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# Frontiers in Ecology and the Environment

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# Putting meaning back into “sustainable intensification”

Jacqueline Loos<sup>1</sup>, David J Abson<sup>2</sup>, M Jahi Chappell<sup>3,4</sup>, Jan Hanspach<sup>1</sup>, Friederike Mikulcak<sup>1</sup>, Muriel Tichit<sup>5</sup>, and Joern Fischer<sup>1\*</sup>

In light of human population growth, global food security is an escalating concern. To meet increasing demand for food, leading scientists have called for “sustainable intensification”, defined as the process of enhancing agricultural yields with minimal environmental impact and without expanding the existing agricultural land base. We argue that this definition is inadequate to merit the term “sustainable”, because it lacks engagement with established principles that are central to sustainability. Sustainable intensification is likely to fail in improving food security if it continues to focus narrowly on food production ahead of other equally or more important variables that influence food security. Sustainable solutions for food security must be holistic and must address issues such as food accessibility. Wider consideration of issues related to equitable distribution of food and individual empowerment in the intensification decision process (distributive and procedural justice) is needed to put meaning back into the term “sustainable intensification”.

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With a rising human population (projected to exceed 9 billion people by 2050), global environmental change, and changing dietary patterns (with a greater emphasis on meat and dairy consumption), global food insecurity is an emerging threat (Godfray *et al.* 2010). Food security exists when “all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 1996). Several recent high-profile papers (eg Benton *et al.* 2011; Tilman *et al.* 2011; Mueller *et al.* 2012) and policy documents (eg FAO 2011; Foresight 2011) have proposed “sustainable intensification” as one potential measure to address food security. Sustainable intensification, as currently framed,

seeks to achieve food security through an increase in production, while minimizing negative environmental impacts and avoiding the expansion of land used for cultivation (Godfray *et al.* 2010; Garnett and Godfray 2012).

Although the proposed “win–win” scenario of more food for more people with less impact on the environment is attractive, a major concern is the missing balance between “sustainable” and “intensification” (Garnett and Godfray 2012). Despite using the term “sustainable”, few advocates of sustainable intensification thoroughly engage with the goals and processes associated with sustainability. Although the concept of sustainability has many facets and interpretations (Panel 1; Lélé 1991; Kuhlman and Farrington 2010), there is broad agreement that it encompasses not only environmental integrity but also human well-being. Given the fundamental importance of food for human well-being, ensuring food security is an inherent objective of sustainability.

We argue that the current usage of the term “sustainable intensification” is potentially misleading because it inadequately addresses the central tenets of sustainability. In this paper, we: (1) highlight critical shortcomings in the definition of sustainable intensification that limit its ability to foster food security and sustainability, and (2) call for a more holistic characterization and assessment of sustainable intensification, including explicit regard for distributive and procedural justice.

## In a nutshell:

- In its current use, the term “sustainable intensification” is often weakly and narrowly defined, and lacks engagement with key principles of sustainability
- Without specific regard for equitable distribution and individual empowerment (distributive and procedural justice), agricultural intensification cannot legitimately claim to be “sustainable” nor does agricultural intensification address issues of food security
- Food security can be achieved only through a holistic agenda that looks beyond production, targets appropriate spatial and temporal scales, and considers regional conditions

## ■ Shortcomings in the current framing of sustainable intensification

### *Inappropriate terminology*

As currently defined, sustainable intensification fails to address key aspects of sustainability. It is widely agreed

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### Panel 1. Definitions and history of sustainable development, sustainability, intensification, and sustainable intensification

Sustainable development and sustainability are often used as synonyms (Wu 2013) and both have various interpretations. The most widely accepted definition of *sustainable development* considers it to be development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987). Although this broad conceptual definition has led to many different operational definitions, most mainstream interpretations agree on the need to balance human development with environmental integrity. Central to *sustainability* is the maintenance of resources over time (Kuhlman and Farrington 2010), in order to ensure that future generations have access to at least the same level of resources (intergenerational justice) as the current generation (Pearce 1988). Here, we consider sustainable development as the process of moving toward sustainability.

