

Global Wheat Production and Fertilizer Use

By Steve Phillips and Rob Norton

Global wheat production has risen over two and a half times since 1960 as the result of better farming practices, improved cultivars, and balanced nutrition. At the same time, fertilizer use in all agriculture has risen 4.3 times to keep up with growing food demand. It is estimated that growers use around 15% of the fertilizer consumed to produce the current 647 M t of wheat grain.

Global Wheat Production

Global production of the major cereal crops of wheat, corn, and rice is 647 M t, 814 M t, and 441M t, respectively (FAOstat, 2012). However, a large proportion of the corn crop is used for feed and fuel, while 93% of rice is consumed in the country where it is produced. Wheat is one of the most important food crops in the world, providing 20% of humanity's dietary energy supply and serving as the main source of protein in developing nations (Braun et al., 2010). There was around 135 M t traded annually from 2006 to 2010 (Table 1), 71% of which was sourced from the USA, France, Canada, Australia, Russia, and Argentina.

The demand for wheat follows rapidly growing populations and is expected to increase by 60% in the third world by 2050 (Rosegrant and Agcaoili, 2010). Over the past 20 years, the average growth in wheat production has been around 1.0%

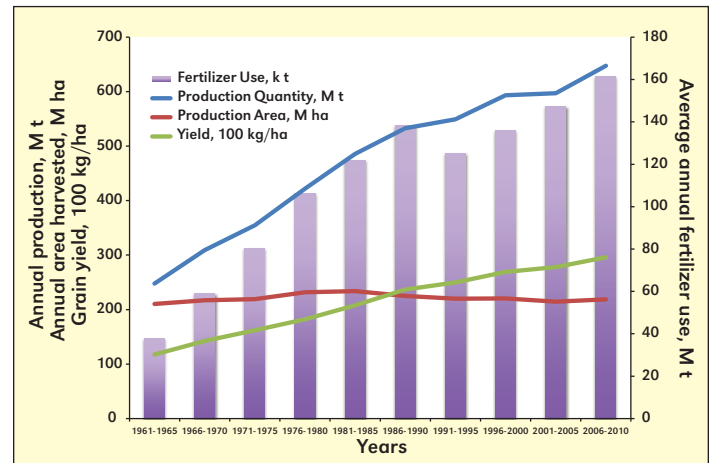


Figure 1. Global wheat production, area, yield, and total fertilizer use (1961 to 2010). (FAOstat, 2012; IFADATA 2012).

per year (Figure 1), but that is considerably less than the 3.3% annual increase between 1960 and 1990, the time of the

Common Abbreviations and Notes: M = million; N = nitrogen; P = phosphate; K = potassium.

Table 1. Production, area, export, yield, and fertilizer use for the top 20 wheat-producing countries in the world (FAOstat, 2012; Heffer 2009, IFADATA 2012).

	Production, M t	Area, M ha	Exports, M t	Yield, t/ha	Fertilizer used in wheat (2006-2007)			Total fertilizer used, k t nutrient
					k t N	k t P ₂ O ₅	k t K ₂ O	
China	112.10	23.90	0.77	4.69	4,258	1,194	255	49,513
India	77.02	27.76	0.16	2.77	2,892	1,109	187	23,906
United States	58.70	20.32	27.11	2.89	1,604	568	224	18,795
Russian Federation	52.26	24.18	12.60	2.15	402	169	70	2,055
France*	36.73	5.31	16.03	6.92	619	240	206	3,249
Canada	24.79	9.25	17.01	2.67	591	173	36	2,770
Germany*	23.71	3.17	6.42	7.47	458	117	129	2,253
Pakistan	22.57	8.75	0.13	2.58	1,004	345	15	3,829
Turkey	19.06	8.15	0.27	2.34	584	252	15	1,925
Ukraine	18.30	6.31	6.43	2.86	**	**	**	955
Australia	17.92	13.04	13.88	1.36	263	284	28	1,908
United Kingdom*	14.83	1.93	2.36	7.66	549	89	87	1,462
Kazakhstan	13.83	12.98	4.09	1.07	**	**	**	55
Islamic Republic of Iran	13.40	6.47	0.06	2.05	414	179	48	1,614
Argentina	12.68	4.69	8.73	2.70	280	165	1	1,321
Poland*	8.79	2.26	0.76	3.87	591	176	140	1,968
Egypt	7.87	1.26	0.00	6.27	302	35	10	1,409
Italy*	7.29	2.00	0.21	3.65	190	141	81	1,128
Spain*	5.80	1.89	0.48	3.06	515	199	114	1,558
Romania*	5.35	2.05	1.14	2.59	150	24	7	397
World	647.30	218.60	134.78	2.96	16,614	6,261	1,617	161,313

*Fertilizer use in wheat for each EU27 country was estimated from mean fertilizer use by crop (Heffer, 2009) and the total fertilizer used in each country.

