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Towards a broad-based and holistic framework of Sustainable Intensification indicators

N. Mahon[a], I. Crute[b], M. Di Bonito[a], E.A. Simmons[c], M.M. Islam[a,*]

[a] School of Animal, Rural and Environmental Sciences, Nottingham Trent University, Brackenhurst, Southwell, Nottingham NG 25 0QF, UK
[b] Agriculture & Horticulture Development Board, Stoneleigh Park, Warwickshire, UK
[c] Nottingham Trent University Directorate, 50 Shakespeare Street, Nottingham, Nottinghamshire, UK

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ABSTRACT

The concept of 'Sustainable Intensification' (SI) has been promoted as a potential solution to the many contemporary challenges facing agriculture, but has also received widespread criticism for being too narrow in scope and failing to address all aspects of sustainability. Despite this, there are few suggestions in the literature as to what a holistic, broad-based approach to SI should comprise and what issues and trade-offs are likely to arise in the adoption and operation of such a broadly-based approach. We report a suit of SI indicators suggested by UK stakeholders, evaluate the plausibility of these in terms of the commonly established principles of sustainability, and identify the critical issues that may arise in the adoption and operation of these indicators. The purpose of this paper is not to recommend a specific blueprint for SI but to raise issues and questions for dialogue amongst stakeholders. Data were collected via semi-structured interviews with 32 stakeholders from throughout the UK agrifood system. The data were analysed thematically and organised using a Social-Ecological Systems (SESs) framework. The interviewees suggested a total of 110 SI indicators, of which the most frequently suggested related to agricultural production and ecological considerations. There was less emphasis placed on social and cultural dimensions of agricultural systems. A number of the indicators suggested were poorly-defined and it was difficult to determine what particular aspects of sustainability they addressed. Many potential trade-offs between the indicators were also evident. The findings raise a number of questions. Is it appropriate to continue referring to SI as *Sustainable* Intensification when it fails to give equal consideration to all accepted aspects of sustainability? Would it be more appropriate to refer to the SI concept as 'Ecological Intensification'? Is a broad-based and all-encompassing definition of 'sustainability' always desirable, or should 'sustainability' be considered as context specific, with the weighting of the different dimensions varying according to operational circumstances? We argue that these questions need to be resolved through stakeholder dialogues in order for the concept of SI to become more widely accepted and implementable in practice.

1. Introduction

Contemporary agriculture is facing multiple, competing expectations. On the one hand, it is expected to produce more for a growing global population amidst increasingly scarce natural resources and the challenges of climate change (Beddington, 2009; Godfray et al., 2010; Hunter et al., 2017). On the other hand, it must also be more sustainable (Altieri, 2004; Hoffmann, 2011; National Research Council and National Research Council, 2010; Pretty et al., 2008; Royal Society, 2009; Tilman et al., 2002; Whitfield et al., 2015). However, many argue that the quest for increased production may not be compatible with the goals of sustainability (Gliessman, 2014; Godfray, 2015; Loos et al., 2014).

The concept of 'Sustainable Intensification' (SI) has been posited by some as a solution to the above challenges (Pretty, 1997; Sutherland et al., 2015; Vanlauwe et al., 2014). It is viewed by some as a *third paradigm* of global agricultural development (Islam et al., 2013; Jordan and Davis, 2015). This paradigm is thought to represent a middle way between, on one hand, 'industrial agriculture', typified by the use of monocultures of high-yielding crops and livestock and the extensive use of agrochemicals and farm machineries (Douthwaite et al., 2003; International Food Policy Research Institute, 2002); and on the other hand, 'alternative agriculture', characterised by localised, small-scale systems, based on agroecological principles and the use of minimal, or

* Corresponding author.
E-mail addresses: niamh.mahon@ntu.ac.uk (N. Mahon), Ian.Crute@ahdb.org.uk, ian.crute@icloud.com (I. Crute), marcello.dibonito@ntu.ac.uk (M. Di Bonito), eunice.simmons@ntu.ac.uk (E.A. Simmons), mofakkarul.islam@ntu.ac.uk (M.M. Islam).

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no external inputs (Altieri, 2004; Pimentel et al., 2005; Pretty, 1995; Raynolds, 2000; Vandermeer, 1995). Since its inception in the nineties (Pretty, 1997), SI has attracted diverse stakeholders, including: national governments (DEFRA SIP, 2016, 2015), policy think tanks (Foresight, 2011; Royal Society, 2009), intergovernmental organizations (FAO, 2011; World Bank et al., 2013), research institutes (Buckwell et al., 2014; The Montpellier Panel, 2013), and transnational agribusinesses (Syngenta foundation for sustainable agriculture, 2016).

Nevertheless, SI has become a contested concept with regard to its precise meaning, means of implementation, and desired outcomes (Garnett and Godfray, 2012; Mahon et al., 2017). Reviews of these debates (Bernard and Lux, 2017; Campbell et al., 2014; Gliessman, 2014; Godfray, 2015; Loos et al., 2014; Petersen and Snapp, 2015) suggest that the most contentious aspect of SI is the *sustainability* dimension. Whilst some – e.g., the UK Royal Society and the Foresight report on food and farming – define SI as producing more from the same area of land while reducing the environmental impacts of agriculture (Foresight, 2011; Royal Society, 2009), others express concerns that this definition is too narrow and does not adequately address the social dimensions of sustainability. Many civil society organisations are therefore sceptical (Collins and Chandrasekaran, 2012; Cook et al., 2015). These authors argue that SI favours the powerful to the detriment of smallholder farmers and the wider public (Collins and Chandrasekaran, 2012; Cook et al., 2015; Lewis-Brown and Lymberry, 2012). Others label SI as an "oxymoron", stating that *intensification* is not compatible with *sustainability* (Lewis-Brown and Lymberry, 2012: 1). Similarly, a recent review (Mahon et al., 2017) of SI indicators finds that the social dimensions are under-represented in the global literature. Loos et al. (2014) mention that the term SI is a misnomer, as its current productivist interpretation does not engage with established principles of sustainability. Gliessman (2014) concludes that there is a need for a holistic approach to SI by integrating agronomic and ecological sustainability with social, economic, and cultural sustainability.

