



RESEARCH
PROGRAMON
Dryland Systems

*Food security and better livelihoods
for rural dryland communities*

Sustainable Intensification: Concept and Challenges from Systems Perspective

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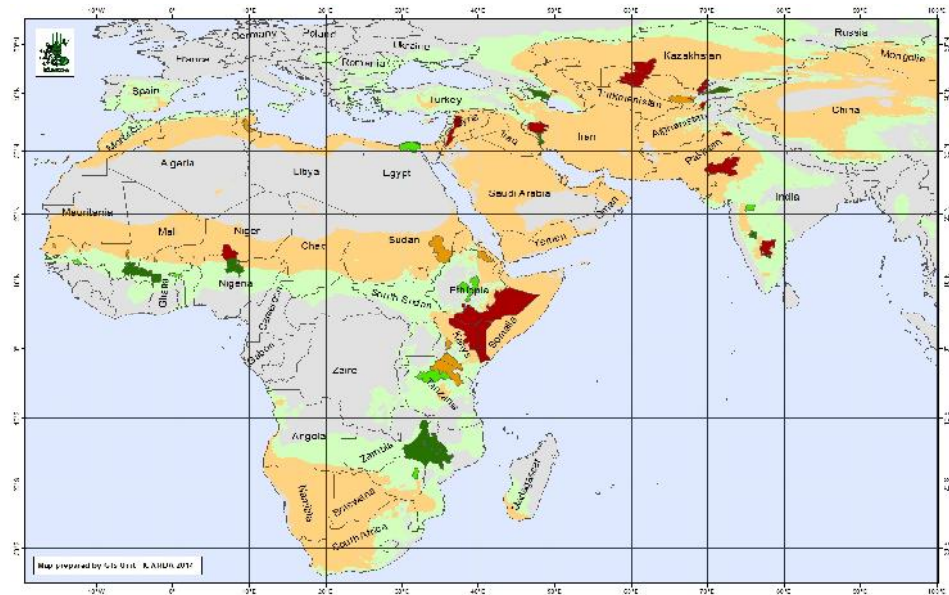
Main points

- Current perceptions of DS on sustainable intensification (SI)
- A view of SI with social-ecological system and resilience perspective
- Methodological perspectives and challenges

CGIAR Dryland Systems

An integrated global research initiative (2012* – 2016) that develops resilient, productive agricultural livelihood systems that reduce hunger and malnutrition, improve the life of the rural poor and conserves the natural resources in drylands.