**No data available

Green Revolution. This production increase has come from a constant production area of around 215 M ha. So production increases have been largely due to higher grain yields (**Figure 1**). To satisfy the growing demand for wheat, annual production increases need to be closer to the rates observed following the Green Revolution (**Figure 1**). While some of this increase in production will be achieved using improved genetics; the rest will need to come from better agronomic practices, so that the gap between potential and actual yields becomes smaller.

Historical Production (1961 to 2010)

Since the period 1961-65, annual global wheat production increased 2.6 fold until 2010. From 1961 to 1980, the Soviet Union produced around 24% of the global wheat supply averaging just over 80 M t/yr (**Figure 2**). The United States was the second largest wheat producer during that period, averaging 13% world production share (44 M t/yr). In the 1980s, China gained, and has continued to hold, the greatest share of world wheat production, averaging 112 M t from 2006 to 2010 (**Figure 2**). Other significant increases in production share over

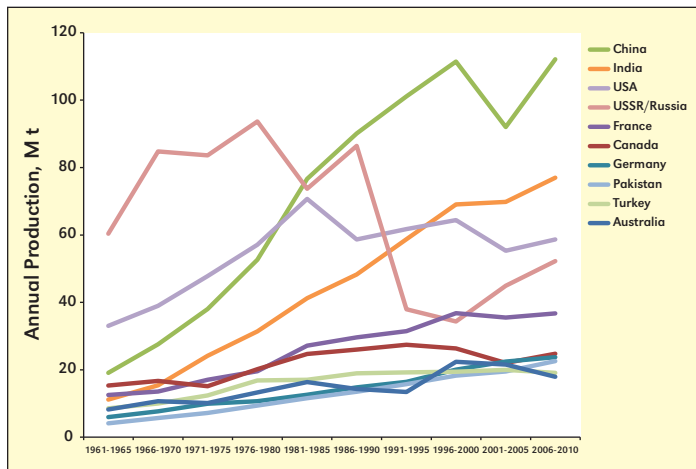


Figure 2. Wheat production trends (1961 to 2010) for the top 10 producing countries. (FAOStat, 2012). Values graphed are the means for each 5-year period.

the last half century occurred in India and Pakistan, while the dissolution of the Soviet Union still left Russia as the largest wheat producer among the former Soviet Union countries. The greatest single-country decreases occurred in North America with the United States and Canada shares dropping 32% and 38%, respectively (**Figure 2**). Out of 123 wheat-producing countries, approximately 70% of world wheat production is currently located in the top 10 countries represented in **Figure 2** and 85% is in the top 20 countries (**Table 1**).

Production Area

The top ten wheat-producing countries also contain nearly 70% of the wheat area (144 M ha) in the world (**Table 1**). This percentage has been consistent since the end of the USSR in the early 1990s. Since 1995, wheat area has increased most in Russia (2.7 M ha), Australia (1.6 M ha), and India (1.2 M ha) although there can be quite large changes in area planted between years due to seasonal and financial conditions. The increase in total wheat area in Russia since 1996 corresponds to an increase in the percentage of total crop area planted to wheat over the same time period, suggesting that this increase is likely a result of wheat substituting for other crops. Australia

also shows a slight increase in the percentage of crop area in wheat. Total crop area there increased by 2.2 M ha between 1996 and 2010, mainly as land that was previously either in permanent pasture or in rotation with crops was brought into wheat production, with a consequent significant decline in sheep numbers. The additional 1.2 M ha of wheat in India is also likely a result of new land being cropped, as the percentage of total crop area allocated to wheat has not changed in the past 15 years. Germany added 400,000 ha of wheat over the past 15 years, which is small relative to total wheat area, but represents a 15% increase in wheat area in the country.

