TempAg; An international Research Consortium for Sustainable Agriculture in Temperate Regions

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Summary

TempAg is an international research network for national governments involved in agricultural research in temperate climates comprising ten countries. The aim of the network is to deliver resilient agricultural production systems at multiple levels. This includes specific focus on: i) optimising land management to produce food and other ecosystem services at the landscape level; and ii) sustainable food production at the farm/enterprise level. The consortium has launched three pilot activities to start its ambitious programme. These are: i) a survey of experts and the literature to identify concepts of sustainability, how it is currently measured and which indicators are important; ii) a stocktaking exercise to overview ecosystem services to and from different agricultural production systems and in different scales; and iii) a modelling exercise to identify the reasons for yield gaps (i.e. actual farmers yields as opposed to potential yields under optimal management) and determine ways in which these might be closed.

Initial assessments show that over the last two decades a multitude of frameworks, metrics and tools have been developed to characterise agricultural sustainability. The majority of frameworks were focused at farm scale, largely for use for farm development with indicator scores were aggregated in many to produce an integrated sustainability assessment. It was noteworthy that almost all of the ISAs implemented by farmers were associated with a specific commercial or certification context. A separate study showed that there was no consensus among individual experts about what constitutes reliable knowledge and useable datasets, and thus how agricultural sustainability might best be measured or expressed by indicators.

Assessments of ecosystem services is at an early stage but work to date indicates few studies where multiple services have been quantified simultaneously in agroecosystems. An expert-based survey of yield gaps indicated that nutrient management was the overriding factor that largely explained crop yield and yield gaps. In some countries environmental legislation is putting barriers to the amount of nutrients that can be used, causing some degree of yield gap, while in other countries it is more an issue of lack of resources.

Introduction

TempAg is an international research network for national governments involved in agricultural research in temperate climates. Following preliminary support by the OECD, the network was launched in April 2015. Membership is by country with each national government represented by a lead organisation for that country. The membership on 1 June 2016 was Belgium, Finland, France, Germany, Netherlands, New Zealand, Norway, Sweden, Switzerland and United Kingdom, with the OECD as an associate member.

The network seeks to increase the impact and return on the investments that members make in their national research programmes. TempAg's activities aim to enable communication between, and coordination of, existing and new research and technology as well as identify areas of research relevant to scientists and policymakers alike that are currently not addressed at an international level. The overarching goal of the network is to deliver resilient agricultural production systems at multiple levels. This includes specific focus on: i) optimising land management to produce food and other ecosystem services at the landscape level; and ii) sustainable food production at the farm/enterprise level.

Temperate agricultural systems include a number of characteristics that distinguish them from tropical systems including: 1) seasonality, leading to well-defined operations and growing periods and seasonally-dependent pest and disease incidence (although some tropical areas may also share some such seasonal characteristics); 2) less weathered soils, with different fertility characteristics and slower soil organic matter dynamics; 3) substantial inputs of fertilisers, agrochemicals or mechanisation in different combinations; 4) substantial investment by the private sector favouring investment in "high-value" crops such as wheat, soya, oil seed rape (canola), maize (corn) and potato, and in improved grasslands, and 5) globally the highest yields (mainly due to 2, 3 and 4).

The consortium has launched three pilot activities to start its ambitious programme. These are: i) a survey of experts and the literature to identify concepts of sustainability, how it is currently measured and which indicators are important; ii) a stocktaking exercise to overview ecosystem services to and from different agricultural production systems and in different scales (including livestock and orchards as well as cropping systems); and iii) a modelling exercise to identify the reasons for yield gaps (i.e. actual farmers yields as opposed to potential yields under optimal management) and determine ways in which these might be closed.

In this paper we focus on the highlights of the on-going study of indicators of sustainability (see Wustenberghs et al., 2015 and de Olde et al., 2016 for full details) and briefly outline progress of the other two activities.

Indicators of sustainability

The question underlying this activity is 'How can sustainability frameworks, metrics and tools and their implementation be enhanced to futureproof agricultural decision-making at multiple levels on multiples scales?’ Over the last two decades a multitude of frameworks, metrics and tools have been developed to characterise agricultural sustainability aimed at a variety of potential end users. TempAg has promoted activity to determine what methodologies are currently being used, how they came into being and the relations between assessment method and purpose.

Wustenberghs et al. (2015) assessed 170 different frameworks and found that 53 of them were specific to temperate agriculture with all 53 having social, economic and environmental components; some also incorporated either cultural or governance elements or both. An email survey of those who had developed the frameworks produced 38 responses from which it was possible to ascertain some common features of content and users. The majority of the respondents had developed frameworks that were focused at farm scale (70%), largely for use for farm development (59%). Most had end users involved from the start and, for those that did, the type of indicators included tended to be quite broad and small in number. Typically, indicator scores were aggregated to produce an integrated sustainability assessment (ISA) with 41% of the ISAs using weighting of indicator scores before aggregation.

The ISAs produced have been implemented in several ways. Only 10% had definitely not been implemented (with an additional 10% where the outcome was unknown) with about one-third of those that had been implemented used only within the project for which they were developed. It was noteworthy that almost all of the ISAs implemented by farmers were associated with a specific commercial or certification context.