* Actually started from May 2013, i.e. currently 2-year old program



A Dummy Choice Strategy: EITHER Sustainable Intensification, OR Security

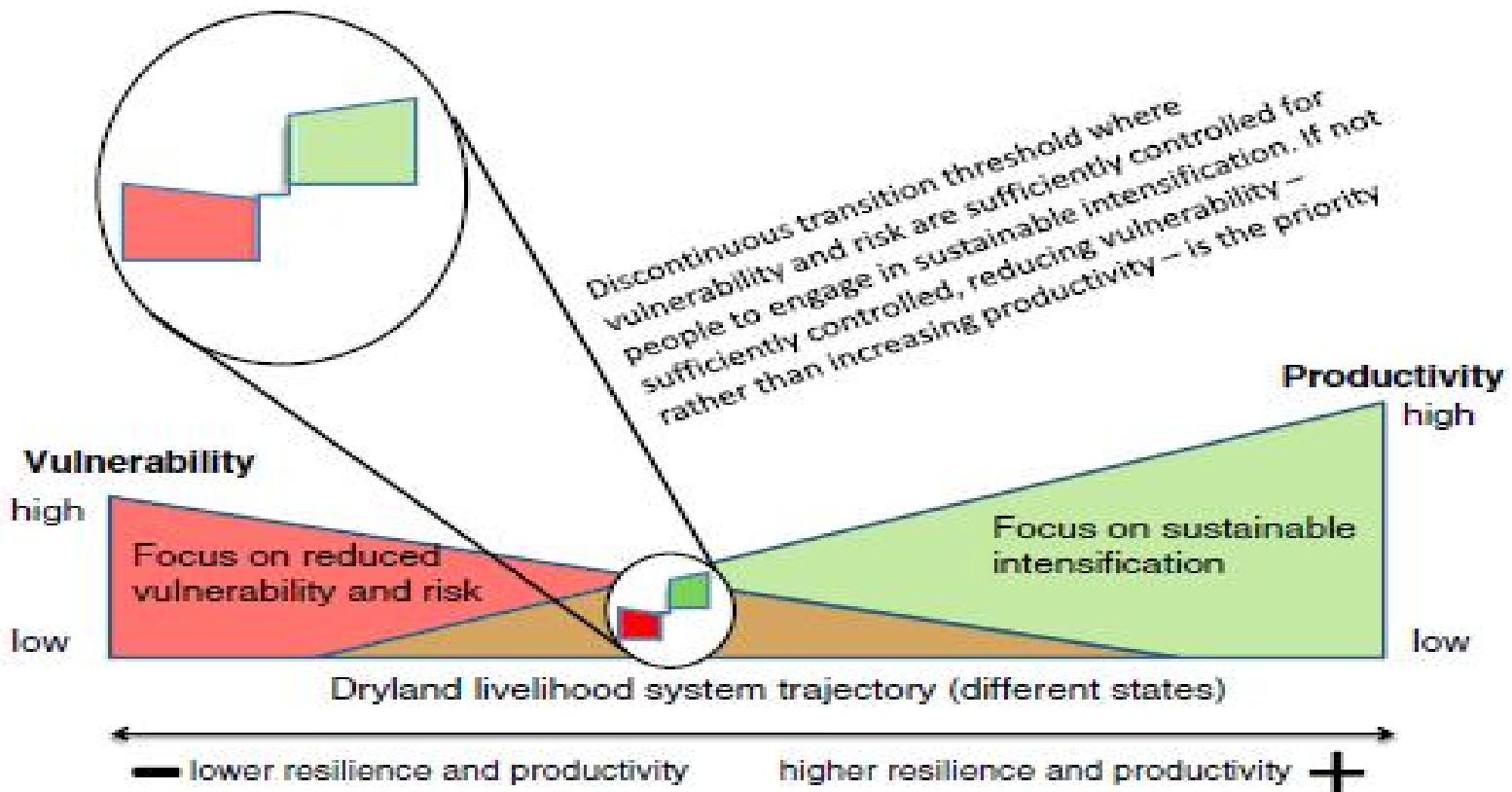


Fig. 1 Focus: reduced vulnerability and risk, or sustainable intensification

Source: Van Ginkel et al. (2013)

The assumption of “Vulnerability – Intensification Potential” continuum in question

L.W. Robinson et al./Agricultural Systems 135 (2015) 133–140

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- NOT allow for the possibility that some forms of intensification can increase vulnerability
- Moving along the continuum is NOT the only pathway out of poverty, i.e. security and intensification can accommodate each other.
 - Dryland: Intensification is NOT necessarily the inverse of extensity or diversification
- Scale/level-sensitive issue

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In (B), reductions in vulnerability only result in increases in intensification once vulnerability has been reduced beyond a certain threshold.