*Intensification* of agriculture is the process of raising the yield output of land. Raising yields can be achieved by either expanding agricultural land or increasing the intensity of cropping in existing fields (Boserup 1965). Expanding land for agricultural purposes is undesirable in the context of biodiversity conservation. For this reason, increasing intensity of use within existing fields has been proposed as a more sustainable way of meeting rising demand for food. Conventionally, intensification has been achieved by shortening crop rotations and fallow times, using irrigation and agrochemicals, planting higher-yielding crop varieties, and introducing mechanization. These activities typically have negative environmental consequences. Alternatively, agro-ecological intensification focuses on “natural means” of increasing outputs, for example by incorporating legumes into fields or using agroforestry techniques.

Originating from sub-Saharan agriculture in the 1990s, the term *sustainable intensification* was used to describe the aim of raising agricultural yields while also benefiting the environment and the economy (Pretty 1997). This original definition emphasized local knowledge and the development of adaptive agricultural methods suited to local conditions. The participation of smallholder farmers was considered crucial for the development and extension of more productive technologies (Pretty 1997). A wide range of bottom-up, integrated methods and technologies were used to conserve water and soils, and to manage nutrient flows and pests. In its original formulation, sustainable intensification focused on building adaptable farming systems that support the livelihoods of the rural poor.

More recent framings of sustainable intensification have moved away from local approaches and instead focus on efficiency enhancement (Lang and Barling 2012), often at a global or national scale (eg Mueller *et al.* 2012). The main argument to promote sustainable intensification is the observation that a growing, wealthier human population is demanding more agricultural products. Current mainstream literature on sustainable intensification tends to focus on aggregate levels of food production rather than on patterns in the distribution and consumption of food.

that sustainability encompasses ecological, economic, and social concerns; considers intra- and intergenerational justice; and aims to maintain and improve human well-being from local to global scales (Panel 1; WCED 1987; Lélé 1991; Johnston *et al.* 2007). Yet the existing characterization of sustainable intensification primarily focuses on minimizing environmental impacts, and does not demonstrate how increased food production will improve human well-being – a crucial oversight given existing gaps between producing food for and providing food security to people (Chappell and LaValle 2011). This framing threatens to reduce the term “sustainable intensification” to a meaningless catch phrase that lacks theoretical rigor and is unable to provide practical guidance for achieving sustainability. Such careless use of the term “sustainable” could lead to misinterpretation or misuse in the context of environmentally destructive activities (Kates *et al.* 2005).

Rather than a simple focus on minimizing environmental impacts, sustainability can be conceptualized in terms of intra- and intergenerational *distributive justice* – ensuring a socially just allocation of resources within and between different generations (Lélé 1991; Langhelle 2000). Moreover, sustainability requires fair and transparent decision-making processes that are adaptable to specific local conditions. Hence, *procedural justice* – the participatory governance by and empowerment of individuals, communities, and societies to decide how their needs are met – forms an additional pillar of sustainability (Agyeman and Evans 2004).

### *Inadequate treatment of ecological sustainability*

In its current usage, sustainable intensification seeks to address ecological sustainability – that is, “the existence of the ecological conditions necessary to support human life at a specified level of well-being through future generations” (Lélé 1991) – primarily by minimizing the amount of land under agricultural production. By contrast, the consequences of intensifying agro-ecosystems have received less attention. For example, the targeted use of fertilizer has been proposed as part of a strategy for sustainable intensification (Tilman *et al.* 2011; Mueller *et al.* 2012), with the implicit assumption that yield gaps can be closed with little or no adverse impact on ecosystems. However, in some systems, even minimal fertilizer application could pose a severe threat to biodiversity (eg parts of Eastern Europe; Figure 1). Other aspects of intensification, including soil compaction, overuse of groundwater, or increasing application of broad-spectrum pesticides, could also degrade the multiple services and long-term ecological sustainability of low-intensity farming systems (Hector and Bagchi 2007; Maestre *et al.* 2012). While some recent work addresses these issues by specifically focusing on agro-ecological intensification (eg Bommarco *et al.* 2013), a coherent framework to assess the long-term impacts of different types of intensification is presently lacking.

