Can India produce enough wheat even by 2020?

S. Nagarajan

From a perpetual food-deficit situation, India became self-sufficient in cereal production due to adoption of modern science and technology that created the 'wheat revolution'. From a mere 12 million tons (MT) in 1965, India produced, 76.37 MT of wheat in the year 2000 and swelled the buffer stock, making feasible an export of about 17 MT in a span of three years. Since then, there is a continued fall in wheat production, thus questioning the soundness of the food security system. During the last five years the reduced fertilizer consumption in the Indo-Gangetic plain, changed fertilizer policy, fatigue in variety development, global economic compulsions and trade readjustment have raised serious concerns over India's ability to meet the projected 109 MT wheat demand by 2020.

Food is fundamental and essential to all living organisms, including man. Food production is governed by individualistic efforts of the farmer and by the policies of the state regulating the inputs and price of the commodity. Impact of globalization and farm subsidies-related issues flagged by the Uruguay and Doha Round of discussions influence the macro global agricultural policies that have their share of effect on micro farm-level decisions. It appears that the trade interests may affect national target setting in foodgrain production.

Wheat (*Triticum aestivum* and *T. durum*) is the most important winter cereal of India and is grown during November to mid-April. Wheat growing in India is divided into six zones, since they differ agro-ecologically and varieties have been developed taking into account the growth period of the crop, soil type and other general requirements. The Indo-Gangetic plain comprising the North Western Plains Zone (NWPZ) and the North Eastern Plains Zone (NEPZ), forms the major wheat tract followed by the Central Zone (CZ) and the Peninsular Zone (PZ). The Northern Hill Zone is still dominated by traditional cereal growing with varieties that mature in May/June, while the Southern Hill Zone has a miniscule area of few hundred hectares under the tropical cold humid environment. In any given time, at least sixty different varieties are grown over 25 mha and only a few varieties occupy substantial area[1].

India is now the second largest producer of wheat in the world and produced a record 76.3 million tons (MT) during crop year 1999–2000. Due to this, India did export some sizable amount to reduce the size of the bulging buffer[2]. But in the last few years in a row, there has been a wide gap between the target and actual wheat production. Following the peak production of 1999–2000 crop season, there was a growing confidence that India would soon produce 78 MT of wheat and will achieve the 109 MT target requirement by 2020. But the current stagnation in wheat production, changes in policy with regard to inputs and globalization pressures have all created a questionable situation on achieving the long-term goal. This has been the case even in Pakistan – the other beneficiary of the wheat revolution. According to Khan *et al.*[3], Pakistan has done too little and too late for its farm sector. They opine that wheat production is not the same peripheral issue and the target of increasing both wheat production and wheat grower's income must be central to the management policy in Pakistan. The perception in India is in no way different.

Production trend

During 1962 to 1968, gain in production was low as area expansion and coverage under irrigation did not happen. Thereafter, till 1998, there was a gradual but substantial increase in the area sown to wheat. Subsequently, area under wheat declined as a consequence of crop diversification efforts. Significant area diversification in different wheat-growing tracts occurred as the economic returns from wheat were no more attractive. Winter maize and Boro rice in the NEPZ, diversion to grain legumes in CZ and mustard in NWPZ occurred in pockets. Since there is a shortage in pulses production, area under chickpea increased and for the same reason area under mustard also increased[2].

The average per hectare wheat production being 2.7 tons, a reduction of 1 mha can result in a shortfall of 2.5 MT or more. Due to successive sub-normal monsoon precipitation, area under rainfed wheat in CZ and PZ reduced and consequently total wheat production also reduced. The last five years have been witnessing a downward production swing from 76.37 to 65.1 MT and such a large deviation had never happened before (Figure 1). This shows the vulnerability of our wheat production and the risk to food security. The Food Corporation of India is of the opinion that enough wheat stocks are available until March 2006, even though procurement during 2005 is much lower than last year[4].

