Why are yields increasing more slowly?

For several years now, wheat yields have been increasing less rapidly. Is this a serious and inevitable trend? What sort of leverage could boost productivity again? ARVALIS – Institut du végétal answers all those questions.

Every year, the potential yield of new registered varieties is increasing

Since 1951, national and regional wheat yields have never improved as little as they have done in the last few years. Since the 50s, yields had followed a + 1.2 q/ha/year trend. But since the mid 1990s, this increase has dropped down to 0.3 q/ha/year *(figure 1)*. Wheat yields continue to grow, but at a much slower pace than in previous decades.

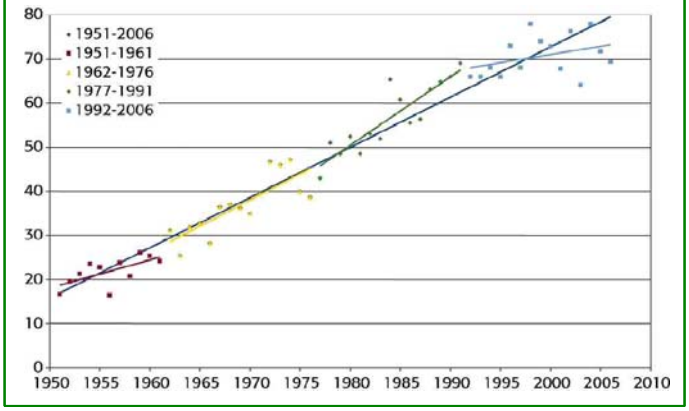
A few hypotheses could explain this slowdown; which ones are most likely? Is it climate change, or has genetic potential reached a plateau? Are diseases and pests increasingly difficult to control? Has fertilisation become a limiting factor? In view of the data gathered by ARVALIS – Institut du végétal, none of those hypotheses can solely explain this new trend. How valid is each of them?

Sustained genetic progress

The hypothesis of slower genetic progress has not been verified. Registration regulations are such that a new variety can only be registered if it brings a 2% to 7% yield improvement compared with reference varieties in its category (BPS, BB, BAU, etc.), after being weighted positively or negatively for specific weight, protein content and resistance to diseases. The analysis of the impact of genetic progress on yields, which was completed by GEVES (seed varietal monitoring group) as part of the CTPS (Technical Selection Committee) trials carried out between 1990 and 2000, indicates gradients between 0.9 q/ha/year (in trials fungicide treated against diseases) and 1.4 q/ha/year (in untreated trials, with, obviously, a lower absolute yield). The post-registration varietal trial summary compiled by ARVALIS – Institut du végétal in 2007, also confirmed a steady and strong increase in potential yields between 1964 and 2006, with estimated gradients ranging from 0.6 to 1 q/ha/year depending on the region. The flow of registrations of new wheat varieties remains very strong, a sign of a dynamic sector. The new varieties coming onto the market do not seem to be a factor limiting yield increase.

For wheat, genetic improvements remain steady.

Changes in winter wheat yields in France, between 1951 and 2007 *(fig. 1)*



Since 1990, yields have been increasing at a significantly lower rate than over previous decades

Since 2000, plant protection products sales have been showing a 42% fall.

However, the following facts must be pointed out:

- progress has been more significant in situations where there was no protection against diseases, reflecting the fact that integration of resistance to leaf diseases is increasing.
- the areas planted with bread-making varieties (recommended for the flour industry and exported at a premium) have increased from 50 to 80% in the last ten years.
- the choice of variety is not only based on yield performance, but also on all other characteristics and gross margin differences. The latter take account of value-adding differences between markets (flour-making quality premium, tolerance to fusariotoxins).
- genetic progress gradients estimated from the results of studies on the age of cropped varieties in several parts of France, are lower than the potential gradients of newly registered varieties or of varieties being tested in experimental trials. The pace at which farmers are integrating new varieties into their cropping programmes seems to have slowed down in several regions, with them taking longer to change to newer varieties.

Re-adjusting protection

As regards disease control, some fungicide molecules, strobilurins and triazoles, appear to be losing efficacy. Innovation in the field of fungicides has been steady though since the 1970s; it has never been interrupted, although it may have suffered from a build-up of approval delays.

But fungicide resistance has undoubtedly contributed to "eroding" the progress that had been made. The national average yield may have been affected when septoria, the main wheat disease, developed some resistance. In addition, wheat prices decreased steadily throughout the 1990s. This cereal price variation also coincided with re-adjustment in fungicidal protection levels, partly through a reduction in application rates. The combination of both trends contributed to yields increasing more slowly, but it is difficult to quantify in what proportions.

Changes in weed control practices could also have played a part. The more widespread use of a single herbicide application at the end of winter, although it offers organisational benefits (time-saving, fewer applications, etc.), results in a definite yield drop compared with precision weed control based on the level of pressure from weeds.

This kind of single application leads to a competition between weeds and the cultivated crop at early stage, unlike herbicide programmes (early autumn application + end of winter application) which permit to reduce consequences of weeds on final yield.

In our trials, late applications at the end of winter resulted in a 7q/ha yield loss on average, compared with an autumn application, or a weed control programme.

Differences in the availability of soil minerals (NPK) do not seem to be the reason for the way yields have evolved. This subject is currently being discussed by the scientific community.

The climate can explain a part of wheat yield variation, since 1990.

