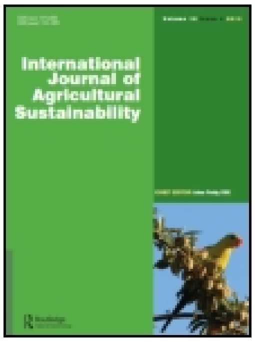

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COMMENT

Comment on sustainability and innovation in staple crop production in the US Midwest

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This comment highlight issues when comparing genetically modified (GM) crops to non-GM ones across countries. Ignoring structural differences between agricultural sectors and assuming common yield trajectories before the time of introduction of GM crops results on misestimating the effect of GM varieties. Further data collection and analyses should guide policy-makers to encourage diverse approaches to agriculture, rather than excluding specific technologies (like GM crops) from the onset.

Keywords: genetic modification; biotechnology; productivity; economics

In a recent paper, Heinemann *et al.* (2013) focused 'on the US staple crop agrobiodiversity, particularly maize' using the contrast between the yield of Western Europe and the USA as a proxy for the comparison between genetically modified (GM) maize versus non-GM maize. They found no yield benefit from using GM maize when comparing the USA to Western Europe.

In addition, Heinemann *et al.* contrasted wheat yields across the USA and Western Europe to highlight the superiority of the European biotechnological package from a sustainability viewpoint.

I am compelled to comment on two aspects that led the authors to draw incorrect conclusions on these issues. My statistical code and data are available as supplementary material.

1. Misestimating the effect of GM maize varieties

Heinemann *et al.* used Food and Agriculture Organization of the United Nations data, from 1961 to 2010 inclusive, to fit linear models with yield as the response variable, country and year as predictors. Based on this analysis, they concluded, 'W. Europe has benefitted from the same, or marginally greater, yield increases without GM'. However, this assumes a common yield trajectory for the USA and Western Europe before significant commercial use of GM maize, conflating GM and non-GM yields. GM maize adoption in the USA has continually increased from 25% of area of maize planted in 2000 to the current 90% (Figure 1, United States Department of Agriculture 2013).

If we fit a linear model from 1961 to 1999 (last year with less than 25% area of GM maize), we obtain the following regression equations $y = 1094.8x + 39,895.6$ (USA, $R^2 = 0.80$) and $y = 1454.5x + 29,802.2$ (W. Europe, $R^2 = 0.90$). This means that Western Europe started with a considerably lower yield than the USA (29,802.2 vs. 39,895.6 hg/ha) in 1961 but increased

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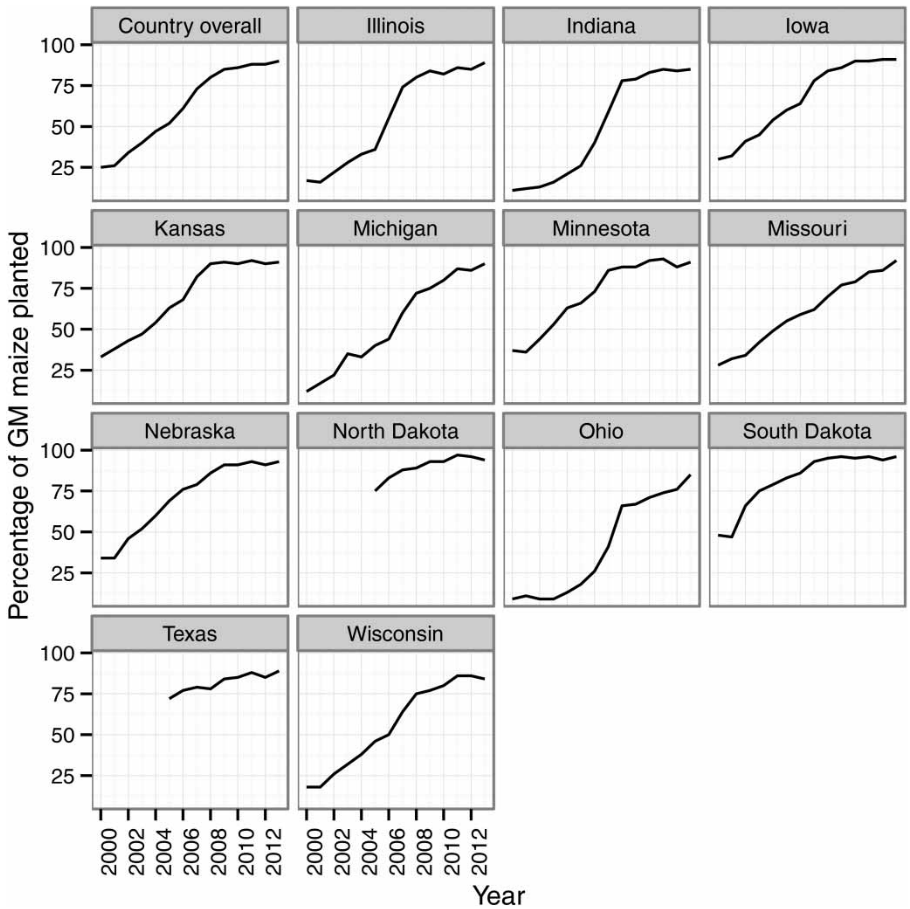