Impact of reduced wheat production on procurement

The Indian Punjab enjoys cool weather, good water resources, consolidated landholdings, well-connected roads, greater input usage and even topography. Punjab is ideally suited for cereal farming and thus is the foodgrain bowl of India. Between Punjab and the adjoining states, there is a yield difference of about 1.2 tons/ha. And as one moves from Amritsar in Punjab to Jalpaiguri in West Bengal, productivity reduces by ~ 100 kg/ha for every 100 km. Empowering the farmers with knowledge, creating an enabling environment, implementing farmer-centric policies and understanding the market forces can all contribute towards reducing the yield gap and increasing the per hectare productivity.

The minimum support price (MSP) assured by the Government and well-organized infrastructure facilities as network of roads, mandi or grain markets promoted higher wheat procurement from Punjab and Haryana. Figure 2 shows that over the last decade there has been a substantial increase in the amount of wheat procured. In 1993–94, Punjab contributed about 6.5 MT to the central pool, Haryana, Uttar Pradesh (UP) and Rajasthan supplied 3.5, 2.1 and 0.3 MT, respectively. During the year 2002,

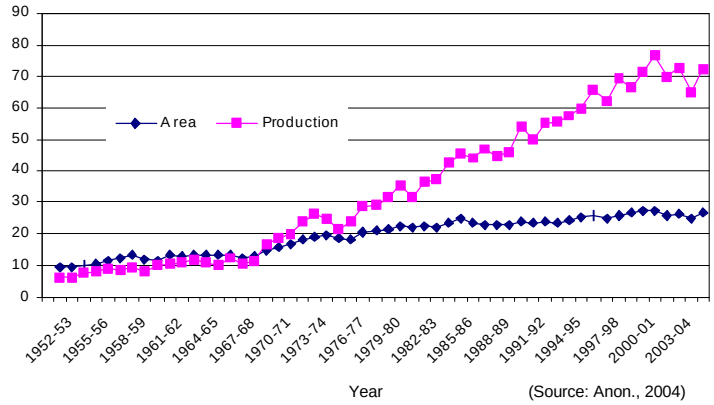


Figure 1. Area (mha) and production (MT) of wheat in India.

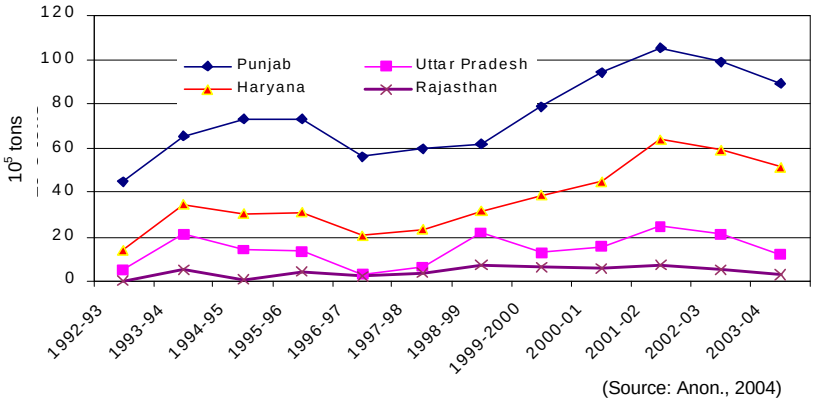


Figure 2. Procurement of wheat from different states.

when maximum procurement was achieved, 10.5, 6.4, 2.4 and 0.7 MT came from Punjab, Haryana, UP and Rajasthan respectively. The little that UP contributes comes from West UP of NWPZ. And the remaining large wheat-growing areas in East UP, Bihar, Madhya Pradesh (MP), Gujarat and Maharashtra contributed only 0.26 MT in 1993 and it remained static till 2004. In other words, the wheat buffer of India rests on Punjab and Haryana. It is disappointing that NEPZ and CZ hardly contribute to the wheat stock, as their production continues to languish at low levels and any amount of effort has not changed the situation. If wheat stocks are low during 2005, it is because these large wheat zones continue to remain at sub-optimal production levels. Lack of market, infrastructure and support to farm sector are the major impediments in NEPZ and CZ and the best production technology has been developed by wheat programme, has not been popularized. National-level wheat production will change if only the states in NEPZ and CZ take their assigned responsibility with seriousness.

