

HFFA Research GmbH

**The economic, social and
environmental value of plant
breeding in the European Union**

An ex post evaluation
and ex ante assessment

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List of abbreviations

AWU	– Annual Working Unit(s)
BCFN	– Barilla Center for Food and Nutrition
BDP	– Bund Deutscher Pflanzenzüchter
BLE	– Bundesanstalt für Landwirtschaft und Ernährung
BSPB	– British Society of Plant Breeders
CBD	– Convention on Biological Diversity
CIS	– Commonwealth of Independent States
DG Agri	– Directorate-General for Agriculture and Rural Development
EC	– European Commission
ETP	– European Technology Platform 'Plants for the Future'
EU	– European Union
FADN	– Farm Accountancy Data Network
FAO	– Food and Agriculture Organization
FNVA	– Farm Net Value Added
GDP	– Gross Domestic Product
GEF-BIO	– Global Environment Facility Benefits Index of Biodiversity
GHG	– Greenhouse Gases
GIPB	– Global Partnership Initiative for Plant Breeding Capacity Building
HLPE	– High Level Panel of Experts on Food Security and Nutrition
IMF	– International Monetary Fund
KTBL	– Kuratorium für Technik und Bauwesen in der Landwirtschaft
MENA	– Middle East/North Africa
NBI	– National Biodiversity Index
OBT	– Observação da Terra

- OECD – Organization for Economic Cooperation and Development
- TFP – Total Factor Productivity
- UBA – Umweltbundesamt
- UNEP – United Nations Environment Programme
- UNESCO – United Nations Educational, Scientific and Cultural Organization
- UNSD – United Nations Statistics Division
- USDA – United States Department of Agriculture
- WRI – World Resources Institute

6 Concluding remarks

The overall working hypothesis of this academic study stated that modern plant breeding in the EU acts at (a) increasing social welfare by generating additional income to farmers as well as in upstream and downstream industries related to the agricultural value chain, (b) providing a greater quantity of less expensive food to meet the rapidly growing needs of the world, (c) stabilising agricultural commodity markets, (d) adding jobs and social value to rural areas of the EU, (e) preserving valuable and scarce natural resources such as land habitats and water reservoirs, (f) reducing GHG emissions resulting from a decreased expansion of the global agricultural acreage, and (g) protecting biodiversity around the globe.

As shown in the paper, plant breeding in the EU contributes to various economic, social and environmental values. The picture drawn is based on sophisticated modelling and calculation tools (chapter 2) as well as a rather comprehensive assessment of plant breeding contributions to land productivity and overall productivity enhancement in EU arable farming (chapter 3). It turns out that plant breeding innovations count a lot: On average and across all major arable crops cultivated in the EU, plant breeding contributes approximately 74 percent to overall productivity growth (figure 3.10) equal to an increase of yields by 1.24 percent per annum (figure 3.11).

Based on this productivity growth, plant breeding activities towards major arable crops in the EU in the last 15 years (chapter 4.1 and chapter 4.2) resulted in benefits which can be characterised, quantified and summarised with the following ten key statements:

1. Increasing yields

With plant breeding for major arable crops in the EU in the last 15 years yields per ha have increased. On average and across all major arable crops harvested in EU member states, yields and consequently production would be more than 16 percent lower without genetic crop improvements (figure 4.1).

2. Improving market conditions

Higher yields per unit of arable land increase the supply of primary agricultural products on international markets. For example, an additional 47 million tons of grains and 7 million tons of oilseeds can currently be produced in the EU with plant breeding for these crops in the last 15 years. This contributes to stabilising markets and reducing price volatility (figure 4.2 and figure 4.4).

3. Increasing potential world food supply

Plant breeding in the EU is also indispensable for combating hunger and malnutrition and improves the world food security situation. Given current global per capita rates of nutrient consumption, genetic crop improvements in the EU in the last 15 years assure the additional availability of carbohydrates, proteins and vegetable oils to feed between 100 and 200 million humans (figure 4.3).

4. Generating economic prosperity and increasing social welfare

Plant breeding in the EU generates additional economic prosperity by increasing the GDP. The entire agricultural value chain benefits from input suppliers to final consumers. Genetic crop improvements in EU arable farming since the turn of the millennium have generated in the agricultural sector alone an additional social welfare gain of almost EUR 9 billion and have added more than EUR 14 billion to the EU's GDP (figure 4.5 and figure 4.6).

