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Introduction / editorial for a special issue of Agricultural Systems

Editorial: Prioritising climate-smart agricultural interventions at different scales

One of the great challenges facing global agriculture in the coming decades is how to deal with the negative effects of climate change. These effects are projected to affect the populations with both the least capacity to adapt and the greatest need for improved agricultural performance to achieve food security and reduce poverty (Thornton and Lipper, 2013). Agricultural systems will need to be transformed if global food security and poverty reduction is to be achieved in a sustainable way. The need to reduce food insecurity, and to respond to the climate change effects which are already occurring, are urgent problems that may well involve new approaches embedded in appropriate enabling environments, if agricultural system transformations that contribute to global, regional and national development goals are to be achieved.

One approach that holds out prospects for helping to transform and reorientate agricultural systems to support food security under the new realities of climate change is climate smart agriculture (CSA). Risks to food security and livelihoods can be reduced by increasing the adaptive capacity of farmers as well as increasing resilience and resource use efficiency in agricultural production systems. The idea of CSA is that it should promote coordinated action towards climate-resilient pathways through building evidence, increase local institutional effectiveness, foster coherence between climate and agricultural policies, and link climate and agricultural financing (Lipper et al., 2014). The discourse surrounding CSA is certainly not uncontested; on the other hand, of the 113 countries that include adaptation in their Intended Nationally Determined Contributions (INDCs) to the UNFCCC at the end of 2015, almost all include agriculture among their adaptation priorities, and 30% of these make explicit mention of CSA (Richards et al., 2015). Support for CSA also comes from initiatives such as the Global Alliance for Climate-Smart Agriculture, consisting of many stakeholders including the World Bank, FAO and IFAD, and research-for-development programs such as CGIAR.

One of the reasons that CSA is not "business as usual" is the emphasis on implementing flexible, context-specific solutions, using approaches that evaluate the trade-offs and synergies between CSA's three pillars of sustainably increasing agricultural productivity to support equitable increases in incomes, food security and development; adapting and building resilience to climate change from the farm to national levels; and developing opportunities to reduce greenhouse gas emissions from agriculture. It is very unlikely that there are silver bullets that can deliver "climate smartness" in all contexts: some practices may be climate smart in one context but not in another, by delivering relatively more benefits in one, two or three of the CSA pillars compared with current practices. Accordingly, information is needed that can help decision makers at all levels, policy makers in national governments and farmers alike, prioritise climate-smart investment.

A review of farm household models to analyse food security in a changing climate (van Wijk et al., 2014) suggested that although there are many examples of models, they are often weak in the areas of decision theory and risk analysis. Currently, there are few tools that can comprehensively evaluate, in an ex ante sense, the range of potential technologies and practices and their possible impacts on food production, environmental sustainability, and mitigation in any context. There is a growing body of work by several of the CGIAR centres and their partners on tools and methods that can be used to prioritise CSA interventions and investments at a range of spatial and temporal scales. This special issue brings together nine papers describing a wide range of approaches and tools, and some of their characteristics are shown in Table 1.

Notenbaert et al. (2017) describe a generic framework for evaluating and prioritising potential CSA interventions that can be used at multiple levels, based on diagnosis and identification of potential options, characterising these and then mapping appropriate recommendation domains, assessing adoption potential, and then estimating impacts. Application of the framework is demonstrated through two examples, one evaluating livestock systems at a regional scale, the second more local in scope evaluating the diary value chain in a district in northern Tanzania. The paper notes that decision-making processes that are part of planning for climate-smart agriculture are invariably multi-stakeholder, multi-scale and multi-objective in nature. This can present considerable challenges, not only in terms of data and information needs for prioritising alternatives but also in relation to identifying effective mechanisms for helping to support decision-making.

Sain et al. (2017) use probabilistic cost benefit analysis to assess eight CSA practices for smallholder farmers in the Dry Corridor of Guatemala. A participatory approach is used to identify and prioritise potential CSA practices. The probabilistic cost benefit analysis method assigns a distribution to variables, and ultimately produces a cumulative distribution function of the economic returns over the lifetime of the practice. The method also examines the effects of the CSA practices on biodiversity, soil and water contamination, GHG emissions, and social impact. The case study assessment suggests that most of the potential CSA practices are profitable. Some practices, such as using more tolerant crop varieties are highly profitable, with a very short payback period. Other practices may involve a long period of time to repay the initial investment, which may be a barrier for smallholder farmers. The methods developed could be used by government and other stakeholders to assess the critical economic characteristics and associated environmental and social externalities of potential CSA practices.

