints which limit the use of these vast fallow lands.

Lack of irrigation, fast receding residual moisture after harvest of rice, soil hardiness of puddled rice fields, lack of short-duration high-yielding varieties of rice and wheat crops, uncertain winter rainfall, and lack of farmers' knowledge to conserve soil moisture have been identified as the major factors limiting the utilization of *rabi* fallows (Joshi *et al.* 2002). Similar constraints were noticed while introducing soybean as a new crop in Madhya Pradesh. But, with gradual improvements in technology and input delivery system, soybean cultivation spread on a huge area. It has been found that given the appropriate technologies, input and extension services, growing of crops in *rabi* fallows is feasible (Joshi *et al.* 2002).

Madhya Pradesh and Bihar have climatic conditions suitable for wheat cultivation, and in these states about 6.6 million hectares of *kharif* rice area remains fallow during *rabi* season. Utilization of even 25 per cent of these vast fallow lands for wheat cultivation would provide about 2 million tonnes of wheat at the current yield levels. This, however, will require investment in water-saving techniques (sprinkler irrigation), breeding of short-duration varieties of rice, enabling farmers to grow wheat varieties capable of escaping terminal drought, and popularizing zero tillage, besides enhancing capability of farmers for their uptake.

Yield augmentation

R&D efforts in wheat production have helped in upward shifting of the yield potential. For example, wheat yield in western India has increased more than two-fold during the past forty years, from 3.4 t/ha in 1965 to 7.2 t/ha in 2003 (DWR 2004). Simultaneously, yield gaps have also widened and farmers are finding it increasingly difficult to transform the yield potential. This limits wheat productivity. Jha and Kumar (2005) in a study on wheat have found the yield gap to be of 1.6 t/ha to 2.1 t/ha across wheat zones. These gaps reveal that there is still potential in raising the actual wheat yield in the country.

Bridging yield gap

The yield gap in wheat production arises due to abiotic, biotic and socioeconomic problems. It is estimated that abiotic problems (poor soil fertility, moisture stress, and delayed sowing) cause about 37 per cent of the existing yield gap; socioeconomic factors (poor knowledge of production technology, inadequate capital and non-availability of inputs in time) cause another 37 per cent, and the remaining 26 per cent of yield gap arises due to biotic factors like lack of location-specific varieties, weeds (*phalaris minor*, and wild oats) and diseases like rusts and loose smut. Though it is difficult to tap the entire production potential of wheat, it is possible to a large extent by managing some of these constraints. Empirical evidence from field indicates that with efficient use of available resources, farmers can harvest 10-40 per cent additional yield (Reddy and Sen 2004).

The challenge is how to manage these constraints? It has been found that the socioeconomic constraints can be managed by enhancing farmers' capacity and access to credit and other inputs in time. The abiotic constraints can be addressed by improving farmers' knowledge about the

management of soil fertility (balanced use of fertilizers, and replenishment of organic matter and micro-nutrients). Availability of organic matter in soil enhances its water-holding capacity, and to a limited extent, its capacity to tolerate moisture stress. Method and timing of sowing and providing critical irrigation are equally important. Delay in sowing causes yield loss of up to 1 t/ha in rice-wheat system, and 2.3 t/ha in cotton-wheat system (DWR 2002). Application of zero tillage is an option in the short-run. It provides saving in time and land preparation cost (Rs 2000-2500 per ha) as compared to that in the conventional method (DWR 2004). In the long-run, however there is a need to develop short-duration varieties of wheat and its preceding crop. Irrigation techniques such as sprinkler irrigation have the potential to save water by 30-40 per cent, without affecting the crop yield (Prabhakar 2001). Development and dissemination of location-specific high-yielding wheat varieties and management of weeds and diseases are important to address the biotic stresses.

The output prices during post-reforms periods have been instrumental in sustaining agricultural growth. In view of the increasing cost on production of wheat and declining profitability per unit area, there is an important role of MSP in increasing output of wheat. But, increasing output prices must be integrated with better technology and other support system.

Summing up

The continued research efforts in wheat production have helped in increasing both potential and actual yields. But, the yield gaps in different wheat zones have also increased. The existing yield gap is of about 30 per cent of total production, and is caused by a number of abiotic, biotic and socioeconomic constraints. The existing yield gap can be bridged by adopting improved production practices, increasing supply of location-specific quality seeds, adoption of optimum input dosages, and through active institutional support. Hence, the role of agricultural R&D policy is critical.

Improving yield level is a more viable and potential option to increase wheat production in the country. Appropriate management of problems like imbalanced and inadequate fertilization, low seed replacement, application of available inputs at proper time and methods, strengthening extension systems and input-delivery units can go a long way in increasing wheat production in the country.

REFERENCES

DWR (2002). *Annual Report 2001-02*. Directorate of Wheat Research, Karnal. p53.

(2003). *Annual Report 2002-03.* Directorate of Wheat Research, Karnal. p14.

(2004) *Annual Report 2003-04.* Directorate of Wheat Research, Karnal. p 63.

FAI (2004). *Fertilizer Statistics 2003-04*. The Fertilizer Association of India, New Delhi.

GoI (2005). *Seed Replacement Rates for Different Crops for the Year 2003-04*. Government of India, http://www.agricoop.nic.in

GoI (2006). *Economic Survey 2005-06*. Ministry of Finance, Government of India, New Delhi.

Jha, Dayanatha and Sant Kumar (2005). *Resource Allocation for Agricultural Research: The Case of Wheat.* A Research Report. National Centre for Agricultural Economics and Policy Research, New Delhi, (mimeo).

Joshi, P. K., Pratap S. Birthal and Vinay A. Bourai (2002). *Socioeconomic Constraints and Opportunities in Rainfed Rabi Cropping in Rice Fallow Areas in India*. Research Report submitted to International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh.

NSSO (2005). *Situation Assessment of Farmers: Some Aspects of Farming*. NSSO 59th Round (January–December). National Sample Survey Organization, Ministry of Statistics and Programme Implementation, Government of India, New Delhi. p 15.

Prabhakar, V. P. (2001). Sprinklers help change cropping pattern. *The Tribune*, Chandigarh. 19 July.

Reddy, A. R. and C. Sen (2004). Technical inefficiency in rice production and its relationship with farm-specific socioeconomic characteristics. *Indian Journal of Agricultural Economics,* 59 (2): 259-267.

Subbarao, G.V., J.V.D.K. Kumar Rao, J. Kumar, C. Johansen, U. K. Deb, I. Ahmed, M. V. Rao, L. Venkataratnam, K. R. Hebbar, M. V. S. R. Sai and D. Harris (2001). *Spatial Distribution and Quantification of Rice-fallows in South Asia —Potential for Legumes*. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, p316.

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