Agriculture puts an enormous pressure on available resources. This is likely to increase further due to the growing human population, increasing per capita consumption, and changes in diets. Agriculture itself is very sensitive to degradation of the resource base. It is mandatory that this pressure stays within the carrying capacity of Planet Earth and within specific sustainability thresholds. Sustainability thresholds are diverse and often normative. They can seldom all be realized to the full extent at the same time, and therefore trade-offs are unavoidable. Choices have to be made in the face of these trade-offs and often criteria upon which such choices are based not only depend on scientific or practical considerations, but also on norms and moral values. There is little consensus on how to make those choices nor is there consensus on the norms and moral values. This applies when local solutions are sought to realize ‘mindful agriculture’, but is further complicated when considering the global nature of agriculture and food production. There is certainly not enough consensus on how to realize sustainable intensification at the global scale as this requires trade-offs across borders. Both intensification and sustainability can be defined and interpreted in various ways. Because of the ambiguity of both concepts detailed contextualization is needed. Combining intensification and sustainability into sustainable intensification makes for an even more ambiguous and hence contested concept.

It is often claimed, and equally often contested, that intensification improves the efficiency with which resources are utilized, but intensification often implies specialization, concentration (of economic resources but also of problems), and increase of scale. The logic of the argument that intensification is associated with an increase in efficiency requires additional in-depth analysis. Trade-offs between different dimensions of efficiency (economic efficiency as well as biophysical resource use efficiency); fair distribution of food, wealth, and welfare; environmental quality; animal welfare; nature conservation; biodiversity; quality of the human diet, among others, are complicated. Nevertheless they need to be evaluated and valued in order to reach an informed consensus on sustainable intensification. Even when economic indicators and environmental quality indicators are both favourable for intensive systems, other sustainability indicators (e.g., animal welfare with associated risks for public health) might not be. Environmental indicators might also show unfavourable values in regions dominated by intensive agriculture, and intensification in certain regions might have a negative impact on sustainability at global level. An integral view on sustainable intensification from a societal, agronomic and environmental perspective is required. This integral view should include the notions that,
in addition to the need to produce more, there is also a need to produce in a different way and that food systems should be compatible with nature and the environment.

This special issue initiates the debate starting from the point that while conceptual diversity is a fact, accurate contextualization is essential. We observe that in the debate on intensification often the wrong questions are asked; and that for that reason many participants in the debate are hardly interested in and do poorly listen to the arguments brought forward by others. This maintains an unsatisfactory state of the debate. It is time to step back, reflect on the ‘right’ questions, which involves questioning different conceptualizations of the frames of the debate. Evidently, the debate on agricultural intensification, economies of scale, and best practices to meet the increased demand for agricultural produce, reflects one of the most urgent sustainability challenges.

Agronomy and animal husbandry have become contested sciences. However, the focus in the debates was quite often instrumental (e.g., how to achieve agronomic sustainability) or with an a priori assumption (e.g., economic efficiency is more important than animal welfare). What is missing is a thorough analysis and synthesis of the technical, economic, environmental, and societal aspects taking conceptual diversity as a given and upgrading the debate by permitting generally agreed-upon scientific facts, different views on the relevance of those facts, and on values in science. Therefore, central in our approach are interdisciplinarity (across-discipline integration), transdisciplinarity (giving a voice to knowledge by other — non-scientist — stakeholders), debate at multiple scales and acknowledgement of the importance of values and extra-scientific judgements in scientific debates.

Finally, we think of intensification as a process, hence the debate on agricultural intensification is by definition a debate on transitions, that is, transitions away from what are generally accepted as unsustainable forms of (intensive) agriculture and towards (more) food security in an environmentally and socially sustainable way. We therefore let the authors of the different contributions free to call this process sustainable intensification or ecological intensification.

The introductory paper by Struik et al. describes the deconstructing and unpacking of scientific controversies on intensification and sustainability. The paper makes an attempt to identify why there are tensions in concepts and values and stresses that trade-offs are unavoidable, and that transparent choices should be made based on scientific and non-scientific arguments and on consensus on norms and values. A paper by Van Bueren et al. demonstrates that inclusive chain management only partially succeeds in sustainable intensification. It illustrates how intensification can result in wicked problems, that is, problems that are resistant to solution, because solutions inevitably feedback on the problem. Wicked problems can even result in ‘organized irresponsibility’, which is illustrated by the case of the Dutch chicken meat chain. Vanlauwe et al. pay special attention to sub-Saharan Africa, the region where the Green Revolution was not successful, where agriculture is often organic-by-default, and where intensification of smallholder agriculture is a must. They describe avenues for the smallholder farmer in Africa towards sustainable intensification and show that pathways to sustainable intensification should recognize the diversity of the farming environments. It obviously requires local innovations to reconcile the need for food with the need to preserve and maintain natural resources. Van der Ploeg and Ventura describe the heterogeneity in agricultural development and the role the analysis of farming styles can play in understanding that heterogeneity. Farming styles are distinctive patterns for the organization and development of agricultural production. Van der Ploeg and Ventura show that some styles combine high levels of productivity with sustainability, whereas other styles do not. Weiler et al. describe in great detail research on the life cycle analysis of milk production in the tropics, in which they show how multifunctionality of livestock (which is still the norm in large parts of the tropics) can be factored into the sustainability of the system. They conclude that the carbon footprint of smallholder milk production is similar to the one of intensive milk production systems. Campbell et al. describe how global climate change affects agricultural production and how the sustainable intensification approach complements climate-smart agriculture. Climate-smart agriculture improves risk management, information flows and local institutions to support adaptive capacity, thus incentivizing and enabling intensification. Caron et al. extensively discuss the role of science in the transition towards sustainable intensification. They show that agricultural performance must be redefined in order to address sustainability properly. Especially the significance of the local context in achieving ecological intensification is important. Research should play a major role in engineering the different sources of knowledge. Tittonell describes the strategy of ecological intensification and analyses why this is the ‘natural’ way towards improving productivity of the existing agricultural systems while balancing agriculture and nature. Ecological intensification requires landscape and community approaches and a shift from autoecology to synecology. Van Noordwijk and Brussaard analyse how yield gaps are related to gaps in resource use efficiency. Yield gaps indicate inefficiency, while resource use efficiency gaps indicate that environmental impacts per unit area are too high. Yield and efficiency gaps are partially independent. They demonstrate that synergy in gap closure is possible but not automatic. A paper by Uphoff analyses systems thinking
in intensification and sustainability and describes interesting examples where practitioners have developed agricultural production systems in which system thinking is central. **Uphoff** claims that sustainability is better defined by intension than by extension and provides details on an alternative practice where the term intensification is also used, the so-called System of Rice Intensification. **Kuypers and Struik** wrote an epilogue in which they conclude that sustainable agriculture is a contested concept and that sustainable or ecological intensification requires a radical rethinking of agricultural production.

The guest editors hope that this special issue contributes to improving the debate on sustainable intensification, not only among scientists, but also between scientists, policy makers, practitioners, farmers, processors, other production chain agents, and buyers and consumers. The debate needs more transparency and clarity. It helps when science makes fewer claims on and assumptions about win-win situations referred to in the phrase of sustainable intensification and stresses more the trade-offs that are unavoidable when we allow the entire world population to exert its right to food in ways that do not negatively affect the right to food of future generations.