Figure 1. Adoption of GM maize in the USA, expressed as percentage of total maize planted area.

yields faster than the USA (1454.5 vs. 1094.8 hg/ha per year) *before* substantial use of GM maize. By 1999, yield in Western Europe was superior to that in the USA.

This is even more evident in Figure 2, which shows average yield per decade, removing year-to-year extraneous variation (e.g. due to weather). Western European yields surpassed USA's during the 1990s (Figure 2). This trend *reverses* in the 2000s, while the USA simultaneously increased the percentage of planted area with GM maize, directly contradicting Heinemann *et al*.'s claim.

2. Ignoring structural differences between agricultural sectors

When discussing non-GM crops using wheat the authors state, 'the combination of biotechnologies used by W. Europe is demonstrating greater productivity than the combination used by the United States'. This sentence summarizes one of the central problems of their paper: assuming that, if it were not for the choice of biotechnology bundle, the agricultural sectors would have the same intrinsic yield, making them comparable. However, many inputs beside biotechnology affect yield. For example, Neumann *et al*. (2010) studied the spatial distribution of yield and found that in the USA '*access* can explain most of the variability in wheat efficiency. In the

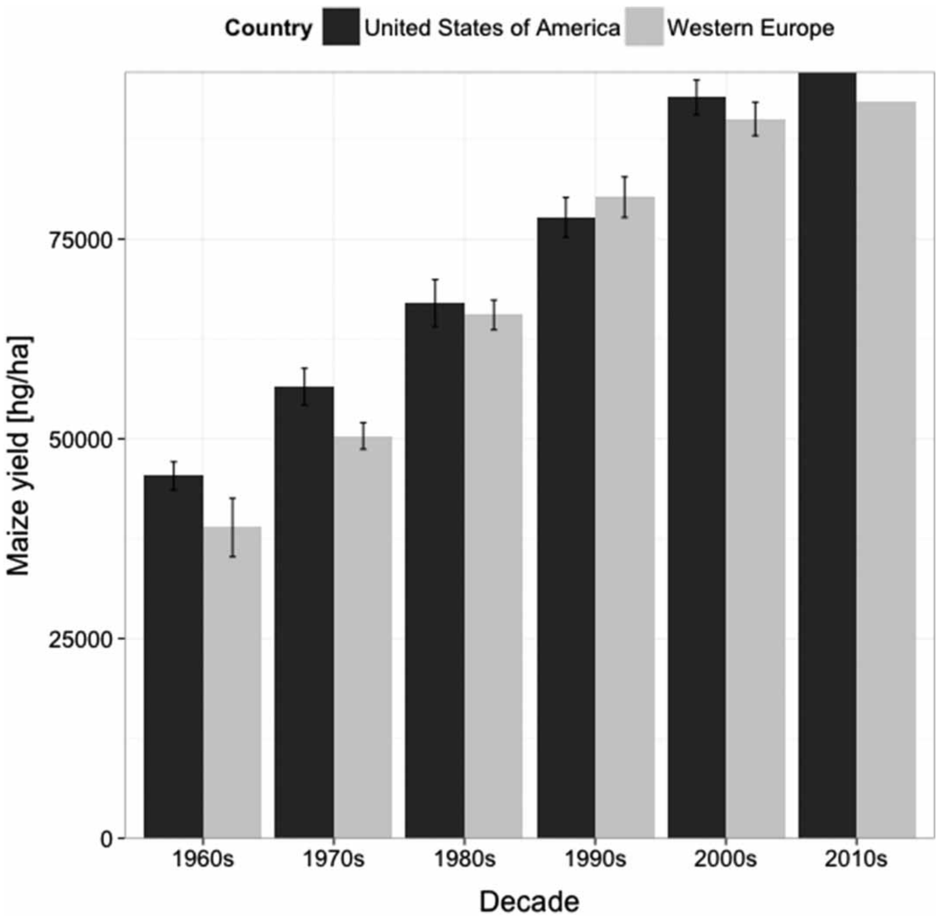

Figure 2. Average maize yield (and standard error) per decade for the USA and Western Europe. The 2010s include a single year to replicate the original data set.

more remote regions land prices are lower and inputs are therefore often substituted by land leading to lower efficiencies'. Lower yields in the USA make sense from an economic point of view, as land replaces more expensive inputs like agrochemicals.

Heinemann *et al.* support their case by comparing pesticide use between the USA and France across *all* crops. However, what is relevant to the discussion is pesticide use for the crops being compared. European cereals, and wheat in particular, are the most widely fungicide-treated group of crops worldwide (Kuck *et al.* 2012). For example, 27% of the wheat planted area in France was already treated with fungicides by 1979 (Jenkins and Lescar 1980). More than 30 years later in the USA, this figure has reached only 19% for winter wheat (which accounts for 70% of the planted area, NASS 2013). Fungicide applications result in higher yield responses (Oerke 2006).