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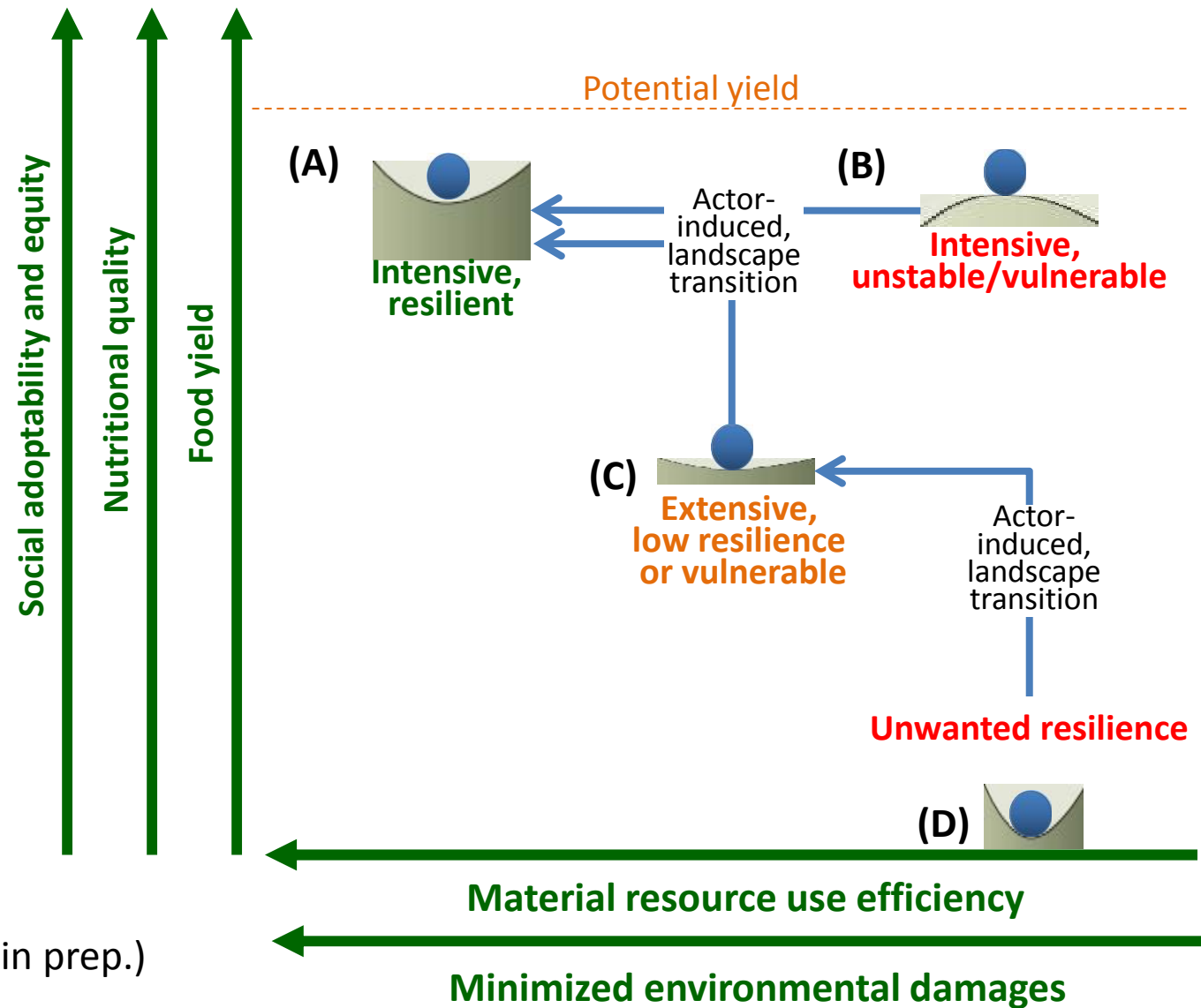
Source: Robinson et al. (2015)

Dimensions mutually defining SI, as a grand goal

- Increased food yield and nutrition quality
- Improved efficiency in material resources uses, minimization of environmental impacts and social adoption
- Resilience of the intensified system to shocks or stresses
- Social equity
- Multi-scale consideration required for all above.

