CellPress

Opinion

Back to the Future – Tapping into Ancient Grains for Food Diversity

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Einkorn, emmer, and spelt are old wheat species that have fed the world for centuries before they have nearly completely been replaced by modern bread wheat. Nowadays, the diversity of these old species lies frozen in gene banks and rare attempts aim to exploit them as a source for genetic diversity in modern wheat breeding. Here, we want to raise a debate on a more holistic exploitation of ancient species via their direct introduction to the consumer market as high quality products. Although exemplified only for ancient wheat species, this innovative self-financing strategy can be directly extended to other species. A central requirement for this concept is intensive communication, coordination, and interdisciplinary research along the entire production chain from farm to fork.

Ancient Grains Increase Crop and Food Diversity

'About 30 000 edible plant **species** (see Glossary) are known, but only 30 of these feed the world and only five cereals – rice (*Oryza sativa*), bread wheat (*Triticum aestivum* ssp. *aestivum*), maize (*Zea mays*), millets (e.g., *Pennisetum glaucum*, *Setaria italica*, *Panicum miliaceum*, *Eleusine coracana*), and sorghum (*Sorghum bicolor*) – provide 60% energy intake of the world population'[i]. Furthermore, within these species only a few dozen **accessions** are grown on a large scale. For instance, the wheat family consists of three species and more than 20 subspecies each represented by hundreds of different accessions. While einkorn (*Triticum monococcum*) and emmer (*Triticum turgidum* ssp. *dicoccum*) have driven the Neolithic revolution in agriculture and together with spelt (*Triticum aestivum* ssp. *spelta*) have been used to feed the world for thousands of years [1–3], today only bread wheat is widely grown[ii] (Figure 1A). This extreme focus on few species and accessions has led to a large loss of biodiversity with negative consequences such as the extinction of species, vulnerability of ecosystems, and difficulties to meet future agricultural demands, because genetic variability to provide climatic and pest adaptation is lost [4]. Furthermore, traditional dishes, recipes, and customs in food preparation have disappeared, resulting in a strong decrease in food diversity.

The exploitation of ancient species is seen as a key factor to further drive genetic improvements in plant breeding. Several strategies have been proposed, from the introgression of single genes [5,6] to breeding strategies aimed at improving quantitatively inherited traits such as grain yield [7,8]. However, we propose to extend these efforts to a more holistic and sustainable use of the available ancient species. We postulate that several of them can be reintroduced as crops by creating markets for specialty products, along with a rediscovery of traditional recipes and customs. This concept allows to not only increase the biological diversity in our agroecosystems but also to enrich our food diversity. These ancient species will hardly help to feed the growing world population as they are often low yielding and not adapted to modern agricultural practices.

Trends

In developed countries, consumer trends go towards regional production of crops that are not intensively bred and produced, but instead offer novel and interesting products and tastes.

Ancient crop species can satisfy these emotionally driven trends and in addition provide interesting new products with health-promoting ingredients while increasing crop and food diversity.

The consumer trends further suit the requirements of small farmers, millers, traders, and end product manufacturers, for example, bakers, providing them with unique market positions against industrial mainstream products and warranting regional product chains with stable returns.

The identification of ancient crop species best suited to current consumer and market needs requires an intensification of interdisciplinary research and long-term funding of undervalued crops.

