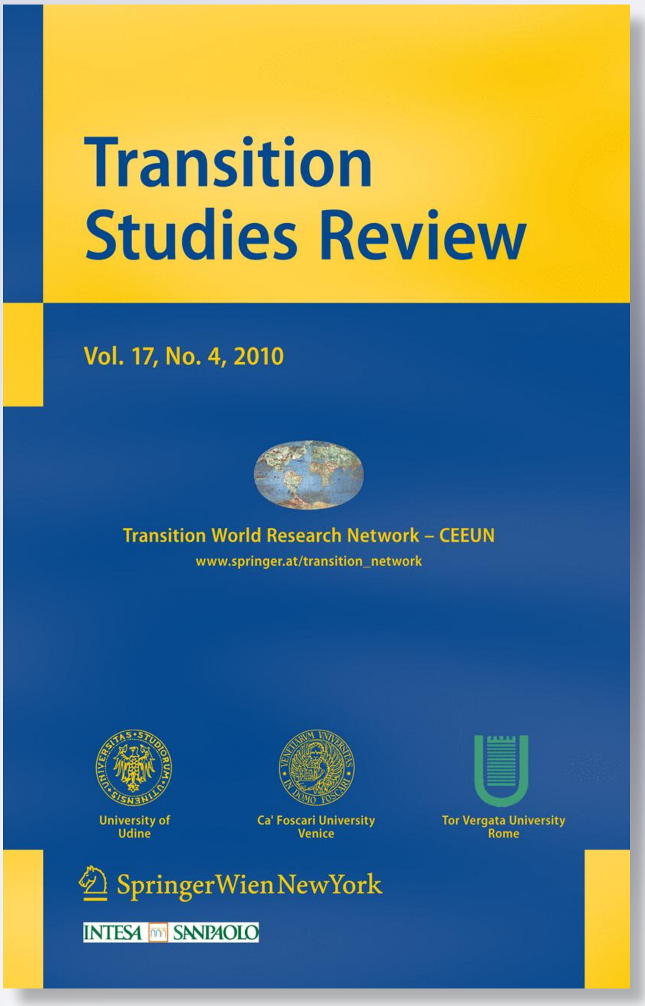
The Challenge of Agricultural Sustainability for Asia and Europe

Transition Studies Review

ISSN 1614-4007
Volume 17
Number 4

Transit Stud Rev (2010)
17:662-667
DOI 10.1007/s11300-010-0181-z



Springer

Transit Stud Rev (2010) 17:662–667
DOI 10.1007/s11300-010-0181-z

EUROPE-ASIA GLOBAL ISSUES

The Challenge of Agricultural Sustainability for Asia and Europe

Michele Pisante · Sandra Corsi · Amir Kassam · Theodor Friedrich

Received: 20 July 2010 / Accepted: 1 September 2010 / Published online: 20 October 2010

Abstract It is expected that climate change (CC), growing population, increasing urbanization and improving living standards are amongst the major drivers influencing future agricultural development needs. Under conventional agricultural systems, the main sources of growth in crop production are well known. Beyond suffering its consequences, agriculture has been shown to act as a driver of CC, primarily through the production and release of about 15% of the atmospheric greenhouse gases but also by altering the resilience of the agro-ecosystems. The main criterion for the production systems called conservation agriculture (CA) is the provision of an optimum environment in the root-zone to maximum possible depth. Under CA the water-holding capacity of the soil increases, and water losses are reduced. CA combined with other complementary techniques can also help reduce the emissions for methane and nitrous oxides and at the same time it can improve rural and socio-economic development.

Keywords Conservation agriculture · Crop production growth · Growing population · Agricultural land expansion · Intensification · Mitigation

M. Pisante (✉) · S. Corsi
Agronomy and Crop Sciences Research and Education Center,
University of Teramo, Teramo, Italy
e-mail: mpisante@unite.it

S. Corsi
e-mail: sandra.corsi@fao.org

S. Corsi · A. Kassam · T. Friedrich
Food and Agriculture Organization (FAO), Rome, Italy
e-mail: amir.kassam@fao.org

T. Friedrich
e-mail: theodor.friedrich@fao.org

JEL Classification Q1 · Q2 · Q3 · O4

It is expected that climate change, growing population, increasing urbanization and improving living standards are amongst the major drivers influencing future agricultural development needs. Land, water and genetic resources are indeed finite, and whose actual availability is likely to be further limited by climate change and by the need to conserve resources for future generations (The resource outlook to 2050, Bruinsma). Irregular water availability, extreme weather events, and higher normal temperatures are some of the challenges agriculture will have to deal with increasingly in the future under changed climatic conditions. At the same time global agricultural production will need to increase by 70% (nearly 100% in developing countries) by 2050 to provide sufficient food for the growing world population (40% increase) and to raise average food consumption due to increasing incomes, urbanisation and changing diets. Figure 1 portrays future crop production growth for developing countries in general and Asia in particular, whereas Fig. 2 shows the projected impacts from climate change for different regions in the EU.