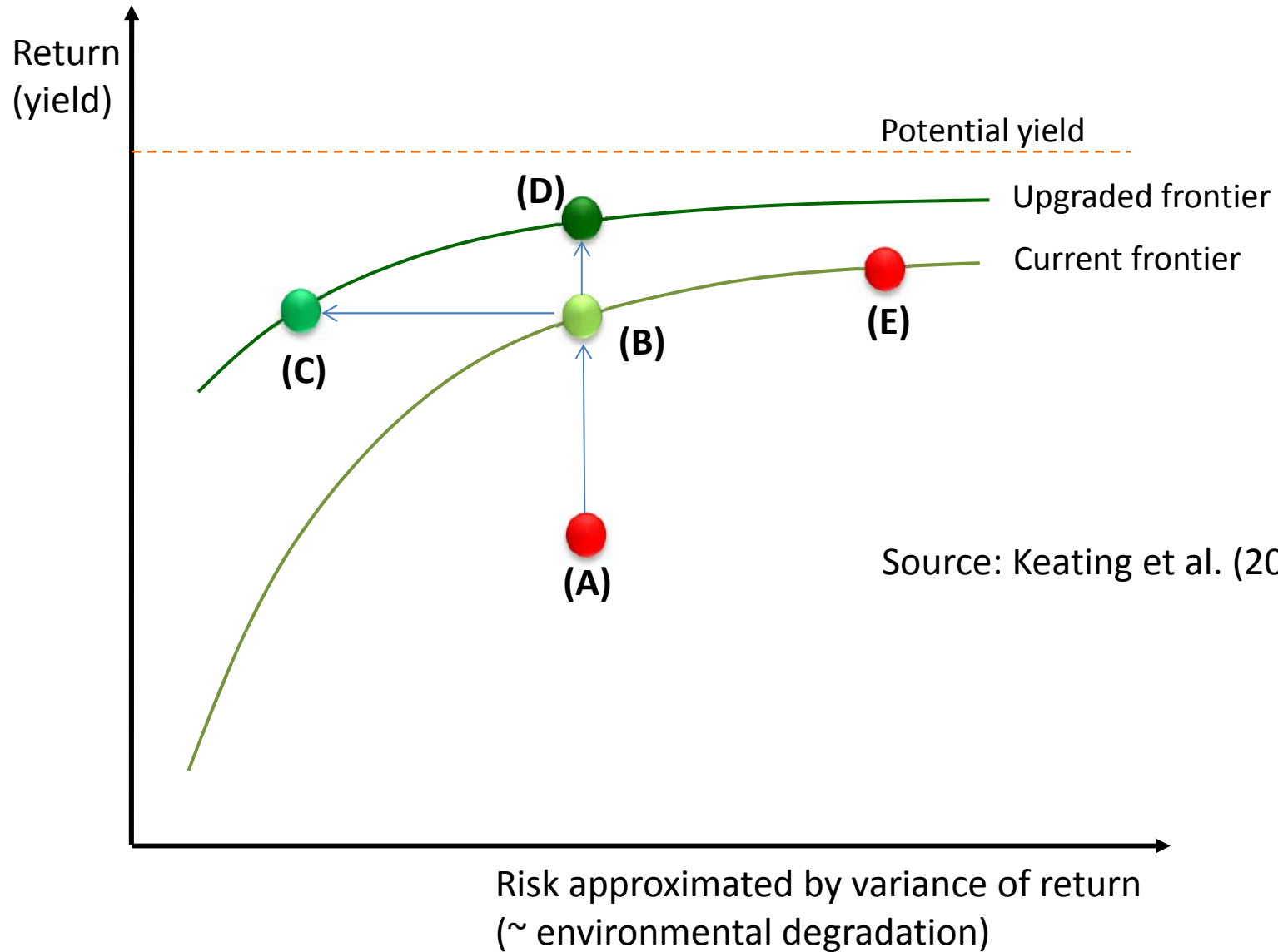
Note: Le et al. (in prep.), not yet discussed widely in DS community

Resilience thinking: SI as a bounding-forward, actor-driven transformation of agricultural livelihood systems