Excessively high temperatures and water deficit

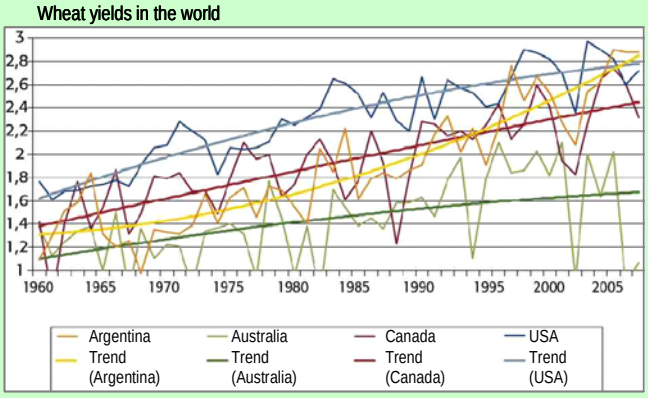
The 2003 to 2006 years all saw a rise in temperatures at the end of the cycle.

This leaves weather conditions as a possible cause. The vagaries of weather that we have just experienced, unfortunately five years in a row, have played a part in yield stagnation. The 2003 to 2006 years all saw a rise in temperatures at the end of the cycle. Even though 2007 will be remembered for its horrendously wet summer, lack of water in the spring and serious brown rust attacks had a negative impact on crops. Both factors affected wheat yields as well as quality. In 2007, rain mainly benefited diseases, by limiting photosynthetic activity in plants and by reducing average grain weight in under-protected crops.

Yield and financial stability

Wheat yields in the main producing countries of the world have increased significantly since the 1960s. The last 15 years show differences, even though the validity of an analysis based on 10 to 15 years is limited.
Some countries have experienced a slow down: Australia, for example, is seeing a strong impact from climate change through drought. Some countries are stagnating, like France, and others are progressing, like Argentina and the USA.
Argentina is benefiting from a positive economic situation and significant changes in the varieties being sown. Yield increases are considerable.
In the USA, wheat areas have been decreasing since 1998, and have been refocused on the most favourable regions. Note that some wheat crops, such as winter wheat, are irrigated.

Wheat yields throughout the world *(fig. 2)*



The wheat yield trends range from being almost linear, to slowing down, to increasing sharply, the latter reflecting Argentinean yields which are now greater than American yields.

According to meteorologists, climate change started being noticeable around 1985-1990. Those changes, especially in temperatures, are said to be due to the level of greenhouse gas emissions. Analysing the way in which weather conditions have evolved since then, does highlight significant changes: rise in temperature starting from the stem elongation stage and especially strong when the grain is being filled, as well as more severe droughts. Those trends did not materialise at the same speed in all regions: those changes and their impact have been felt most keenly in southern regions, whereas coastal northern regions have not yet been affected. The part played by the weather in yield variations since 1990 is therefore becoming a factor that cannot be ignored. Solutions are being offered to adapt certain cropping practices. Research work is also being carried out to try and get back to greater yield increases.

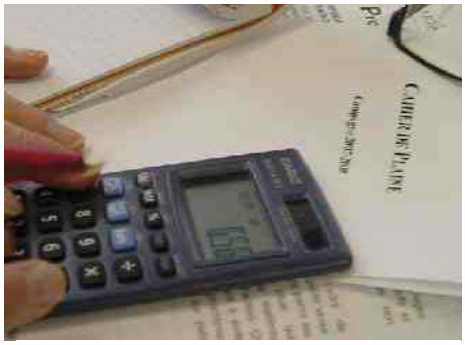
Reducing costs?

What if, at the end of the day, this slower increase in productivity was also due to the fact that producers have adapted their practices to the economic climate?

An analysis based on data from CNCER (national rural economy centre) and ONIGC (national cereal sector agency) studies, shows that between 1992 and 2006, in France, direct variable costs dropped as a result of the CAP reform (1992 to 1994), before rising again and then stagnating (1994 to 2000). They fluctuated between 2000 and 2006, but rose overall.

The situation varies drastically from one region to the next, making any link between cost control and yield unreliable. Especially when between 2000 and 2006, fertiliser price increases largely accounted for the increase in direct variable costs, while practices changed very little.

This being the case, 2007, 2008 and 2009 will bring partial answers to the way producers are adapting their practices to the new production situation. The new economic order – high wheat and nitrogen prices – restores the role of agronomy as major leverage for achieving better results.



Direct variable costs reduction have maintained farm rentability, but maybe with other consequences.

Genetics is a positive component of yield, but fertilisation can slow down its upward trend. Diseases, weeds and pests, as well as climate, are dominant negative factors.

High potential land

French farmers, whose land has one of the highest potentials in the world, using high-performance equipment in a climate perfectly suited to growing wheat, and benefiting from very well organised sectors, still regard productivity of their farm as a main objective: it is the only way of ensuring they position themselves in a growing world market.

To help them, ARVALIS – Institut du végétal continues to develop decision-making tools, in order to optimise protection against diseases as well as fertilisation and to control quality.

This topic is the subject of a complete dossier in the April 2009 issue of *Perspectives Agricoles*, based on specific work carried out by ARVALIS – Institut du végétal and INRA.

Jacques MATHIEU
j.mathieu@arvalisinstitutduvegetal.fr
Ludovic BONIN
l.bonin@arvalisinstitutduvegetal.fr
Philippe GATE
p.gate@arvalisinstitutduvegetal.fr
Valérie LEVEAU
v.leveau@arvalisinstitutduvegetal.fr
Josiane LORGEOU
j.lorgeou@arvalisinstitutduvegetal.fr
Claude MAUMENÉ
c.maumene@arvalisinstitutduvegetal.fr

From Perspectives Agricoles n° 348 Sept. 2008