Imbalanced input usage erodes productivity of the system

An examination of the annual fertilizer usage in Punjab, Haryana and Uttar Pradesh from 1990–91 to 2002–03, supplied by the Indian Agricultural Statistics Research Institute, New Delhi, showed that since 2000 there is stagnation in the application of nutrients as N, P and K. Therefore, information for five districts of Punjab covering the period 1990–91 to 2002–03 was analysed. Growth rate of N use showed gradual decline in usage of N in Punjab from 2000 onwards. In fact in Punjab compared to 1990–91 and 2002–03, N usage was slightly higher with minor year-to-year variation. As N application in a calendar year became static or even declined marginally, P consumption in these five districts also sharply declined and reached a bare minimum during crop year 2000–02 (Figure 3 *a*). Also, consumption of K reduced drastically. In the rice/wheat-growing states of NWPZ, there is widespread (50% of the sampled fields) deficiency of zinc. In this cropping system, response to N declined, showing the need for balanced application of P, K and other nutrients[5]. And this micro- and macro-nutrient imbalance in the soils of Punjab and probably the entire NWPZ is a serious issue and is a fallout of the fertilizer policy and availability. This is one of the major reasons for stagnant agricultural productivity in this zone.

Fertilizer consumption pattern for 13 widely separated districts of UP was examined in great detail for N, P and K. In UP, unlike Punjab, rice/wheat is not the dominant cropping system. The state is diverse and grows an array of crops and so recorded a marginal increase in N consumption during the last decade. But, like Punjab, in UP districts also, application of P and K declined over time. The escalation of nutrient cost due to pricing policy changes had created an imbalanced usage of fertilizer in the highly productive Indo-Gangetic plain, which is the main cereal-growing tract of the country. Of the various forms of fertilizer used, urea dominated as it is low-priced and the other form of N used in the NWPZ is DAP (diammonium phosphate). Over years, application of narrow band of fertilizers and almost total withdrawal of farmyard manure or green manuring practices have created widespread micronutrient deficiency in the intensively cultivated areas of NWPZ. It appears that in NWPZ soils, Liebig's law of minimum has become operational. This implies that reduced availability of one nutrient is interfering with the normal plant growth even if all other nutrients are adequately supplied. The deficiency of zinc, manganese and sulphur in our soils reduced the factor of productivity[5] and is causing yield depression and poor profit margin.

Population increase and grain surplus

Rural India accounts for nearly 70% of the population growth and as wheat production reduces, flow of farm surplus gets small due to domestic compulsions and household food needs. The population of the major wheat-producing states, i.e. Punjab, Haryana, Rajasthan, UP, MP and Bihar together was 398.91 million in 2000–01 and it increased[6] to 440.81 million in 2004–05. Population grew in these states at 2.5% per year, necessitating retention of additional grain by the farmer himself and is reflected by the reduced