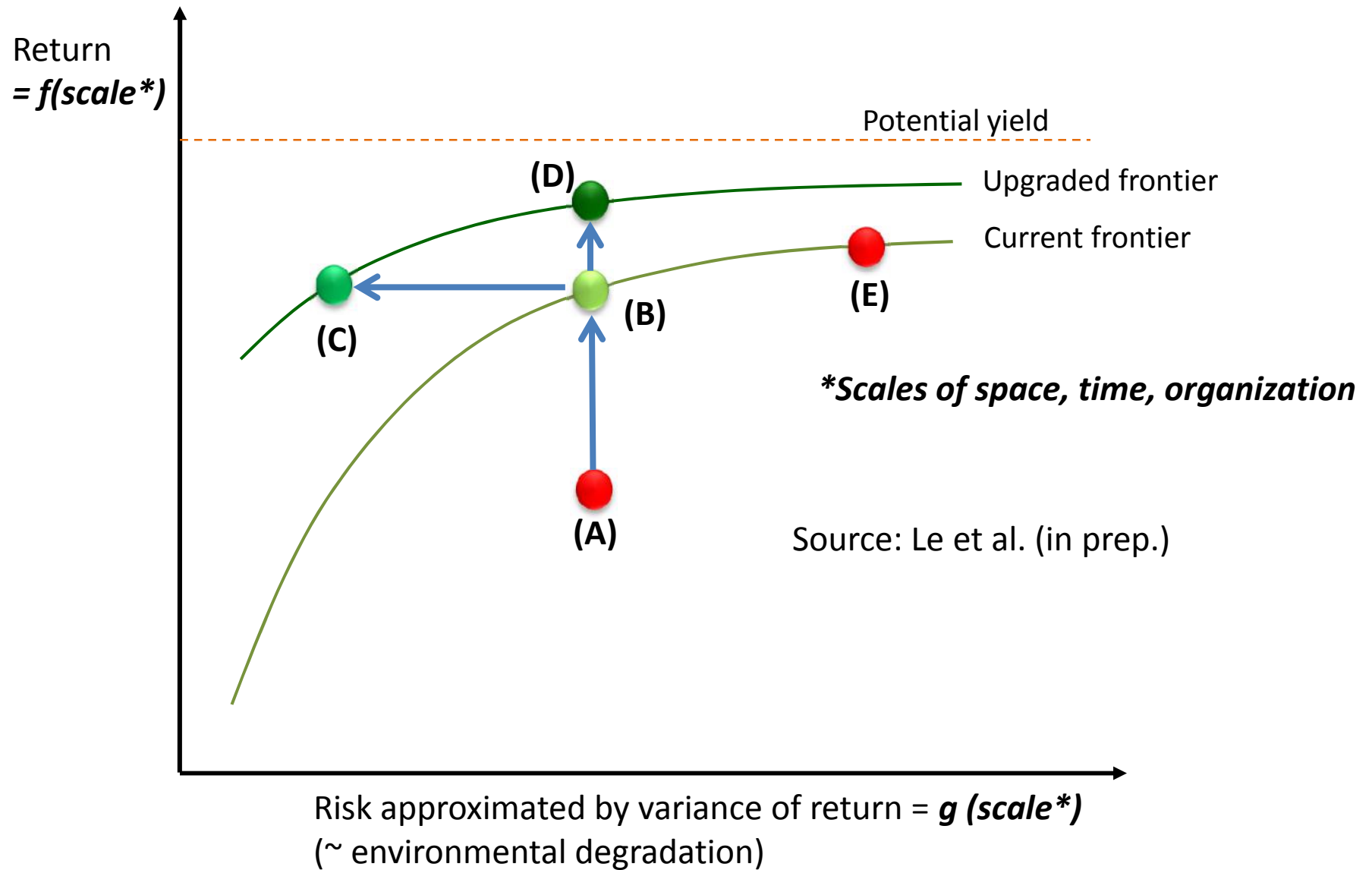
Source: Le et al. (in prep.)