Under conventional agricultural systems, the main sources of growth in crop production are: expansion of the land area and intensification; this latter encompasses increasing multiple cropping with shorter fallow periods, and boosting crops yields. Only in areas with a lot of spare land resources can production growth draw on the expansion of land area. In the future, some 80% of increased crop production in developing countries is expected to come from crop intensification. Water shortages, as worsened by climate change, make irrigation crucial for agricultural production in many areas of the world and a large part of the irrigation

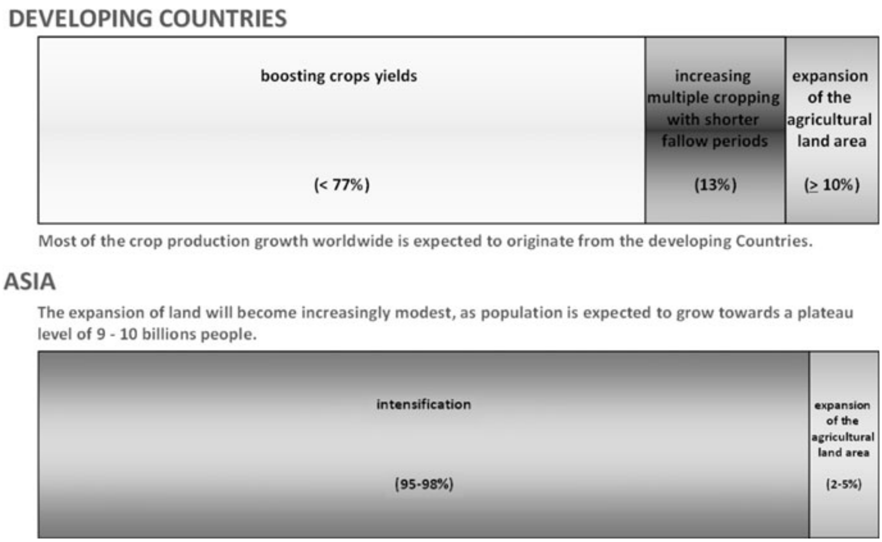


Fig. 1 Crop production growth

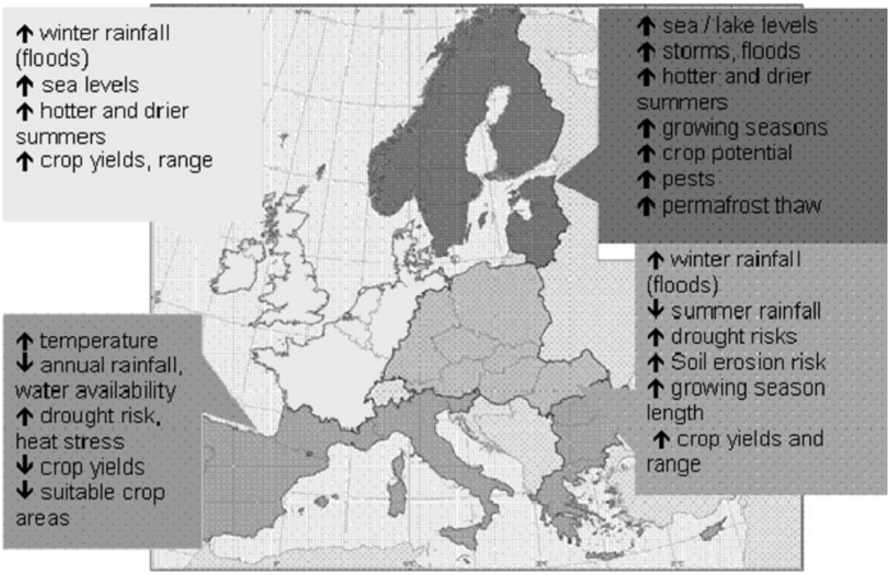


Fig. 2 Projected impacts from climate change for different regions in the EU

potential is already in use. In Asia, population pressure on natural resources is already high and it is expected to increase further. However, based on past trends, as population continues to grow towards a plateau level of 9–10 billion people, the expansion of land will become increasingly modest. The growth in commodity production in south Asia is now almost completely (94%) based on increases in yields and cropping intensities (FAO, Agriculture towards 2050), and available water resources are the limiting factors there. In east and south-east Asia there is still a lot of water that could be used for irrigation but the agricultural land resources are becoming scarce.