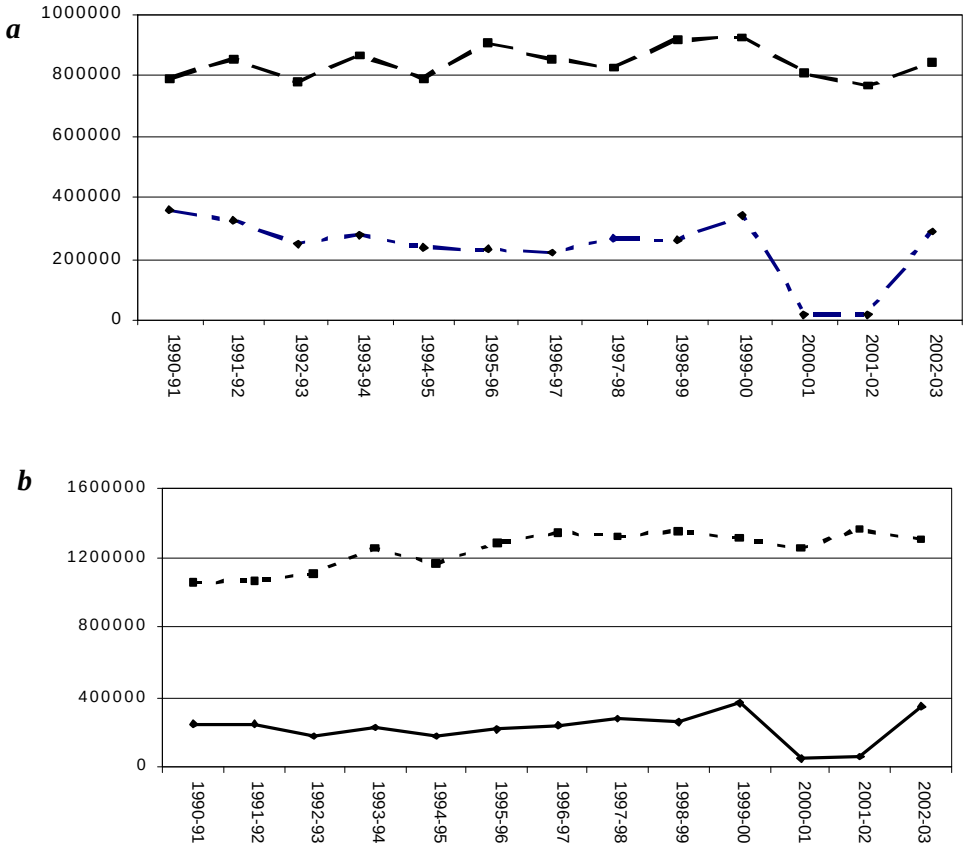


Figure 3. Consumption (in tons) of N (upper line) and P (lower line) in (***a***) selected five districts of Punjab and (***b***) selected 13 districts of UP.

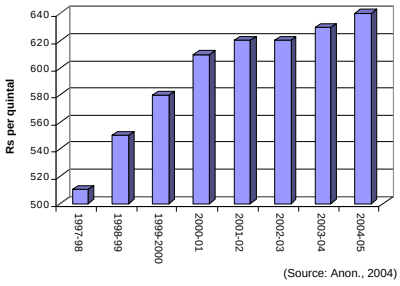


Figure 4. Minimum support price of wheat declared by the Central Government.

market arrival and procurement by the concerned agencies[4]. Wheat production during 1999–2000 was a record 76.37 MT and the mean of the five years from 2001 till 2005 stands at 70.55 MT/yr. In other words, production, rather than growing beyond 2000 level, has reduced by a mean value of 1.164 MT/year. Reduced farm yield and increased rural population make farmers retain more grain for home needs and thus lowered the level of procurement in 2005.

