Co-Designing Organic Residue Recycling Chains in Off-Balance Regions

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1 Introduction

An increasing number of (urbanizing) regions worldwide is increasingly out of balance, in terms of nutrient cycles and organic waste production and use. On the one hand, resulting land tenure and market mechanisms push farming systems of these regions to intensify. On the other hand, resulting social, regulatory and environmental constraints curb the potential for intensification through conventional practices. While crop farming systems of diminishing fertility remain largely dependent on fertilizer imports, organic waste flows out of animal farming systems – and other productive and consumptive systems – threaten ecosystems and socio-economic development. Synergetic connections between these systems, i.e. industrial symbiosis, carry the promise of unlocking development while increasing individual and overall resilience and sustainability.
The small and isolated territory of Réunion, with its fast growing population and standard of living, exemplifies such a region. The island imports large amounts of nutrients, be it to feed its population, its crops or its livestock. In the absence of significant nutrient exports the large structural excess keeps increasing. This hampers the island's development, while its agricultural sector remains largely dependent upon fertilizer imports. The agricultural recycling of raw livestock manure reaches the limit of its regulatory and practical capacity, while these unbalanced applications – with respect to crop needs – lead to very little fertilizer substitution. Beyond agriculture a range of other activities produce substantial amounts of organic waste, each with their own – and often contrasting – characteristics. Co-processing a propitious combination of waste sources may allow to elaborate organic or organo-mineral fertilizer and soil amendments with characteristics that meet both crop and farmer requirements. Within such an integrated waste management system cropping systems would thereby add a (waste) consumptive function to their productive functions. Far from a constraint, this carries the promise to increase their individual as well as the overall system's productive capacity. Designing such system changes calls for a science facilitated, both interdisciplinary and inter-sectorial, participatory process. We developed a method for co-designing realistic and accepted solutions and implemented it in Réunion in an attempt to kick-off an innovation process.

2 Method and Tools for the participatory design of recycling scenarios

The adoption of recycling "innovations" – even though the practice of Returning Organic Residues to Agricultural Land (RORAL) is as old as agriculture itself – by increasingly complex, integrated and globalized production systems is far from straightforward. Still more daunting is the definition of new practices adapted to the multiple (economic, social, societal and environmental) constraints of today's world. Wassenaar et al. (2014) detail the epistemological basis of interdisciplinary research exploring the potential for favoring adoption of RORAL in off-balance regions. The proposed problem-solving approach is invariably built around very specific intervention possibilities that favor adaptation and uptake (Hagmann et al., 2002). Conventional technical science encompasses a systemic component in order to feed the co-design process with realistic, technically and agronomically valid ideas. Led by a 'facilitator' social science group, the technical science group is then a constituent of the co-design process 'following' its own technology, whereas other stakeholders' motivation to participate is that 'plausible promise' (initially) made by the R&D team to solve a real (farming) problem (Douthwaite et al., 2002). This implies the value-based choice by science of a technology to 'follow', i.e. to catalyze change. Accepting negotiation theory as a basis for organizing the participatory efforts, as argued by Leeuwis (2000), it becomes clear that the 'facilitator' research group has a strong interest in having 'involved actor' RORAL scientists associated with them: they provide the facilitator (who according to Leeuwis (2000) is not a neutral figure but in need of an active strategy, resources and a power-base to forge agreements) with credibility, insights and the capacity to fill knowledge gaps.
We developed and tested a method favoring collective learning through participatory design exercises. The crop farming systems' demand driven, stepwise design process puts to work tools selected from among those developed for participatory research, as deemed appropriate to each individual step (e.g. problem trees, role playing games). The method comprises five steps: (1) establishing an initial, shared diagnostic of the current situation; (2) the exhaustive description of the characteristics of ideal fertilizer and soil amendment products for all potential uses followed by the analysis of their redundancy; (3) the formulation of hypothetical recycling chains manufacturing and distributing selected fertilizer/amendment products; (4) the combined and coupled representation of these production chains in develoment scenarios of the study region; (5) feasibility and sustainability assessments of the scenarios. Iterations among these latter steps will in many cases be required. This co-design process takes place at three distinct but

interacting levels of participation: at a "technical" level ad hoc working groups of coopted members elaborate proposals which then constitute the basis for a consultation process at a "practical" level composed of selected representatives of all ground level stakeholder groups. Emerging orientations and problems are then discussed at an "institutional" level by representatives mandated by their institution or company.

In addition to the participatory research tools, in particular steps 4 and 5 of the co-design process call for systems modeling in order to conceptualize the system, to build a common understanding among stakeholders, to identify leverage points for interventions, to analyze different scenarios, to form the basis of decision support systems, to assist in stakeholder negotiations, to identify systems performance indicators and to facilitate impact assessments (Sayer and Campbell, 2002). Multi-agent modeling allows capturing farm/plant/site level knowledge elicited in the process, as well as representing and analyzing – at regional scale – prospective scenarios that constitute the outcome of that process. Coupled to biophysical models and global databases, such a model also allows simulating economic and environmental consequences, at local level and beyond, that contribute to the provision of relevant information for stakeholders feeding back into the process.

3 Application to Réunion

A project team including all major stakeholders (e.g. the main waste producers, collectors and processors; fertilizer industry; the farmer council and the federation of cooperatives) was built around a coordinating science core, legitimate to perform that function as an impartial stakeholder. All were convinced to participate through the proposed conflict-avoiding shift of paradigm from a waste disposal logic in favor of an agricultural demand focused approach. At the "practical" level, representatives of 12 target groups have been invited to a series of 5 workshops from mid-2011 to early 2014. A broad range of institutions was convened to steering committee meetings presided by a local and a national government official. The initial plausible promise – which put substantial accent on soil amendments, some little conventional processing techniques and the potential of some controversial waste sources – has been seriously altered during the co-design process. Largely as a result of local topographic, land tenure, agricultural, economic, regulatory and know-how constraints, but also factors like mistrust, envisaged new resulting recycling chains mainly focus on the production of fairly concentrated fertilizers. Soil amendments would continue to be provided to a structurally small market by improved existing recycling chains (green waste compost and sugar cane filter cake). Fertilizers would result from the co-composting of complementary organic wastes (layer manure with vinasse; poultry litter with pig slurry) using ground municipal green waste as a structuring agent. While vegetable gardening would consume one of these co-composts directly, the majority of the production would supply a fertilizer plant where they would be dried, supplemented and pelletized. Model simulations suggest that resulting fertilizers could potentially satisfy a large share of the major fertilizers demands: the sugar cane and vegetable gardening sectors. But their combined purchasing and application costs would be close to that of mineral fertilizer and the adaptation of policy instruments is required for these recycling chains to be viable.

4 Conclusions

RORAL research does not claim to come up with the solutions alone. It typically generates knowledge and tools to help generate and assess integrated solutions to complex problems. The Réunion proof of concept shows that it takes more expertise and parties to be able to identify effective and acceptable solutions favouring local recycling of organic residues in agriculture, representing a gain in sustainability for the region concerned without harming any of its constituent parts. Although successful, the proof of concept also highlights the importance of a careful planning of the participatory process' rhythm and time span. The consolidated definition of broadly accepted scenarios signaled the end of the participatory research process, but the innovation process continues. Qualitropic, a business and research cluster around the island's bioeconomy, currently seeks to develop and accompany industrial projects. Several factors hinder the implementation of such projects, among which the absence of technical references of the envisaged products' agronomic efficiency. Although on-going, establishing such references requires fairly long-term experiments.

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