Shift-up efficiency frontier as positive resilience transitions



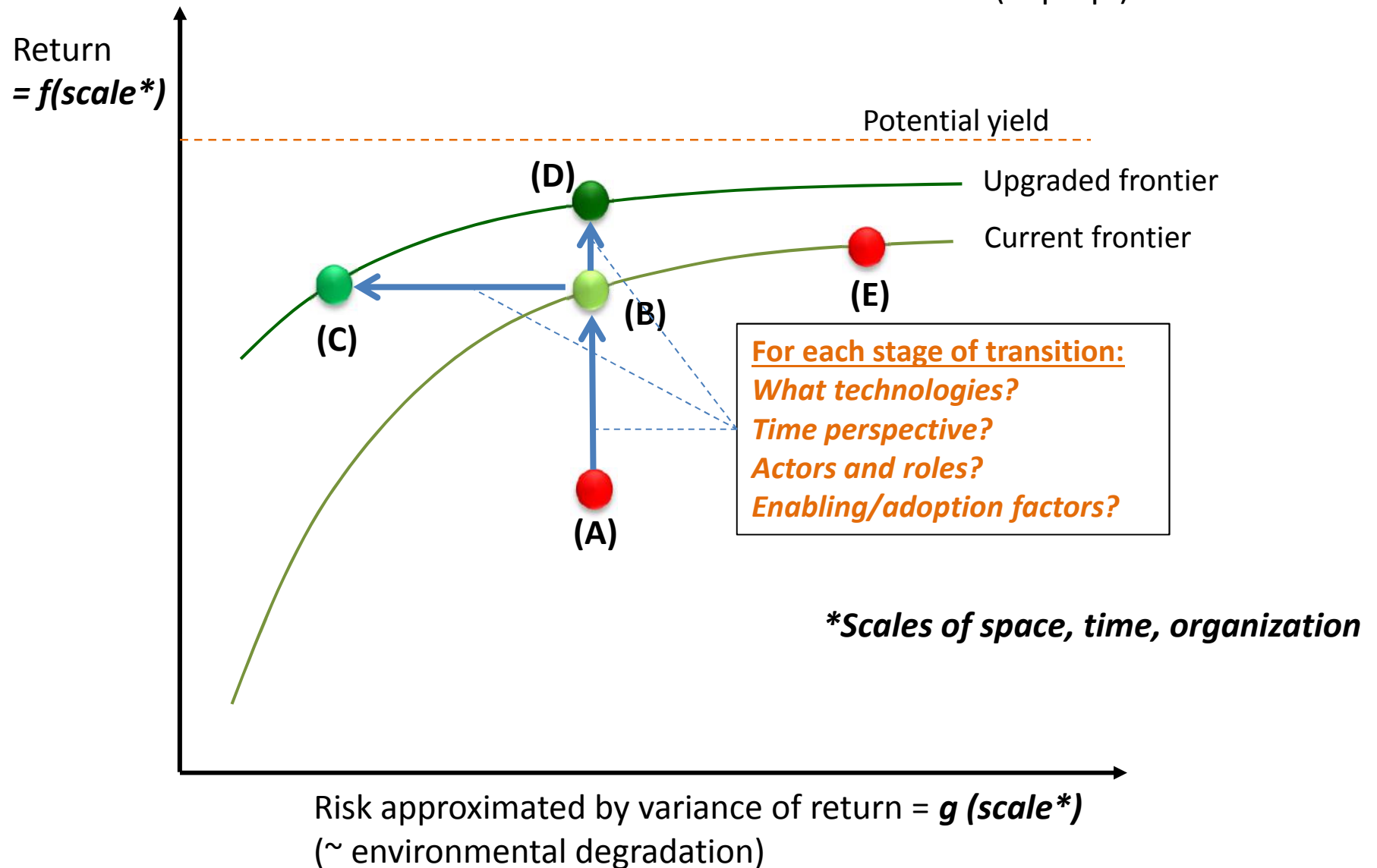
Source: Keating et al. (2010)

Shift-up efficiency frontier as scale/level-sensitive processes, requiring multi-scale/-level efforts



Shift-up efficiency frontier as context-specific and actor-based processes

Source: Le et al. (in prep.)