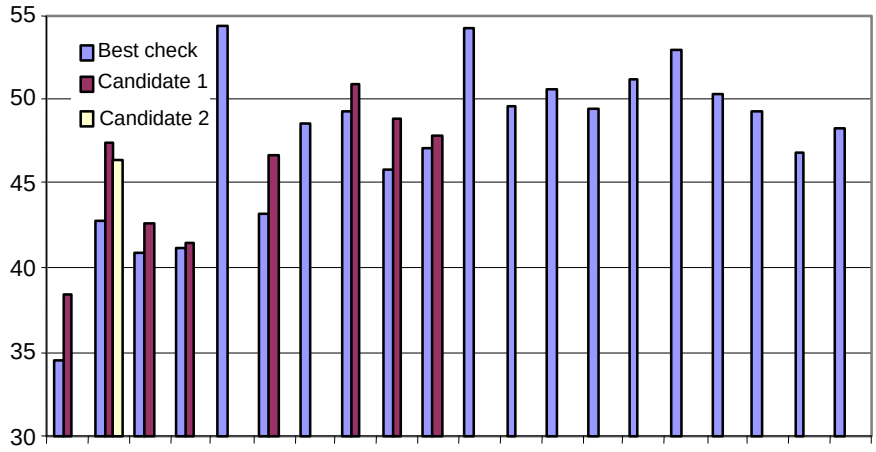
The wheat-growing Punjab, Haryana, UP and Bihar are agriculture-dependent provinces and 28 to 42% of their state domestic product comes out of agriculture. In contrast, Maharashtra, Gujarat and Tamil Nadu earn 12 to 18% of their state domestic product out of agriculture. This shows that any continued drop in production, productivity and procurement of wheat in the agriculture-dependent states will affect their economy. Therefore, the present stagnation in wheat production needs an in-depth examination from several points of view.

The Government of India introduced MSP to ensure that the increased arrival of wheat in the market does not lead to a price collapse. By this, the Government ensured that the surplus grain produced is procured and stored as buffer stock to be used during demanding times. The MSP has remained static for quite sometime compared to the earlier increases (Figure 4). Since the input cost of diesel, fertilizer, pesticide, etc. has moved up, the margin of profit has reduced[7]. Less profit from wheat consistently for the last few years has made farmers withdraw from cost-intensive balanced use of fertilizers and thus set in motion the reduced factor of productivity.

The population of India will be 1.4 billion by 2020 and will need ~ 109 MT of wheat to meet the changing kitchen and other needs. Any unforeseen food shortages will push the price of essential food items such as wheat beyond the purchasing power of the 230 million people below the poverty line. The record 76.37 MT of wheat production achieved during 2000 has remained a feat. In the next fifteen years, the total wheat production should reach 109 MT. In other words, wheat production must increase at least by two and a half million tons per year from the base level of 2005. But then if the current negative production trend continues unabated, then achieving this wheat target by 2020 will remain a difficult task.

Fatigue in plant breeding and varietal development

The temperature during grain-filling period in the NWPZ has been higher for the last



(Source: AICWIP)

Figure 5. Performance of candidate entries and best check in the AVT II of the NWPZ irrigated timely sown trials (in quintals) (AICWIP data).

five crop seasons in comparison to the harvest year 2000, when a record wheat production was achieved. The high maximum and minimum temperatures interfere with the process of grain-filling and thereby cause yield depression. The NWPZ is sandwiched between the cold Himalaya on one side and the arid, warm Rajasthan desert on the other. The temperature trajectory of the season influences crop duration. And it is widely recognized that one day growth reduction affects about 35 kg/ha of grain production. And if the crop matures a week earlier due to continued warm weather conditions towards harvest, the yield of wheat comes down substantially. The reduced wheat production that occurred during 2003–04 is attributed to the terminal heat stress and the late heat in general is a major production limitation in the NWPZ.

Availability of good quality seed of recent varieties is a requirement for any production increase. At national level, each year breeder seeds of more than 60 wheat varieties are produced, even though the top ten varieties account for 60% of the demand. There was a steep increase in the production and distribution of certified or authenticated seed during 1995–2000, and it has then tapered off. This increase in breeder seed production was because the seed of variety PBW343, released in 1995 for the irrigated timely sown conditions of NWPZ, was in great demand till 2000–01. Following the saturation in the area under this variety, which now covers 6 mha, there has been no growth in the amount of certified seed produced.