### *Lack of attention to justice*

The current manner in which sustainable intensification is framed also fails to consider justice, a fundamental

component of sustainability (Hopwood *et al.* 2005). Food insecurity does not primarily stem from a lack of food production, but from a lack of access to food caused by the disempowerment of the world's poor (Sen 1982; Chappell and LaValle 2011; De Schutter 2012). In many cases, food security could be enhanced without intensification, through improvements to justice. Increasing demand for food (which sustainable intensification seeks to address) disproportionately represents the wants of those with the financial resources to influence food markets, but greatly underrepresents the needs of those who are the most food insecure (Khan 1985). Although agricultural intensification does not necessarily imply a specific method to achieve higher yields, some of the most obvious interventions – such as the use of irrigation, agrochemicals, and modern machinery – are investment intensive. Without explicit regard to justice, there is a risk that certain types of supposedly “sustainable” intensification could lead to the dispossession of (capital poor) smallholder farmers, who represent the “true safeguards of global food security” (Tschardt *et al.* 2012). For example, intensification can make previously marginal agricultural land economically profitable, creating an incentive for landowners to evict subsistence tenant farmers and grow crops for sale on international markets (Shiva 1991).

### **Lack of attention to regional conditions**

Global analyses of sustainable intensification have largely dismissed potential problems that intensification might cause regionally. Although useful in identifying the limits of global food production within the bounds of existing agricultural land, such analyses cannot generalize people's needs, which vary between different cultures and regions. Moreover, global analyses obscure a range of services beyond the production of food that agricultural landscapes may provide (eg cultural ecosystem services). Clearly, yield gains are important for food security in some regions, such as parts of sub-Saharan Africa (Pretty *et al.* 2011). Yet, in other regions, such as Eastern Europe (Figure 1), it is unclear how increasing yields would serve to offset hunger worldwide. If food security is the ultimate goal, regional approaches are needed that consider the multifunctionality of agricultural landscapes, and that focus on places where people are genuinely threatened by food insecurity.

### **Missing links to other elements of food security**

In its current mainstream use, sustainable intensification is poorly integrated with a broader set of documented strategies to improve food security. Many authors advocating sustainable intensification acknowledge the im-



**Figure 1.** A landscape in Transylvania, Romania. In this region, intensification is possible because of the presence of yield gaps, but it would undermine the long-term provision of other ecosystem services such as carbon storage and the build-up of nutrient pools. Intensification very likely would not benefit those in need of greater food security.

portance of other factors contributing to food insecurity, including gender inequality, food waste, poverty, and lack of power to access food (Godfray *et al.* 2010; Foley *et al.* 2011; Garnett and Godfray 2012; Mueller *et al.* 2012). However, there is a danger in assuming (implicitly or otherwise) that the multiple variables that influence food security are additive or independent, or that intensification is a useful goal, regardless of the state of these other confounding variables (Figure 2a; Hanspach *et al.* 2013).

### **Possible solutions**

Reductions in food waste and more equitable distribution of existing food are logical first steps to improve food security. In those locations where agricultural intensification is necessary, whether such intensification is “sustainable” needs to be judged against a framework that explicitly considers key principles of sustainability.