Model-based SI research: what needed?

Problem

- Complex human-environment interactions
- Uncertainties
- Externalities and trade-offs
 - vs. time
 - vs. space
 - vs. social group
 - vs. goal

Method requirement

- Interdisciplinary approach
- Uncertainty management
- Long-term perspective
- Micro-macro links
- Stakeholder participation
- Distributed outputs vs. space, time, and actor groups
- Multi-dimensional outputs

Model-based SI research: what needed (continue)?

Problem

- Flexible (not fixed) feedback loops generated by actors' decisions
- Actors' decisions changable along learning
- Heterogeneity as important source of buffering, adaptive capacities
- Framing drivers

Method requirement

- Actors' behavior explained
- Relevant learning process captured
- Within- and between- farm heterogeneities represented
- Sensitive to key drivers

Model-based SI research: How do current methods meet requirement?

Table 1. Comparative assessment of contemporary farming system modeling approach with respect to criteria for farm resilient research. Note: publications in parentheses are as relevant examples).

Criteria (synthesized from Bousquet and Le Page (2004), Boulanger and Bréchet (2005), Kelly <i>et al.</i> (2013), Cabell and Oelofse (2012))	Output-input nutrient balance models (NUTMON ^a model (Den Bosch <i>et al.</i> , 1998a; Den Bosch <i>et al.</i> , 1998b))	System dynamics models (Shepherd and Sole, (1998); Sendzimir <i>et al.</i> (2011)	Bayesian Network models (Poppenborg and Koellner, 2013)	Bio-economic models (Witcover <i>et al.</i> (Witcover <i>et al.</i> , 2006))	Coupled component models (NUANCES ^b (Giller <i>et al.</i> , (2011), IAT ^c (MacLeod <i>et al.</i> , 2007)), SEAMLESS (Van Ittersum <i>et al.</i> , 2008)	Multi-agent system models (LUDAS ^d (Le <i>et al.</i> , 2008a; Le <i>et al.</i> , 2010b; Le <i>et al.</i> , 2012b), MP-MAS ^e (Schreinemachers and Berger, 2011))
Interdisciplinary	no ^d	strong	medium	weak ^f	weak ^g	strong
Long-term perspective	no	strong	no	weak	strong	strong
Uncertainty management	no	weak	strong	no	no/weak	strong
Local-global perspective	no	no	no	weak	strong	strong
Participation mediation	weak	strong	strong	weak	strong	strong
Multi-scale feedback loops	no	no	no	no	unclear	strong
Actors' behavior	no	weak	strong	no	no	strong
Social learning and adaptation	no	no - weak	strong	no	no	strong ^f
Farm heterogeneity	strong	no	strong	weak	strong	strong ^g
Multi-dimensional outputs	strong	strong	strong	medium	strong	strong
Distributed outputs	no	strong	no	no	no	strong
Driver sensitive - Biophysical - Economic - Social	no	weak unclear unclear	weak medium strong	weak strong no - weak	strong med.-strong no	weak - medium medium - strong strong

Tools box needed to utilize methods' complementarities

^a NUTMON = Nutrient Monitoring

^b NUANCES = Nutrient Use in Animal and Cropping systems – Efficiencies and Scales

