ESA2018

XV[e] European Society for Agronomy Congress

August 27-31, 2018 - Geneva, Switzerland

www.esa-congress-2018.ch

ABSTRACT BOOK

INNOVATIVE CROPPING AND FARMING SYSTEMS FOR HIGH QUALITY FOOD PRODUCTION SYSTEMS

CICG, GENEVA SWITZERLAND
27 - 31 AUGUST 2018

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B. PARALLEL SESSIONS

1. PARALLEL SESSION 9.2 – FARMING SYSTEMS

PS-9.2-01

Challenges and Opportunities of Legume-Supported Cropping Systems

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Abstract: It is challenging to meet the global demand for protein to feed an increasing world population, while reducing negative environmental impacts of current production systems. Legumes produce high quality protein for food and feed, and provide ecosystem services contributing to sustainable cropping systems. Rotational effects are generally not taken into account when cropping systems are evaluated, but such effects need to be considered when estimating the environmental and economic effects of legumes in the system. Yield instability of grain legumes is perceived to be high, resulting in low adoption by farmers in Europe. There is a lack of knowledge about the options farmers have to design and optimize cropping systems with legumes. A four-year research project addressed these issues by (i) developing a framework to assess impacts of legumes at the cropping system scale, (ii) identifying trade-offs of integrating legumes into cropping systems, (iii) assessing grain legume yield stability compared to other crops, and (iv) evaluating different approaches to optimize grain legume cropping systems.

We developed a novel cropping system assessment framework and applied it to five case study regions across Europe. The framework supported the design of cropping systems and assessed their impacts in a participatory approach with experts. The application indicated trade-offs and synergies between economic and environmental impacts of introducing legumes into cropping systems. On average, cropping systems with legumes reduced N_2O emissions by 18 % and 33 % and N fertilizer use by 24 % and 38 % in arable and forage systems, respectively, compared to systems without legumes. Grain legumes reduced gross margins in 3 of 5 regions and forage legumes increased gross margins in 3 of 3 regions. By using a scale-adjusted stability measure that accounted for the yield differences between crops following Taylor's Power Law, we showed that yield instability of grain legumes (30%) was higher than that of autumn-sown cereals (19%), but lower than that of other spring-sown broad-leaved crops (35%), and only slightly greater than spring-sown cereals (27%), using data from five long-term field experiments. Finally, we compared on-station experiments, on-farm experiments and crop rotation modelling as approaches to design cropping systems to better integrate legumes in crop rotations. We identified strengths and weaknesses of the different approaches and provide guidelines on how to use these methods effectively in future farmer-oriented research.

Overall, we demonstrate that grain legume yields are as reliable as those of other spring-sown crops and that increasing the cultivation of legumes could potentially lead to economic competitive cropping systems and positive environmental impacts. Achieving this aim will be supported by the design of site-specific management strategies informed by the involvement of farmers.

Keywords: Multi-criteria assessment, pulses, rotations, scaling

PS-9.2-02

Livestock in Diverse No-Till Cropping Systems Suppress Weeds and Conserve Diversity, Whilst Reducing Inputs and Sustaining Yields

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Abstract: Weeds are a major challenge in no-till arable systems. Producers are usually heavily dependent on chemical control, which promotes weed species that are either tolerant or resistant to herbicides. Crop rotation presents an opportunity to mitigate this effect through introducing alternative selection pressures on weeds, by varying crop-weed interactions and the conditions imposed by management practices associated with different crops. In this study, we investigate weed abundance and diversity over twelve years in eight different rotation systems, using weed seedbank data from a long-term trial in South Africa's Western Cape. Crop diversity among the eight systems varied from one to three species, and four of the rotations contained grazing phases (annual *Medicago/Trifolium* spp. with sheep). The eight systems thus differed in crop diversity, weed management actions (herbicides and sheep), and in nitrogen availability and source diversity (fertiliser, legumes, and sheep manure). We used linear mixed regression models to explore how weed abundance, diversity and community composition differed between rotation systems in response to these management variables. Grazing was found to be the most important difference between rotations, resulting in lower weed abundances and higher weed diversities. In contrast, only a weak effect on weeds was observed for as herbicide quantity increased, and no effect was observed as herbicide mode-of-action group diversity increased. This suggests that integrating management actions with distinct selection mechanisms (grazing plus herbicides) into rotation systems is most effective for weed management. Crop diversity also had an effect on weed abundance and diversity, suggesting that variation in crop-weed interactions has an additional effect to management variation. Lastly, we compared spring wheat (*Triticum aestivum*) yields between rotation systems, and found yields to be highest in the most diverse crop rotations. However, if a diverse rotation was also grazed, these high yields could be sustained at reduced herbicide and fertiliser rates. Integrating livestock into diverse crop rotations therefore has strong potential to improve weed management and environmental sustainability in no-till systems.

Keywords: weed management; crop rotation; crop diversity; grazing; integrated livestock; spring wheat