5. Creating additional farm income and securing agricultural jobs

Breeding for yields in arable farming in the EU also secures employment and increases the income of farmers and agricultural employees. Approximately 7 000 EUR/AWU on average, i.e. 30 percent of the income of an arable farmer in the EU, have been induced by plant breeding in the last 15 years (figure 4.7). Moreover, almost 70 000 jobs have been created in the arable sector (figure 4.8) as well as upstream and downstream the agricultural value chain in the EU.

6. Improving the agricultural trade balance

Plant breeding in the EU not only brings about positive economic and social effects, but it also generates substantial environmental effects. It helps save scarce land resources around the globe by generating higher yields per unit of area. This improves the EU agricultural trade balance. Without plant breeding in the last 15 years, the EU would have become a net importer in all major arable crops (figure 4.9).

7. Minimising net virtual land imports

In addition, plant breeding minimises the net virtual land imports of the EU, which currently amount to more than 17 million ha. In the absence of plant breeding for major arable crops in the EU in the last 15 years the global agricultural acreage would have to be expanded by more than 19 million ha (figure 4.10 and figure 4.11).

8. Reducing CO₂ emissions

This contributes to preserving natural habitats and to reducing GHG emissions resulting from an expansion of the global acreage. Plant breeding in the EU secures less CO₂ being emitted by helping avoid negative land use change. A total of about 3.4 billion tons of direct CO₂ emissions have been avoided by genetic improvements in major arable crops in the EU in the last 15 years (figure 4.12).

9. Preserving biodiversity

In addition, plant breeding in the EU generates a large positive biodiversity effect. Without plant breeding in the EU in the last 15 years, global biodiversity equivalent to 6.6 million ha of Brazilian rainforest or 9.4 million ha of Indonesian rainforest would have been lost (figure 4.13).

10. Saving agricultural water resources

Plant breeding in the EU for major arable crops in the last 15 years has finally contributed to saving scarce water resources around the globe. Without plant breeding 55 million m³ of water would be additionally needed (figure 4.16). This is as much as the water volume of Lago Maggiore and Lago di Como.

Considering other than major arable crops, i.e. some selected fruits and vegetables as well as temporary forage crops on the one hand and other breeding objectives than breeding for yield on the other hand, even more benefits and values of EU plant breeding can be identified (chapter 4.3). The specific research findings portray genetic crop improvements offering more than a substantial contribution towards the availability of food and other agricultural raw materials per se, namely an entire tool-kit for meeting many, if not most, of the important global challenges agriculture is facing.

Looking ahead, the perspective changes only a bit (chapter 5). Most of the indicators which have been analysed with respect to plant breeding for major arable crops in the EU in the last 15 years, i.e. since the turn of the millennium, show an even higher or rather stable value if applied to plant breeding in the upcoming 15 years, i.e. until 2030. This allows to summarise that successfully innovated genetic crop improvements in the EU have been and will be essential for economic, social and environmental benefits at large scale and should indeed be considered a highly effective measure for adapting to new and very dynamic settings.

Plant breeders in the EU, however, face a rather challenging policy and regulatory framework, as made clear in the introductory remarks of this study (chapter 1). They have to be encouraged to further and even more invest into new seed varieties and sophisticated breeding technologies instead of being hindered to spend the necessary

resources on urgently needed future productivity and efficiency growth. The obviously high societal rates of return plant breeding investments generate have to be broader acknowledged and politically supported be it through proper administration, sound legislation, higher financial support (e.g. by boosting public investment in basic research), or overall awareness raising.

This study has tried to increase such an awareness by providing evidence of the multiple benefits of plant breeding in agriculture and beyond based on reproducible findings and scientific facts. In particular, the results of the study should help better inform and facilitate an unbiased public debate on the importance of historic, current and future genetic crop improvements for specific socio-economic and environmental objectives. As such, the study should be considered an initial. Further research has to follow.

Potential points of departure are obvious: The rather general discussion of EU plant breeding could be further focussed and might be fine-tuned towards individual EU member states, specific crops and/or current as well as upcoming breeding technologies; qualitative arguments discussed (e.g. breeding for water stress tolerance, combating food waste, nutritional and health value) but also others not at all mentioned above might be quantifiable as well; plant breeding could also be seen as just one – of course: important – technology which is able to create even more benefits in symbiosis with other technologies such as modern fertilisation, irrigation, plant protection, tillage, etc. Analysing the various values and benefits from a more holistic point of view would certainly help to identify additional promising measures targeted at desperately needed future productivity growth in EU and global agriculture.



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