^c IAT = Integrated Analysis Tool

^d LUDAS = Land Use Dynamics Simulator

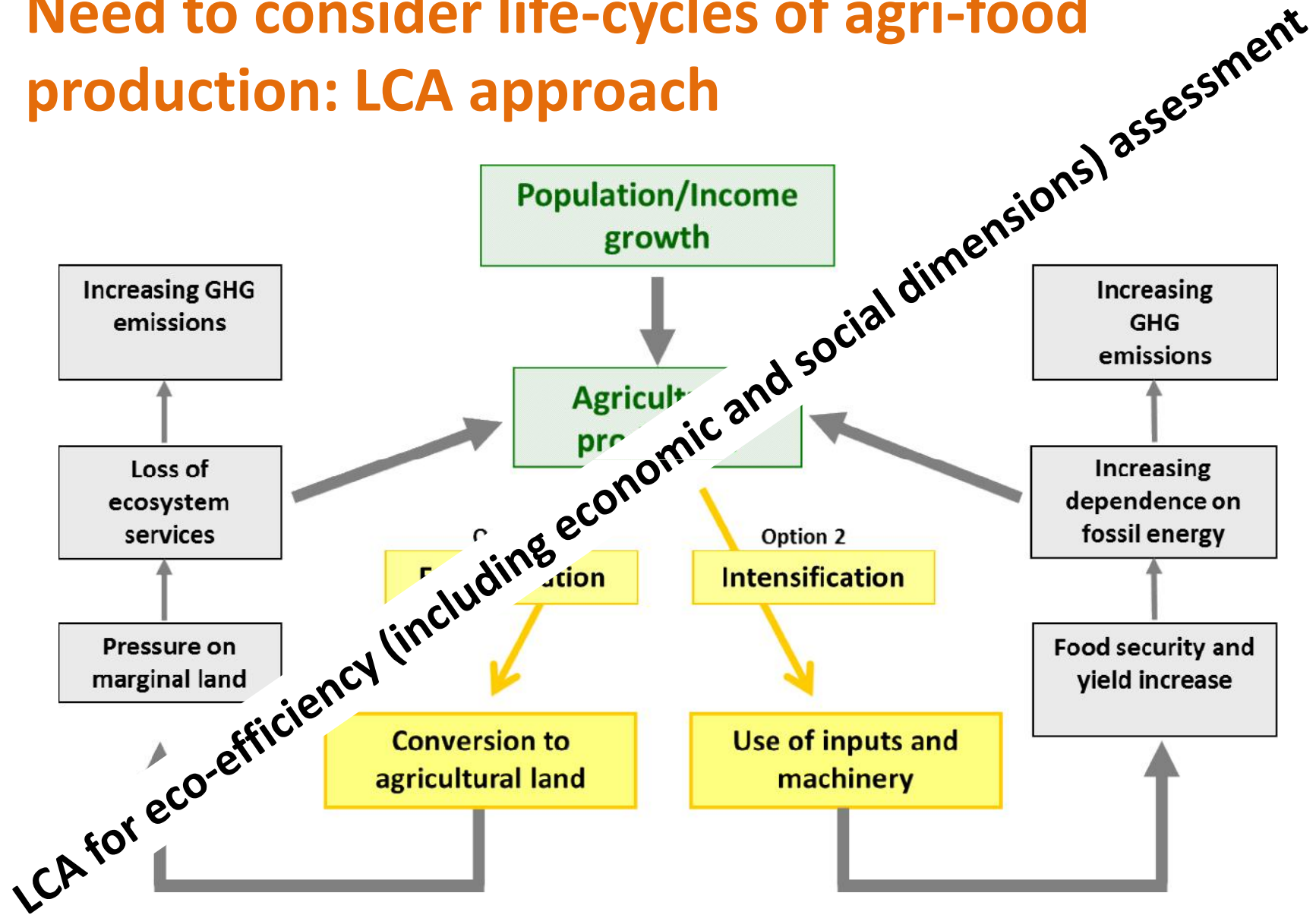
^e MP-MAS = Mathematic Programming - Multi-Agent System

^f rather multi-disciplinary, e.g. disciplines stand side-by-side

^g with some. rather all. MAS models. e.g. LUDAS model

Source: Le (2015), Le *et al.* (in revision)

Need to consider life-cycles of agri-food production: LCA approach



Figure's source: Vlek (2012)

Thank you