Beyond suffering the consequences of climate change, agricultural activities have been shown to also act as drivers of climate change, primarily through the direct production and release of about 15% of the atmospheric greenhouse gases (GHG)—such as carbon dioxide, methane, nitrous oxide—but also by altering the resilience of the agro-ecosystems.

Conventional agriculture is based on soil tillage to loosen the soil, prepare the soil for sowing, and control weeds. This is a very energy-consuming process that uses energy derived from fossil fuels. However, while ploughing uses 80 l ha^{-1} of fuel, no-till uses only 10 l ha^{-1}. Tractor fuel emissions should be added up with those that originate from the oxidative breakdown of soil organic matter through mechanical tillage—mainly mouldboard and/or disc ploughing. As in a vicious circle, the reduction of soil organic matter, which is the substrate for soil life, endangers the biological soil structuring processes carried out by the soil edaphons, which in turn reinforces the need for more mechanical tillage leading to further soil degradation. Molecules of methane (CH_4) and nitrous oxide (N_2O) have a similar but greater greenhouse effect than CO_2: the global warming potential of methane is

20 times that of CO_2, while that of nitrous dioxide has almost 300 times more impact. Methane in agriculture is principally released by cultivation of flooded rice and cattle's enteric fermentation, while nitrogen added to most agricultural soils as synthetic and organic fertilizers can then be converted to N_2O, particularly under compacted and badly aerated soil conditions.

In order to mitigate GHG emissions from agricultural activities, action should be taken to establish a virtuous circle in this sector. First of all, the mean rate of soil recovery by soil biota should be always kept high enough to compensate for the mean rate of soil's physical degradation. The main criterion for the production systems called conservation agriculture (CA) is the provision of an optimum environment in the root-zone to maximum possible depth. Roots are thus able to function effectively and without restrictions to capture plant nutrients and water (Kassam et al. 2009). Under CA systems the water-holding capacity of the soil increases, and water losses from runoff and evaporation are reduced to a minimum. This, more efficient water use, can translate into irrigation water savings.

Not tilling the soil requires less input of energy per unit area, per unit output, and lower depreciation rates of equipment. Over time, less fertilizer is required for the same output (Lafond et al. 2008) if the no-till system is complemented by continuous organic soil cover and diversified crop rotations corresponding to CA. Production costs are thus lower, thereby increasing profit margins as well as lessening emissions from tractor fuel (Hengxin et al. 2008): up to 70% in fuel savings with CA have been reported (FAO 2008). CA systems combined with other complementary techniques can also help reduce the emissions for methane and nitrous oxides. Both of these latter emissions result from poorly aerated soils, such as permanently flooded rice paddies, severely compacted soils or heavy poorly drained soils. CA improves the internal drainage of soils and the aeration and avoids anaerobic areas in the soil profile, so long as soil compactions through heavy machinery traffic are avoided and the irrigation water management is adequate. Furthermore CA has the potential to lower overall N_2O emissions by reducing the need for mineral N by 30–50% and enhancing nitrogen factor productivity. Also, N leaching and runoff are minimal under CA. Figure 3 describes the interactions between soil organic matter and biodiversity under different agricultural systems.