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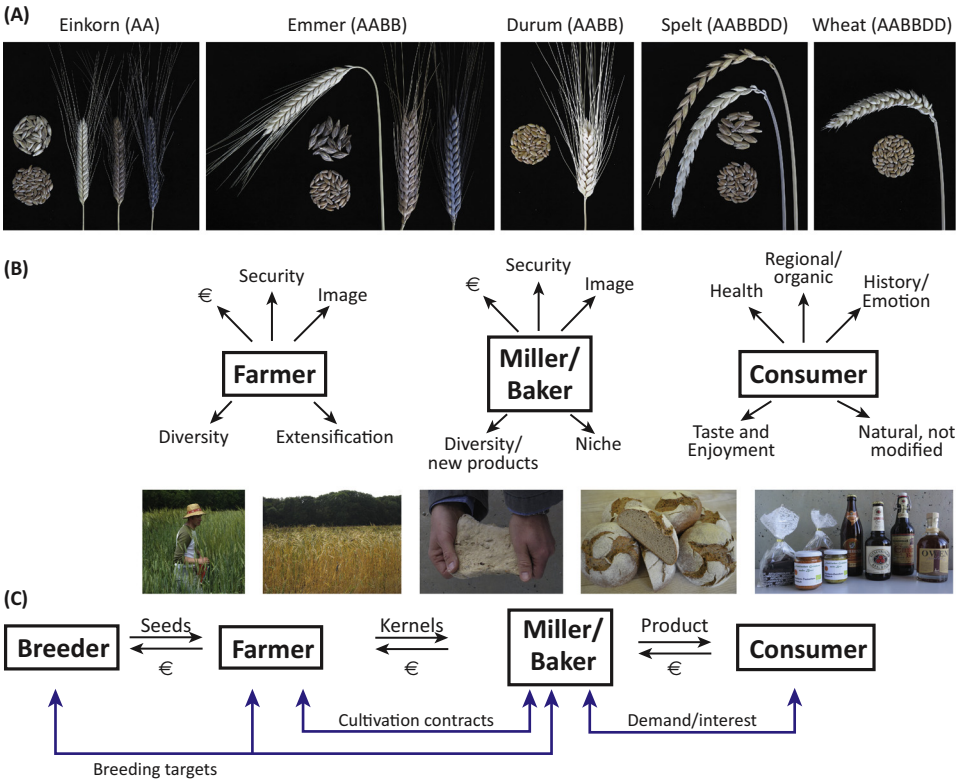

Figure 1. The Wheat Product Chain.

For a Figure360 author presentation of Figure 1, see the figure online at http://dx.doi.org/10.1016/j.tplants.2016.05.005#mmc1.

(A) Spikes, hulled grains, and naked grains of einkorn, emmer, durum wheat, spelt, and bread wheat, with their genome formula in parentheses. (B, C) A simplified wheat production chain with (B) the relevant requests of the specific stakeholders, that is, farmers, millers, and bakers, as well as consumers, and (C) their interactions in a sustainable and coordinated product chain.

However, in developed countries, consumer trends towards high quality, regional products are 'back to the future' by utilizing crops that are not intensively bred and/or produced on a large scale, but instead offer novel and interesting products and tastes[iii].

Needs and Interests along the Product Chain

An attractive approach to satisfy trendy consumer requests, while conserving biodiversity, is to identify those ancient species within the plethora of genetic resources frozen in gene banks, which allow a self-financing re-establishment along the whole product chain. In our opinion, this requires two steps. First, the identification of the interests and needs of the market players and consumers to establish stable product chains with these ancient species and, second, the elaboration of the potential risks and demands in their holistic production from farm to fork. We illustrate these steps with the classical wheat production chain, which can serve as an example for other species and product chains.

A classical wheat production chain involves farmers, millers, and bakers (or other end producers), as well as the consumer (Figure 1C). Together with stakeholders and socioeconomics, it is necessary to determine the basic needs of the single players within this product chain for the present and the near future. We have summarized our main conclusions from numerous discussions, meetings, and field days with numerous stakeholders of the whole cereal product chain in Figure 1 and will elaborate on them in the following.

Glossary

Accession: variation within one species, which is distinguishable from other accessions in this species.
Lodging: falling down or even breaking of the stalk of plants caused by wind, rain, or other events in the field. Thus, all ears lie close to the soil within lots of straw leading to very humid conditions, which are ideal for the growth of fungi or also the germination of the kernels in the ear reducing yield and kernel quality.
Phenotyping: determination of a single characteristic, for example, disease resistance in the field or baking quality in the bakery laboratory.
Species: fundamental unit of biological classification. Bread wheat represents a single species, so does einkorn and emmer.