The largest decreases in wheat area during the same time period occurred in China (-5.1 M ha), United States (-3.3 M ha), Canada (-1.9 M ha), and Turkey (-1.2 M ha) (**Figure 3**). China, United States, and Canada all had corresponding

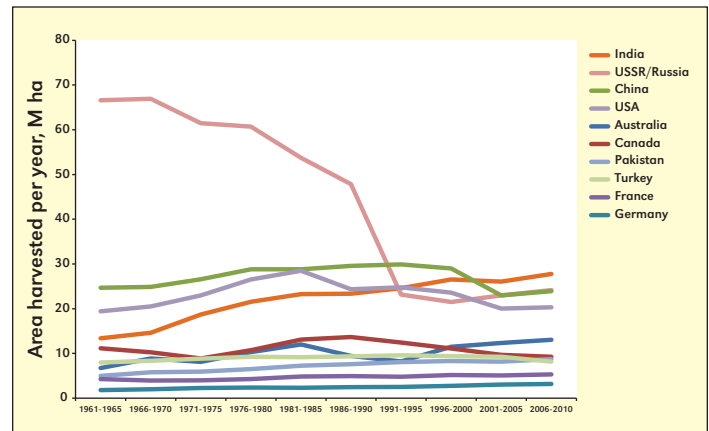


Figure 3. Trends in harvested wheat area (1961 to 2010) for the top 10 producing countries. (FAOStat, 2012). Values graphed are the means for each 5-year period.

drops in wheat area percentages indicating crop shifts, while in Turkey the percentage of total crop area growing wheat did not change, reflecting a reduction in total crop area.

These changes in wheat area can explain, at least in part, the increases observed in overall production in India, Russia, and Germany and the decreases seen in the United States and Canada.

Grain Yield

Changes in total wheat production over time, not related to changes in area, are likely a result of changes in grain yield. Global wheat yield doubled from 1.2 t/ha in 1961 to 2.4 t/ha in 1990 (**Figure 1**). Yield has continued to increase but at a slower rate, moving from 2.4 t/ha in 1990 to 3.0 t/ha in 2010 (**Figure 1**). The progress in wheat yields for the 10 top-producing countries is shown in **Figure 4**. The countries with the highest wheat yields among the top 10 producers have always been Germany and France. However in the last decade, yield gains in Germany have slowed considerably and yield has declined slightly in France. Yields in China have increased at approximately the same rate as those in Europe over the past several decades and have continued to increase over the last 10 years. These large and consistent yield gains explain how Chinese production has continued to increase despite a significant reduction in wheat-producing area over the past 15 years.

The average grain yield in Canada has also increased

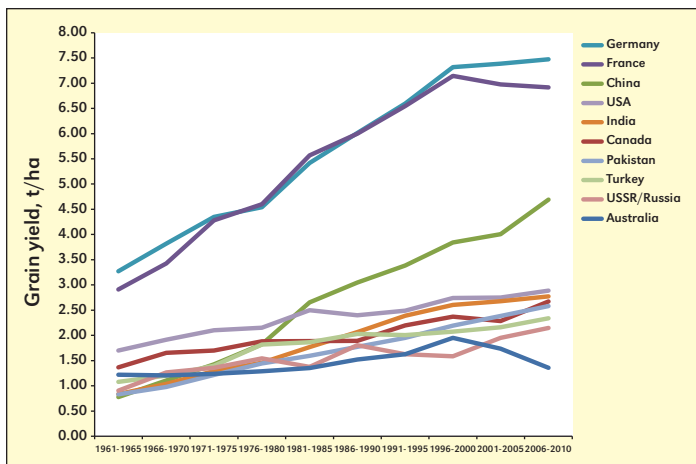


Figure 4. Wheat grain yield trends (1961 to 2010) for the top 10 producing countries. (FAOSTAT, 2012). Values graphed are the means for each 5-year period.

rapidly in the last decade; but of the top 10 wheat producers, only Germany, France, and China have grain yields above the global average (Table 1). Grain yields in Pakistan, Russia, and Turkey are rising at or near the global average of 1% annually, but are still at least 0.5 t/ha below the global average. Nonetheless, these yield gains have been enough to contribute to overall production increases in Pakistan and Russia and kept production stable in Turkey despite reductions in the wheat growing area. Yields in India and the United States are near the global average of 3.0 t/ha, but growth rates are well below 1%/yr. Due to a 10-year drought in Australia, yields have fallen at around 2.2%/yr since 1996 to 2000. This fall helps to explain the drop in overall production in Australia despite recent increases in wheat area.

