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Review

Towards ecologically sustainable crop production: A South African perspective

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ABSTRACT

Food production comes at an ecological cost, and the lack of sustainability of South Africa's crop production systems is becoming increasingly worrisome. While small scale emerging and homestead subsistence farming are significant in the agricultural sector, food production is dominated by large scale commercial agriculture. In this paper we analyse the ecological impact of South African commercial crop production and what can be done about it. Impact categories considered are divided into what we consider 'better-researched' problems: fresh water depletion, salinisation, soil degradation, eutrophication and land use change; and into what we consider 'emerging' problems for agriculture: greenhouse gas emissions, soil profile acidification, ecotoxicity and non-renewable resource consumption. While there is a paucity of quantitative information, it is clear that after decades of cultivation many of our agroecosystems are degraded or degrading. Sustainable crop production and food security are 'wicked' problems – containing dynamic social, economic and biophysical complexities. Increased stakeholder engagement to better understand these problems, the tradeoffs linked to finding solutions and to involve those with the resources to turn knowledge into action is required. Collecting key data, turning it into information within local contexts (involving the ecology, agronomy, sociology, psychology, economics and other disciplines simultaneously) and communicating it effectively to allow learning and adaptive management at various spatial and temporal scales is essential. An example is the display of river flows on a website in real-time to help farmers manage and adapt irrigation practices better, and to connect them with other stakeholders to improve understanding of the responsibilities of managing water at local and catchment scales.

Contents

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1. Introduction

Producing food is arguably the most important use of our natural resources. Since the Second World War, intensive, mechanised agriculture has been evolving, so many of the fields we continue to cultivate today have produced food under intensifying practices for more than 70 years. In 2005, 90% of all food calories and 80% of all food protein and fats were derived from croplands (Kastner et al., 2012). Unfortunately, these practices have resulted in salinization of irrigated fields, depletion of freshwater aquifers, degradation of ecosystems due to the export of harmful agrochemicals, soil profile acidification, net soil organic matter (SOM) decomposition, and general loss of soil quality and fertility. According to the United Nations, sustainability ' . . . calls for a decent standard of living for everyone today without compromising the needs of future generations'. Based on this definition of 'sustainability', most of the world's crop production systems cannot be considered sustainable simply as a result of the wide range of impacts – both onsite and offsite – associated with crop production (Fig. 1).

South Africa cultivates around 12–13% of its total area of 122 million ha. Just over 14 million ha is under commercial agriculture (approximately 40,000 farming units), a well-developed sector relying on a high degree of mechanisation and synthetic agrochemical use. There are around 1.3 million smallholder farmers in former homelands, with around 2.9 million households engaging primarily in agriculture at the subsistence level (DAFF, 2012), generally charactersised by low input – low production systems. Approximately 1.3 million ha of South Africa (1% of total 13% of cultivated land) is under irrigation (DAFF, 2012), compared to the global national average of irrigation covering 21% of arable land (http://www.fao.org/nr/water). Food insecurity remains widespread throughout South Africa affecting 25% of the population (Labadarios et al., 2011), which is projected to increase from the present 50 million to 60 million by 2030 (United Nations, no date). This population is also becoming more affluent, placing ever greater pressures on the natural environment.

Feeding 9 billion people with the average diet from North America (USA and Canada) would require doubling crop land even if global yields were able to reach the current North American average (Kastner et al., 2012). If no new land is to be brought into cultivation, this translates into a 2.4% yield increase per hectare per year for maize, rice, wheat and soybean, but yields for these crops are only increasing at 1.6%, 1.0%, 0.9% and 1.3% per year, respectively (Ray et al., 2013). Food security is, however, not just about total

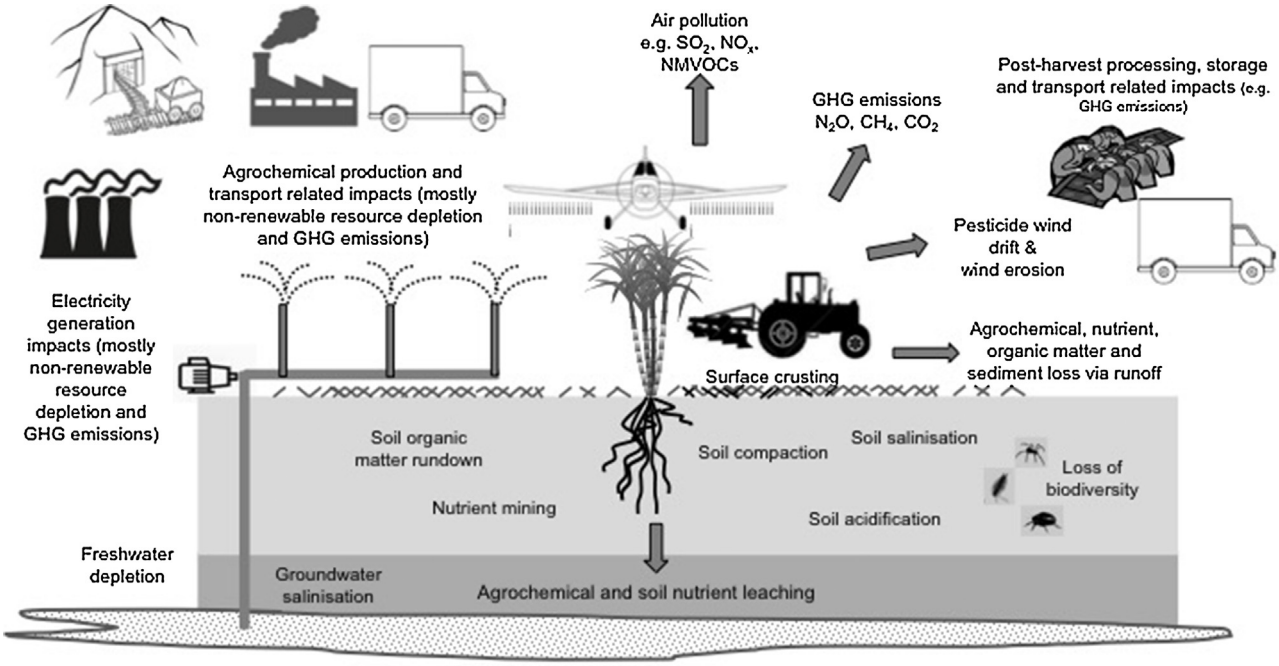

Fig. 1. Schematic of impacts that crop production has or can have on the environment (GHG = greenhouse gas, SO_2 = sulphur dioxide, N_2O = nitrous oxide, NOx = nitrogen oxides, NMVOCs = non-methane volatile organic compounds, CH_4 = methane, CO_2 = carbon dioxide).