TempAg has also encouraged work that examines the motives and criteria underpinning the selection of indicators of sustainability (de Olde et al., 2016). As shown in the study by Wustenberghs et al. (2015), a large number of indicators has been proposed in the many frameworks for assessing sustainability raising questions about their validity and usefulness, and the trust that can be placed in them. De Olde et al. (2016) asked two groups of experts, comprising 38 respondents, to rank the relative importance of eleven criteria for selecting individual sustainability indicators and of nine criteria for balancing a collective set of indicators; agreement on such matters is important if the selection, weighting and aggregation of criteria is to gain widespread acceptance. The survey found no consensus among the individual experts about what constitutes reliable knowledge and useable datasets, and thus how agricultural sustainability might best be measured or expressed by indicators.

A conclusion of this work is that the transparency, relevance and robustness of sustainablility assessments could be substantially improved if the context of the assessment and the prioritization of the selection criteria for indicators were more openly selection accounted for in, for example, a collaborative design process (de Olde et al., 2016). Such a process could start by recognizing how sustainability is operationalized in different contexts, and at different scales and levels. Participation in the process by which indicators and sustainability assessment tools are established may prove a more important determinant of their success than the final shape of the assessment tools. Such an emphasis on process would make assessments more transparent, transformative and enduring.

Progress with ecosystem services and yield gaps

TempAg's two other pilot activities focus have focused on the multifunctionality of land use as expressed through assessments of ecosystem services, and on the assessment of yield gaps.

Ecosystem services

The ecosystem activity is reviewing: i) which ecosystems have been most studied, both those obtained from agriculture and those delivering services to agriculture; ii) what combinations of services have been studied together to address multi-functionality and synergies or trade-offs; and iii) which agri-ecosystems (e.g. grasslands, cereals) have been studied with an ecosystem approach. The work to date has largely involved data mining of the scientific literature.

Text analysis and a web search found 2,800 papers had mentioned ecosystem services. From these 10% were selected, abstracts read, and papers classified into studies relevant and non-relevant to agriculture. Further analysis distinguished between those that implicitly assess ecosystem services based on broad scale indicators/proxies and those that contain quantitative measures of ecosystem services in agricultural studies and examine production functions; only a few papers have been found to contain studies of production functions.

Preliminary analysis of the surveys to date indicates that the research community is fragmented with little communication between groups. Moreover, very few projects have analysed multiple ecosystem services; most studies have examined only one service, some have explored two or three services, while the maximum was 34. Most studies have assessed ecosystem services employing proxies for broad scale indicators. A large number of these proxies mention the importance of landscape, but only by proxy, rather than using a clear measure. Finally, making assessments using production functions is a topic that could lead to policy advice could be provided, but this approach is rare.

Yield gaps

This activity has been advanced through two complementary work packages: the first uses local crop, weather and soil data to model crop growth and yield and then scales up to a national level; the second has used a semi-quantitative survey that has been responded to by 11 countries.

The modelling activity has mainly been with cereal crops. The initial selection of data is often from locations based on hotspots of crop production which are then modelled and results verified at various local points and then again at national level. Work has been completed for several European countries and is being extended to include Uruguay, USA, Ukraine and Australia.

The purpose of the survey was to explain crop yields, crop yield gaps and, to a certain extent, resource use efficiency, examining factors that directly influence crop yields and crop management factors combined with physical conditions such as soil and climate. The semi-quantitative survey received assessments for 17 wheat, 13 barley, and 8 maize crops. The detailed results can be found in López Porrero (2016), but crop management was regarded as the most important factor explain yields that were less than the potential yield. Nutrient management was overriding factor that largely explained crop yield and yield gaps. In some countries environmental legislation is putting barriers to the amount of nutrients that can be used, causing some degree of yield gap, while in other countries it is more an issue of lack of resources.

Concluding remarks

The work of all three activities is ongoing and will be added to following a stakeholder workshop planned for October 2016 in London. Current plans include: 1) Exploration of how the topic of integration and normalization of sustainability indicators used by different stakeholders might fit with the other two activities; 2) Tabulation of which ecosystem services have been studied together in agroecosystems followed by examination of trade-offs, synergies and clusters. There will be consideration of ecosystem disservices and how they should be treated together with how human inputs might best be related to ecosystem services in agriculture; and 3) Continued refinement of yield gap analysis by expansion to considerations of efficiency of resource use and technology gaps, based on a recently developed method, plus expansion of work on trade-off analysis for food production, yield gaps, resource use efficiency and and environmental impacts. The latter will involve estimating resource use efficiencies not just for land and water but also for nutrients, greenhouse gasses, energy and labour.

References

de Olde, E.M. et al. (2016). When experts disagree: the need to rethink indicator selection for assessing sustainability of agriculture. Environmental Development and Sustainability. DOI 10.1007/s10668-016-9803-x.

López Porrero, E.J. (2016). Explaining yield gaps of cereals in temperate regions using an expert-based survey. MSc Thesis, Wageningen University.

Wustenberghs, H., Coteur, I., Debruyne, L. and Marchand, F. (2015). TempAg Pilot Activity 1.1.1. Survey of Sustainability assessment methods. ILVO, Merelbeke, Belgium.