Fertilizer Use in Wheat

The quantity of fertilizer (total N, P₂O₅, K₂O) used in wheat by the top 10 producing countries is approximately 18 M t (Table 1). Total annual fertilizer use for all crops has risen from 37 M t of N+P₂O₅+K₂O in 1961-65 to 161 M t in 2005-09 (Figure 1). Since 1990 the consumption of fertilizer has risen for all crops and this is also likely to be the case for wheat, although the only data on fertilizer use by crop were released in 2009 (Heffer, 2009). Wheat-growing consumes around 15% of the total nutrients used, and 83% of the fertilizer used on wheat is applied in the top 10 wheat-producing countries.

In the period between 1991 and 1995, France and Germany began reducing fertilizer use and currently apply 34% and 23% less, respectively, than amounts used in the early 1990s (Figure 5). Australia has also reduced fertilizer use in wheat by 18% since 2000. The greatest increases in fertilizer use have occurred in India, Pakistan, Russia, and China—all of which have increased use between 40 and 46% in the past 15 years (Figure 5). Fertilizer use in Canada and Turkey has been fairly stable for the past several years, and use in the USA has declined by 6% since the period 1996 to 2000. Without

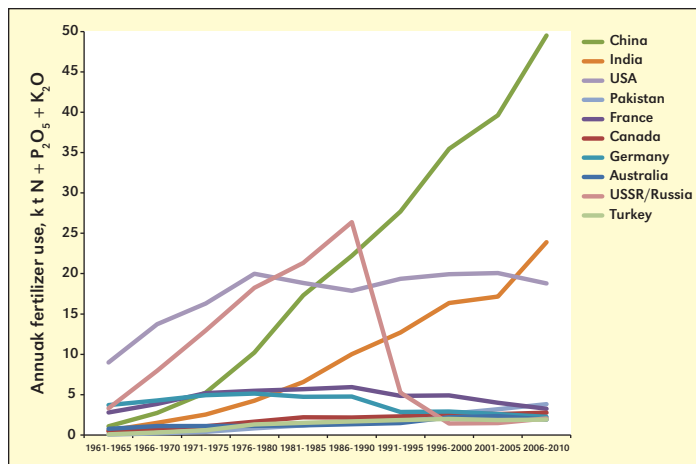


Figure 5. Annual total fertilizer use trends (1961 to 2010) for the top 10 wheat producing countries. (IFADATA, 2012). Values graphed are the means for each 5-year period.

knowing use patterns in each crop it is not possible to define which crops have had use rates lowered.

In the cases of China, Pakistan, and Russia, the timing of the yield increases compared with the timing of increases in total fertilizer use coincide, indicating the significant role good nutrition plays in sustaining wheat yields. However, a relationship between increasing fertilizer use and subsequent increases in wheat grain yield is no indication that the current fertilizer management in these countries is at an optimum. Fertilizer rate is only one component of 4R Nutrient Stewardship, which is applying the right nutrient source, at the right rate, at the right time, and in the right place. The 4R's are interdependent and if one is wrong, none of the others can be right.

Conclusion

Increased yields rather than increased area sown has been the main factor behind the increase in wheat production. A range of interventions including the increased use of fertilizers has supported this trend. Increase in fertilizer use mirrors the gains in productivity, although to maintain production it will require continual review of nutrient inputs. The challenge will be to ensure that future growth in food production is met by careful and targeted use of fertilizers. **DB**

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References

- Braun, H.J., G. Atlin, and T. Payne. 2010. *In: Reynolds, CRP. (ed.). Climate change and crop production*, CABI, London, UK.
- FAOSTAT. 2012. [online] available at <http://faostat.fao.org>.
- Heffer, P. 2009. International Fertilizer Industry Association. Paris, France
- IFADATA, 2012. [online] available at <http://www.fertilizer/Homepage/STATISTICS>.
- Rosegrant, M.W., and M. Agcaoili. 2010. International Food Policy Research Institute, Washington, D.C., USA.