Boosting sustainable crop productivity

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The global demand for plant-derived products such as feed and food is increasing dramatically, as illustrated by the recent doubling of the price of most commodity crops. Unfortunally, the poorest people on earth will be the first victims of this food shortage and, recently, the United Nations has estimated that currently 37 countries struggle with a food crisis. Why do food prices rise so quickly? The first obvious factor is the still exponentionally growing world population. It is hard to fathom, but in the coming decades three billion additional people will have to be fed while less arable land is utilized. Furthermore, the standard of living is anticipated to continue to go up in many developing countries where consumption of animal products is burgeoning, in turn necessitating a larger input of plant-derived feed because, on average, the production of one kilogram of meat requires 4 to 8 kilograms of cereals. The high energy prices also make food production more expensive. Last but not least, plants also start to play a major role in supplying the ever-increasing energy needs. Indeed, the next generation of bio-energy crops might provide a sustainable, CO_2-neutral solution. Needless to say that efficient utilization of bio-energy crops has to be fully compatible and non-competitive with agriculture for food and feed production and has to preserve the earth's most precious ecosystems.

How can we deal with these exponentially growing demands for food, feed and bio-energy? How can we cope with the fact that we will have to produce more food on less arable land, under environmentally more challenging conditions?

There is an obvious and urgent need to further increase crop productivity. Whereas in the sixties the so-called ‘green revolution’, based on the use of new crop varieties and the efficient application of agrochemicals, immensely contributed to increased plant productivity, biotechnological innovations are expected to enhance the ability of plants to capture light energy and to convert it into useful products for mankind. One major area for biotechnological improvement is boosting up intrinsic crop yield in a sustainable manner with a minimum input of water, fertilizers, and agrochemicals.

As yield is the most important trait for breeding, a considerable amount of (eco)physiological research has been conducted on yield performance of crops. In contrast, surprisingly little is known about the molecular networks underpinning crop yield, partly because of its multifactorial nature in which many physiological processes, such as photosynthesis, water and mineral uptake, mobilization of starch and lipid reserves, and stress tolerance determine the resources available to new cells, tissues, and organs of the most vital crops.

However, by using model plants, such as *Arabidopsis thaliana* (thalecress) and *Oryza sativa* (rice), scientists world-wide start to unravel the mechanisms that control plant growth and productivity under both optimal and environmentally less favorable conditions, such as drought. Plant growth and stress tolerance are complex processes, but novel approaches collectively called “systems biology” allow us to better understand this complexity. I will discuss how this rapidly growing know-how is now being applied for crop enhancement by scientists from the academic and industrial world. Already now, many key genes affecting crop yield and stress tolerance have been identified and spectacular increases in plant productivity have been obtained by using genetic engineering. In view of what is ahead, it is of utmost importance that the world adopts this technology and that these improved plant varieties are delivered to the poorest on earth.