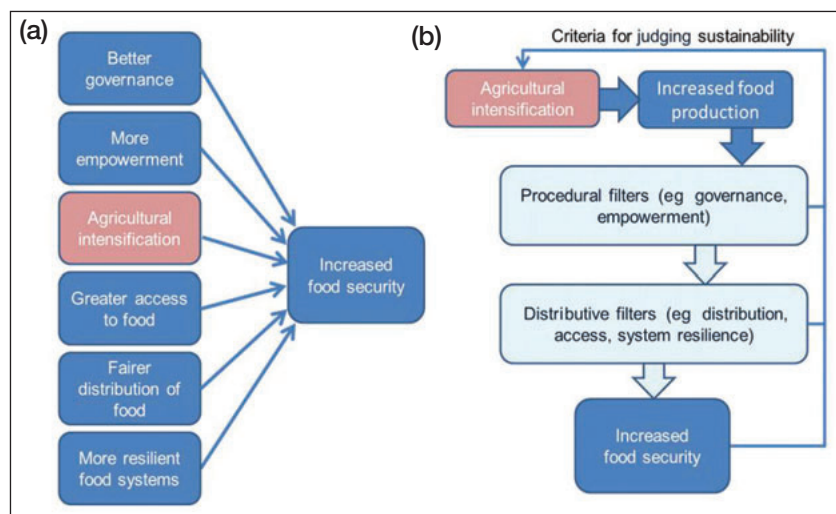
### **Distributive justice and sustainable intensification**

From the perspective of distributive justice, a coherent approach to sustainable intensification requires (1) adequate and equitable access to food within the current generation; (2) acknowledgment that heterogeneous, multifunctional agro-ecosystems meet more needs than simply the provision of food; and (3) maintaining the multifunctionality of agro-ecosystems for future generations.

### **Adequate and equitable access to food**

Distributive justice requires an explicit focus on the allocation of food, which in turn requires addressing issues of





**Figure 2.** Contrasting ways to conceptualize the role of intensification for food security. (a) Conventional view of several variables influencing food security, implying that variables are independent and additive (additional variables may be considered important by some authors). (b) Alternative view, highlighting interactions and conditionality, with increased production increasing food security only if it passes through filters of distributive and procedural justice. According to this view, intensification can only be said to be sustainable if it successfully passes through these filters.

power and food distribution. Food security must satisfy the “needs” of all people (FAO *et al.* 2012) but not necessarily all food “wants” – such as those related to the desire for a diet rich in animal proteins. Increased food production is not a guarantee of increased food security (Chappell and LaValle 2011; Sumberg 2012). Current literature on sustainable intensification often notes distributional issues but rarely addresses them in depth (eg Mueller *et al.* 2012). Such cursory treatment of food distribution implies that changes in food production can be meaningfully separated from issues of power and justice when addressing food insecurity. Yet land-use changes are inextricably linked to the multiple social and political contexts within which they occur (Turner and Robbins 2008). In the context of food security, food production and food distribution cannot be meaningfully analyzed separately. We believe a more appropriate way to conceptualize food security is to recognize that there are a series of filters that determine the extent to which intensification is sustainable and contributes to greater food security. That is, unless it meets the demands of both distributive and procedural justice, increased food production cannot be described as sustainable (Figure 2b).

#### *Multiple functions of agro-ecosystems*

Beyond the allocation of food, distributive justice also needs to be considered for other socially valued goods and services associated with multifunctional agricultural landscapes. An increase in food production does not contribute to sustainability if it erodes other aspects of human well-being (Fish *et al.* 2013). One function of

many traditional agricultural landscapes (other than the provision of food) is biodiversity conservation. Some landscapes characterized by low-intensity agriculture support high levels of biodiversity (Ranganathan *et al.* 2008). Conventional intensification in such landscapes not only negatively affects biodiversity in a given field but also has spillover effects on the wider landscape (Gibbs *et al.* 2009).

Another function of agro-ecosystems relates to their potential cultural value. In some settings, the ongoing persistence of cultural landscapes may be desirable from an ecological as well as a sociocultural perspective. Often, cultural landscapes represent co-evolved social–ecological systems with high natural and cultural heritage values (Figure 1; Fischer *et al.* 2012). Careful assessment and a thorough understanding of such systems is needed to maintain the indirect, unmanaged, underappreciated, and undervalued ecosystem services (Swinton *et al.*

2007) that intensification may otherwise erode.