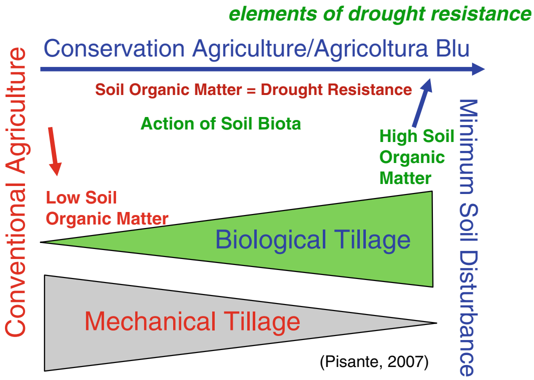


Fig. 3 Soil organic matter and biodiversity under different agricultural systems

It is interesting to add some further considerations on paddy rice, as this accounts for some 160 million ha worldwide, and it is mostly grown under some form of tillage. Also in the wheat-rice cropping system in India and in the Indo-Gangetic Plains most of the rice is still established by transplanting into puddled fields. Wheat there, on the contrary, is grown under no-till in about 5 million ha: tillage would otherwise take too much time, and hence cause seeding delays and yield losses (Hobbs et al. 2008). Long-term experiments suggest that continued puddling for rice destroys soil physical properties and affects both the puddled rice yield and the following crop negatively (FAO, TECA http://www.fao.org/teca/content/alternatives-rice-puddling-and-transplanting). Some improvements in rice cultivation have already been achieved through Systems of Rice Intensification (SRI), innovative production systems of intensification by optimisation of external inputs and improvement of soil and water management (SRI, Uphoff and Kassam 2009). Given that irrigated rice under the SRI does not require anaerobic conditions, and therefore does away with flooding, it would appear that SRI practices can combine well with CA (Friedrich et al. 2009). Systematic research is required to evaluate and adapt SRI for CA, so that soil puddling can be avoided, transplanting-based systems converted to direct seeding, and weeds incidence still kept under control with integrated management practices. This would noticeably reduce the total growing period (Conservation agriculture: synergies of resource-conserving technologies in rice-based systems, Friedrich and Gustafson) and make it possible to save labour, fuel, water—SRI has already proven to reduce water requirements by 25–50%—even in the irrigated rice production areas in the Mediterranean Europe.

CA is not yet widespread in Europe (Basch et al. 2008; Lahmar 2009): no-till systems do not exceed 2% of the agricultural cropland. The shift of European farmers to conservation agriculture is being achieved through a step-by-step attitude, large scale farms are the most adopters (Lahmar 2009). In Italy, the adoption of CA for orchards, in particular olive orchards and vineyards, accounts for some 500,000 ha and the positive results achieved make further diffusion of these practices feasible (Pisante 2007). More scientific research is yet needed to find out to which extent CA can contribute to the mitigation of climate change in Europe. Besides reducing negative externalities associated with tillage-based agriculture, CA may help improve farms' competitiveness and slash some of the most relevant costs for larger producers, such as the above mentioned machinery and fuel costs. With zero tillage farmers can use smaller tractors and make fewer passes over the field, which also results in lower fuel and repair costs (FAO 2001a).

In conclusion we believe that sustainable agriculture based on CA offers adaptability to climate change as well as contributing the most to climate mitigation and can do so most cost-effectively. At the same time it also can improve rural and socio-economic development.

References

Basch G, Geraghty J, Stret B, Sturny WG (2008) No-tillage in Europe—state of the art: constraints and perspective. In: Goddard T, Zoebisch MA, Gan YT, Ellis W, Watson A, Sombatpanit S (eds) No-till farming systems. Special Publication No. 3. World Association of Soil and Water Conservation (WASWC), Bangkok, pp 159–168

Friedrich T, Kassam A, Shaxson F (2009) STOA Project "Agricultural Technologies for Developing Countries"—case study. Conservation agriculture. Institute of Technology Assessment and Systems Analysis (ITAS), Forschungszentrum Karlsruhe

Hengxin L, Hongwen L, Xuemin F, Liyu X (2008) The current status of conservation tillage in China. In: Goddard T, Zoebisch MA, Gan YT, Ellis W, Watson A, Sombatpanit S (eds) No-till farming systems. Special Publication No. 3. World association of soil and water conservation (WASWC), Bangkok, pp 413–428

Hobbs P, Sayre K, Gupta R (2008) The role of conservation agriculture in sustainable agriculture. Phil Trans R Soc B 363:543–555. doi:10.1098/rstb.2007.2169

Kassam A, Friedrich T, Shaxson TF, Pretty J (2009) The spread of conservation agriculture: justification, sustainability and uptake. Int J Agric Sustain 7(4):292–320. ISSN: 1473-5903 (print), 1747-762X (online). doi:10.3763/ijas.2009.0477. Earthscan: http://www.earthscanjournals.com

Lafond GP, Walley H, Schoenau J, May WE, Holzapfel CB, McKell J, Halford J (2008) Long-term vs. short-term conservation tillage. In: Proceedings of the 20th annual meeting and conference of the Saaskatchewan soil conservation association, 12–13 February, Regina, Saaskatchewan, pp 28–43

Lahmar R (2009) Adoption of conservation agriculture in Europe: lessons of the KASSA project. Land Use Policy 27(1):4–10. doi:10.1016/j.landusepol.2008.02.001

Pisante M (2007) Agricoltura Blu—La via italiana dell'agricoltura conservativa—Principi, tecnologie e metodi per una produzione sostenibile. Il Sole 24 Ore Edagricole, Bologna, XII + 317

Uphoff N, Kassam A (2009) STOA Project "Agricultural Technologies for Developing Countries"—case study system of rice intensification. Institute of Technology Assessment and Systems Analysis (ITAS), Forschungszentrum Karlsruhe