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Table 1
Overview of papers in the special issue "Prioritising climate-smart agricultural interventions at different scales"

#	Authors	Theme	Analytical Framework	Scale	System, Location	Interventions	Methods of analysis		
							Adaptation	Food security	Mitigation
1	Notenbaert et al. (2017)	A generic framework for evaluating and prioritising potential interventions	Iteration between diagnosis and identification of potential options, identifying recommendation domains, assessing adoption potential and estimating impacts	Local, regional	Livestock production systems in East Africa; dairy value chains in Lushoto district, Tanzania	Improved feeding, improved animal husbandry and health, improved breeds, reduced seasonality of feed availability	Income, soil loss, N balance (farm-scale modelling)	Livestock production (GLEAM)	GHG emissions intensity (GLEAM)
2	Sain et al. (2017)	Comparative analysis of eight CSA technologies	Participatory identification of CSA practices, cost benefit analysis to compare relative profitability.	Regional	Smallholder maize and beans, Central America	Agroforestry, water management, improved varieties, conservation tillage, contour ditches and barriers, crop rotations.	Internal rate of return distribution	Not directly – potential for improved yield and income	Estimation of impact on carbon sequestration
3	Shirsath et al. (2017)	Prioritising land-use options for CSA	Quantitative framework based on production functions, target yields under current and future climates (2050s, 2080s)	District (34 zones, 194 land units)	Cropping systems in Bihar, India	Ten portfolios of interventions of increasing sophistication dealing with intensification and CSA	Crop yields (crop simulation models)	Gross & net income	GHG emissions (technical coefficient generator, The Cool Farm Tool)
4	Chhetri et al. (2017)	Participatory prioritisation processes	The framework integrates focused group discussion and key informant surveys into contingent valuation method to prioritize climate smart technologies, practices and services of CSA	Local (farm, village and landscape)	Livestock-crop integrated system, drought prone areas of Rajasthan, India	Six categories of technologies dealing with water, energy, nutrient, carbon, weather and knowledge	Benefit (yield, income) and cost (technology implementation) indicators	Potential of farm yield and income improvement	Not directly considered as an indicator of prioritization
5	Mwongera et al. (2017)	A rapid appraisal tool CSA-RA to prioritise interventions	The framework combines participatory and rapid rural appraisals, and qualitative and quantitative data analysis, with a level of gender disaggregation	Local (several tens of farm households)	Cropping systems in Gulu district, Uganda, and Kilolo district, Tanzania	Intercropping, seed selection, use of improved varieties, agroforestry, minimum tillage	Crop income (gross margin analysis)	Wellbeing and asset indicators (survey data and PCA)	Not analysed except in broad terms
6	Shikuku et al. (2017)	Evaluating trade-offs and synergies in livestock systems	Quantitative framework made up of a ruminant production model and a bio-economic trade-off analysis model, under current conditions	Local (several hundred farm households)	Livestock and mixed systems in Lushoto district, Tanzania	Combinations of improved feeding regimes and improved livestock breeds	Farm income (TOA model)	Income-based poverty rate & food security indicator (TOA model)	Methane emission intensity of milk production (ruminant model)
7	Rigolot et al. (2017)	Evaluation of intervention packages in mixed crop-livestock systems	Farm simulation modelling framework built around crop and animal production models and a household model for current and future (2050s) climate	Farm level (representative households)	Smaller and larger mixed farms in northern Burkina Faso	Crop fertilisation, feed supplementation, feeding strategies, mulching	Crop and livestock yields (simulated)	Gross & net income, available dietary energy	Not reported
8	Hammond et al. (2017)	A survey tool to characterise households with respect to indicators of production, nutrition, food security, poverty, GHG emissions	Modular survey tool with set of standardised performance indicators on CSA	Local (households)	Agriculture and livestock systems in Central America (El Salvador, Guatemala and Honduras) and East Africa (Tanzania)	Intensification, crop diversity, market orientation	Value of farm produce, gender equity	Farm productivity	GHG emissions and GHG intensity
9	Brandt et al. (2017)	Multi-criteria decision support framework	Spatially-explicit multi-criteria decision support framework using analytic hierarchy process and a goal optimization approach.	Local, regional	Agriculture and livestock systems in Kenya	Water harvesting, agroforestry, soil fertility management, drought tolerant crops, GHG reduction interventions from livestock sector, livestock insurance	Diversity, soil fertility, water harvesting, gender participation	Vulnerability indicators	Reduction in GHG from livestock