#### *Persistence of agricultural landscapes for future generations*

Finally, distributive justice with a focus on future generations requires that agricultural landscapes are not irreparably damaged. To some extent, most agricultural landscapes are resilient to shocks and external inputs, from both social and ecological perspectives. That is, these landscapes are able to buffer and adapt to external influences up to a certain threshold level. However, exceeding such thresholds can cause major changes, known as regime shifts (Folke *et al.* 2004). While not inherently “good” or “bad”, regime shifts are likely to be undesirable in landscapes that are valued for the specific way in which humans and other organisms co-exist there.

Regional analyses of the impacts of yield improvements are required that consider the ability of particular social–ecological systems to persist under more intensive land use. In some regions with high potential for intensification, even moderate intensification (eg through minor increases in nutrient input) would cause severe ecological degradation (Stevens *et al.* 2004; Payne *et al.* 2012; Ceulemans *et al.* 2013), thereby reducing the ability of those systems to provide certain functions to future generations.

#### *Procedural justice and sustainable intensification*

A clear focus on procedural justice regarding where and how to close yield gaps would help identify possible conflicts between intensified production, access to food, and

## Panel 2. The MASIPAG network in the Philippines

The Farmer–Scientist Partnership for Development MASIPAG (Magsasaka at Siyentipiko para sa Pag-unladng Agrikultura) is a network of Philippine rice farmers that illustrates synergies between agricultural intensification and a wider set of aspects that are important for sustainability. The network originated from a bottom-up approach that involved a wide range of farmers working to improve their access to safe, sufficient, and nutritious food, while maintaining farmland in a sound ecological state. The network provides farmers with training facilities and with access to a seed bank containing various traditional, locally developed rice varieties (Figure 3). By giving farmers the freedom to control their own management decisions, the network integrates intra- and intergenerational aspects of sustainability and successfully improves food security for the rural poor (Bachmann *et al.* 2009; Sievers-Glotzbach 2014).

**Figure 3.** Garden of a MASIPAG rice cultivator in the Philippines. This garden contains 84 rice varieties and offers a seed bank for the farmers in the village.



other services from agro-ecosystems that contribute to human well-being. In a food systems context, procedural justice can be characterized in terms of food sovereignty, which Patel (2009) described as calling for “new political spaces to be filled with argument... a call for people to figure out for themselves what they want the right to food to mean in their communities, bearing in mind the community’s needs, climate, geography, food preferences, social mix, and history”, and “the building of a sustainable and widespread process of democracy”. Allowing people to understand and engage in their food choices very likely will improve the sustainability of food systems, because people would be empowered to take control of their own lives – a key objective of sustainability (Panel 2; Lyons *et al.* 2001).

Crucially, concern for procedural justice would help to ameliorate conflicts that may otherwise arise during the course of agricultural intensification. Such strategies may include changes in land tenure, training for farmers, and better education for women. Smith and Haddad (2000) demonstrated a strong link between food security and procedural justice, and found that improved education for women reduced infant malnutrition to a greater extent than maximizing agricultural production.

## Conclusions

Despite its appeal, sustainable intensification as it is currently framed – as a vaguely defined global vision – cannot be a meaningful solution for food security in its own right. It is not our intention to dismiss the notion of sustainable intensification; instead, we are calling for greater engagement with the wider literature on sustainability, food security, and food sovereignty. This suggests moving beyond top-down, global analyses framed from narrow, production-oriented perspectives, and requires revisiting earlier, regionally grounded, bottom-up approaches (Panel 1). Appropriate governance, access, and distribution issues are foundational preconditions for

– not additional concerns of – food security, without which other measures to reduce hunger will remain futile (Figure 2). Therefore, producing more food in an (ecologically and economically) efficient way should be just one of several measures that must be embedded within holistic, regional-scale approaches to food security. Strategies aimed at enhancing food security must move away from a one-sided view that emphasizes narrowly defined land-use efficiency. Instead, these strategies must take into account food systems in their entirety, from production to consumption, including the desires and needs of those who live within and depend upon the multiple functions provided by agro-ecosystems. We suggest that an explicit focus on the notions of distributive and procedural justice in the framing of sustainable intensification would help to better align the term with key principles of sustainability.

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