An examination of the yield performance of the advanced material in the All India Coordinated Wheat Improvement Project (AICWIP) multi-location yield trials of the timely sown conditions of NWPZ, shows that during the last decade there was no entry that yielded statistically higher than PBW343. In other words, the 1% annual genetic gain in yield achieved by wheat varietal breeding[8] has become an event of the past. This fatigue in varietal improvement is also due to reduced exchange of advanced germplasm between wheat-growing nations and from the Centrao Internacional de Mejoramiento de Maiz Y Trigo (CIMMYT) in Mexico. The changed research priorities of CIMMYT[9] and IPR-related issues have resulted in denial of elite germplasm to the national programme at a time when we need them the most. The AICWIP second-year irrigated, timely-sown Advanced Varietal Trial (AVT) data, which are the pre-final evaluation before a variety is identified, show that during 1984–85 crop season bread wheat Raj 2535 was the best check and WH416 candidate variety yielded statistically higher value. In the 1985–86 testing, there were two entries that outyielded the check. Thereafter, up to crop year 1993–94, HD 2329, a variety that occupied 4 mha or WH 542, a CIMMYT selection from Kauz, were the best check and often each year at least one test entry performed better than the best check (Figure 5). From 1995 onwards, when PBW343 (a selection from Attila of CIMMYT) was identified and became the check in the yield trial, no test entry in the last ten years has been able to yield statistically higher than PBW343. These CIMMYT-developed India-adopted wheat varieties and several parental lines supplied by them are said to have accounted for 90% of the spring bread wheat released in the developing world[10]. This over dependence on exotic, elite germplasm by the wheat-breeding centres of the AICWIP, is a point of great concern. And as the material flow now is not what it was during the wheat revolution days, it has affected the process of varietal breeding in India. In other words, there has been no yield gain for the last 10 years and there is a plant-breeding fatigue. This is a serious issue and needs to be redressed without delay.

Breaking the wheat-production fatigue

From the above discussion the following points emerge as limitations in increasing wheat production to the level of 109 MT by 2020. Possibly by addressing them, there can be a sustained increase in wheat production.

1. Fall in the level of consumption of N, P and K in Punjab and in general in the Indo-Gangetic plain (NWPZ + NEPZ) has come under concern and is affecting wheat production. Enabling policy environment would promote balanced use of nutrients and will result in increased and sustainable farm yields.
2. It is inferred that reduction in the factor of productivity is due to 'law of minimum' operating as micronutrient imbalance in the soil of this tract. Designing the fertilizer policy to promote addition of micronutrients in the normal fertilizer has to be considered.
3. The level of profit for wheat growers of NWPZ and to some extent to NEPZ farmers has shrunk. This has led to sub-optimal fertilizer application and managerial practices culminating in gradual yield-fatigue syndrome. Therefore, the pricing of wheat has to be examined and it should be used as an instrument to increase production as well as grain quality.
4. Lack of any genetic gain in NWPZ through varietial improvement, poor seed replacement and loss due to heat stress has emerged as serious research and development issues. There should be a goal-driven effort in applying modern science to solve this production limitation.
5. Restricted flow of genetic stocks and elite germplasm from international crop research system has delayed the process of technology upgradation. As a consequence, grip of the national effort in varietial development is getting weakened. Hence to break the yield barrier, urgent steps are needed to consolidate the gains made from earlier initiated programmes such as genetic stock improvement, designer wheat of high yield potential, harnessing the benefit of heterosis (hybrid vigour) and maintenance breeding for an efficient seed production chain.
6. Population growth and stagnant wheat production of NEPZ and CZ for more than a decade, is now causing concern over whether the 109 MT wheat requirement of India is achievable. Since this zone has enormous unharvested yield, a massive production drive and infrastructure development activities are to be taken. Private promoted systems on the pattern of e-choupal can be used as a vehicle of change.
7. A critical assessment of the reasons for wheat yield stagnation backed by a zonal and micro-level action plan focusing on NEPZ and CZ is required for increasing the nation's wheat production.

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S. Nagarajan is with the Protection of Plant Variety and Farmers Rights Authority, Government of India, NASC Complex, Todapur, IARI Campus, New Delhi 110 012, India. e-mail: snagarajan@iari.res.in