Despite such criticisms and expectations, there are few suggestions as to what holistic, broad-based approaches to SI might look like and what issues and trade-offs would arise in the adoption and operation of such approaches. The issue of trade-offs is especially important since *sustainability* itself is a highly contested term, often involving compromises between its components (Ayres et al., 1998; McShane et al., 2011). Moreover, debates about what SI should or should not be have largely been top-down, reflecting a multitude of individual opinions. Attempts to contextualise such debates based on the opinions of multiple stakeholders are rare. A bottom-up and stakeholder-sensitive approach is important, since insights from agency-oriented sustainability transition theories (see Geels, 2010) suggest that the absence of a shared vision among key stakeholders may hamper successful transitions to sustainability. This is especially true for concepts that are ambiguous and contested, as is the case of SI.

In this paper we intend to:

- apply a holistic, systems framework to identify the indicators of SI from the viewpoints of UK stakeholders;
- evaluate the plausibility of the indicators in terms of the commonly established principles of sustainability; and
- identify the critical issues that may arise in the adoption and operation of the suggested indicators.

The purpose of this paper is not to recommend a particular blueprint for SI but to raise issues and questions for dialogue among stakeholders.

2. Analytical framework and methods

In the literature, SI indicators have been considered largely based on limited aspects of agriculture, in particular, '*outcomes*' (Mahon et al., 2017). Such approaches can be of limited use from a policy point of view. Although it is important to identify expected outcomes from agricultural systems (e.g., increased crop yield), it is equally important to understand the *processes* (e.g. use of hybrid crop varieties, application of agrochemicals, etc.) required to produce such outcomes, as well as the *conditions* (e.g. soil fertility, water availability, etc.) under which such processes may be applicable. This necessitates the development of a holistic, systems-based approach. Such thinking is not new in agriculture, e.g., the Farming Systems Research (FSR) approach came to prominence in the 1970s (Bawden, 1995; McCown, 2001; Norman, 1978; Simmonds, 1985). However, agricultural systems have traditionally been conceptualised as ecological systems, e.g., crop systems modelling (Holzworth et al., 2014; Jones et al., 2003; Keating et al., 2003; Stöckle et al., 2003, 2014), with little consideration of the social elements. Nevertheless, there are increasing calls for other dimensions of to be given consideration (Prokopy et al., 2008; Willock et al., 1999b).

In order to capture UK stakeholder prescriptions of SI indicators we conceptualised agricultural systems as Social-Ecological Systems (SESs) and applied an adapted version of an SES framework developed by Ostrom and colleagues (McGinnis and Ostrom, 2014; Ostrom, 2007, 2009; Ostrom and Cox, 2010) to guide data collection and analysis. This framework states that the complex outcomes of SESs (e.g., sustainability and equity) are the function of both the ecological and the human components, and the interactions between these components (Ostrom, 2007, 2009; Vogt et al., 2015). Although this framework was devised primarily for the investigation of common-pool resources, e.g., forests and fisheries (Anderies et al., 2004; Basurto et al., 2013; Hinkel et al., 2015; Nagendra and Ostrom, 2014), it has been applied to agricultural systems as well (Halliday and Glaser, 2011; Hanspach et al., 2017; Lescourret et al., 2015; Mahon et al., 2017).

In Ostrom's framework, SESs are conceptualised as comprising seven sub-systems (Fig. 1). The 'Resource System', e.g., a designated national park, or a demarcated fishery (Ostrom et al., 2007; Ostrom, 2009), comprises the characteristics of the SES as a whole, e.g., its predictability and location (Ostrom, 2009). It is suggested that more predictable systems are more sustainable, as users are more able to estimate how much of a resource can be extracted each year (Ostrom, 2009). The 'Resource Units' meanwhile are the individual variables that make up the 'Resource System' (Basurto et al., 2013). These include the biotic components (e.g., individual plants and animals), abiotic components (e.g., the volume and flow of water within a river), and their characteristics (e.g., growth rate and economic value) (Ostrom, 2009). It is suggested that a high degree of knowledge of the Resource Units is required for sustainable harvesting (Ostrom et al., 2007). Together,

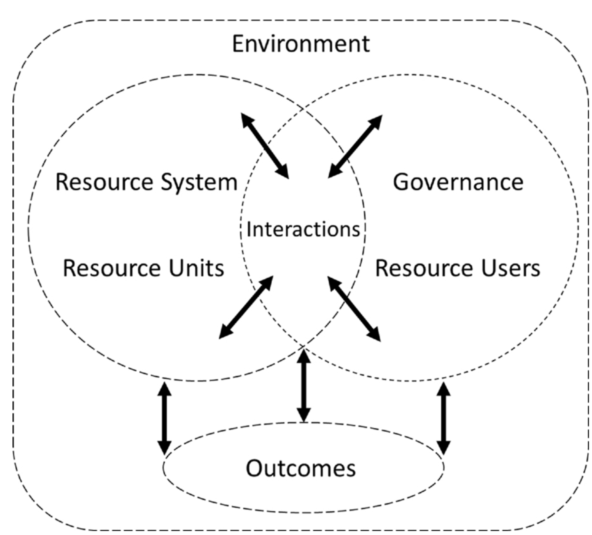

Fig. 1. A diagrammatic representation of the SES framework (adapted from Ostrom, 2009).