Final remarks

Heinemann *et al.* ignored the available data on GM adoption when analysing maize yields. They also mistakenly treated biotechnological bundles as the only/main explanation for non-genetically modified organism yield differences between the USA and Western Europe. These issues mean that the thrust of their general conclusion is unsupported by the available evidence. Nevertheless, their paper also raised issues that deserve more consideration, for example, the roles of agricultural subsidies and market concentration on food security.

Agricultural sustainability requires carefully matching options in the biotechnology portfolio to site-specific economic, environmental and cultural constraints. Further data collection and analyses should lead policy-makers to encourage diverse approaches to agriculture, rather than excluding specific technologies (such as GMOs and pesticides) from the onset.

Supplementary data

Supplemental data for this article can be accessed in the online version http://dx.doi.org/10.1080/14735903.2014.939842.

References

Heinemann, J.A., *et al*., 2013. Sustainability and innovation in staple crop production in the US Midwest. *International journal of agricultural sustainability*. Available from: http://dx.doi.org/10.1080/14735903.2013.806408 [Accessed 2 July 2013].

Jenkins, J.E.E. and Lescar, L., 1980. Use of foliar fungicides on cereals in Western Europe. *Plant disease*, 64 (11), 987–994.

Kuck, K.H., Leadbeater, A., and Gisi, U., 2012. FRAC mode of action classification and resistance risk of fungicides. *In*: W. Krämer, U. Schirmer, P. Jeschke, and M. Witschel, eds. *Modern crop protection* compounds. Weinheim: Wiley, 539–567.

NASS, 2013. *Highlights: 2012 agricultural chemical use survey. Wheat*. [online] United States Department of Agriculture. Available from: http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/ChemUseHighlights-Wheat-2012.pdf [Accessed 7 July 2013].

Neumann, K., *et al*., 2010. The yield gap of global grain production: a spatial analysis. *Agricultural systems*, 103 (5), 316–326.

Oerke, E.-C., 2006. Crop losses to pests. *The Journal of agricultural science*, 144 (1), 31–43.

United States Department of Agriculture, 2013. *Adoption of genetically engineered crops in the U.S. USDA economic research service* [online]. Available from: http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx [Accessed 7 July 2013].