

Sustainable Intensification: Self-organization as a Promising Resource for Institutional Change in Agricultural Science and Development

Paper for the 7th International Conference in Interpretive Policy Analysis:
Understanding the Drama of Democracy: Policy Work, Power and Transformation
Tilburg University, The Netherlands, 5-7 July 2012

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Abstract

As a result of growing concern over the harmful social and environmental consequences of food production, procurement and consumption, the international community is calling for “sustainable intensification” of smallholder agriculture and food systems. Diverse sources propose further investments in the institutions of Agricultural Knowledge, Science and Technology for Development (AKSTD). Nevertheless, the underlying problems of modern food – e.g., mass soil degradation and the destruction of hydric systems, pesticide poisonings, loss of agrobiodiversity, production of green house gases and obesity -- appear deeply rooted in the past “solutions” of Agricultural Science. Drawing on experiences in Ecuador, we call attention to peoples’ production practices and counter-movements as locally distributed and resolved processes and examples of self-organization – what we view as a neglected resource for social change. We argue that self-organization is not based on dichotomies of internal-external, expert-lay, traditional-modern or local-global organization, but simultaneously each. The paper discusses the two hundred year institutional gulf between present-day AKSTD institutions and how socio-technical change happens in practice. We close by highlighting public policy re-directions for strengthening self-organization as a promising, if problematic means of sustainable intensification of food.

The institutional crisis in agricultural science in development

In his study of social developments in Dutch agriculture, van der Ploeg (2000) explains that “Agricultural Modernization” (also conceived of here as “Modern Food”) depended on the historic institutionalization of four social innovations: the commoditization of rural life (natural resources and time as well as products, such as food), the intermediation of relationships through currency and financial systems, the geographic and social distancing of markets, and dependence on externally based knowledge and technology. In concurrence with van der Ploeg, there is growing agreement that over the long-run Modern Food has become a driving force of environmental degradation across the globe, in particular major destruction of soils through conventional total tillage regimes and reliance on synthetic fertilizers (Foley et al., 2005), loss of crop genetic resources (Normander, 2012), and ecological disturbance as well as ties with the subsequent global rise in non-communicable diseases, such as poisoning by pesticides and obesity (Sherwood, Arce et al., submitted; Popkin, 2007).

By tying rural communities and food to capital and financial systems, rural producers and urban consumers have suffered from creative forms of market exclusion, such as the usurious credit schemes and supermarket monopolies as well as volatile fluctuations in global financial markets (Badham et al., 2010). Furthermore, feeding growing populations in the context of rising climate change adds new layers of complexity and uncertainty to the already overwhelming challenges of food (IPPC, 2007; Godfray et al., 2010). Meanwhile, public investment in agricultural research and development around the world has diminished

substantially and is further threatened by the on-going global financial crisis (NRC, 2010, GO-Science, 2011).

Increasingly, there have been growing international consensus that the model of AKSTD-driven, prescriptive agricultural development has reached a limit, leading to the need of fundamentally rethinking and revising dominant institutional designs and purposes (IAASTD, 2009; NRC, 2010, GO-Science, 2011). In particular, this has led to a call for institutional change towards the “sustainable intensification” of agriculture – producing more food from the same area of land while reducing the environmental and social impacts (Royal Society of London, 2009) and major new policy directions at the Food and Agriculture Organization, World Bank and beyond.¹

Over time, the common pool resources of agricultural science have been placed at the service of private commercial enterprise, initially in seeds and the agrochemical industries, but also financial services, food processing, distribution, and retail (Potter, 1998). Together, in terms of gross volume and value, Modern Food has become the single largest industry on the planet. The complicity of AKSTD in the growth of commercial industry as well as its harmful consequences in terms of social disparities, environmental degradation and human health raises serious questions over whether the institutions of Modern Food can change from within. Nonetheless, that fact does not undermine the fundamental need for change in the organization of food.

Meanwhile, it has become increasingly clear that an expectation of change from within existing institutional frameworks is not realistic (Wagemans, 2002). Regardless of curative claims, AKSTD institutions appear to be structurally tied to the same logic and value systems that induce and perpetuate the problematic qualities of modernity (Potter, 1998; Pretty, 1995). Complex interdependencies and regularised interaction patterns (including communication) tend to constrain the space for meaningful change, not least since a number of actors in the current social networks are likely to have a vested interest in maintaining the existing situation. Such vested interests are reflected in the prevailing formal and informal societal rules and arrangements (described here as institutions, structure or regimes) that actors draw upon and reproduce in their interaction (Leeuwis and Aarts, 2010). Radical change is facing an arduous uphill battle. This is because if we are to achieve radical change, networks need to be altered simultaneously. So to know and to engage in debate in the most obvious ways is also to reproduce the most obvious institutional forms, structures and regimes (Law, 2011).

Despite significant institutional obstacles as well as the experience that deliberately designed changes are not easily achieved and implemented, change is continuous and, at times, quite radical (Leeuwis and Aarts, 2010). Giddens (1984) shows that societal contexts and structural conditions are not only constraining but also enabling. So if latent opportunities for change exist (even if unacknowledged), then there must be realistic alternatives to these hegemonic AKSTD institutions. But how does institutional change come about when institutions are deeply embedded in dominant structures, such as government and economy, that they become seemingly naturalised, difficult or impossible to influence in particular locations? How are more respectful and less dominant alternatives generated in such circumstances? How do they grow in influence to shape social change?

To ground our analysis, we situate this paper in long-term, multi-disciplinary socio-technical research on agriculture in Ecuador. In particular, we focus on research with potato farmers in the northern Province of Carchi (Crissman et al., 1998; Yanggen et al., 2004; Sherwood, 2009; Paredes, 2010), a region commonly described as the Andean model of Agricultural

¹ For example, see: FAO. 2009. Strategic Framework 2010-2019, Rome 18-23 November. (available at: [ftp://ftp.fao.org/docrep/fao/meeting/017/k5864e01.pdf](http://ftp.fao.org/docrep/fao/meeting/017/k5864e01.pdf)) and World Bank (2011).

Modernization – where relatively successful agrarian reform in favour of smallholder family production was followed by broad adoption of industrial-era technology and integration with commercial markets. In Carchi, rural families and their communities tightly embraced an unusually visionary, deliberate and ambitious public policy towards Modern Food and its consequences. We then follow national food movements and their activity in shaping public policy (Bekkering, 2011; Ongeval, in process; and Sherwood and Arce, submitted).

In particular, drawing on the work of Paredes (2010), despite the arrival of a very dominant regime of thought in agriculture and food, we explore how no pure form of Modernization exists at the household level. Families continually re-organize their food production-consumption-circulation activity according to their diverse sense of need, preference, creativity and flair, leading to richly nuanced and characteristically unique patterns of living and being. Finding the need for opening up a new debate in institutional transition in Modern Food towards greater human health, productivity and sustainability, we call attention to heterogeneity as an example of self-organization as a largely neglected resource for social change.

Self-organization as a counter-movement to Modern Food

Looking down the barrel of unidirectional development

The instrumental “top-down”, “linear”, “technology transfer” or “pipeline” agricultural research and development model has its roots in the notion of change as a continuum of research-extension-education (Biggs, 1990; Clark 1995). Biggs (2006: 145) explains:

“At the heart of the [pipeline] model is the idea that most new, significant technological innovations come from the actions of planned research and development. There are stages in this process that start with research formulation and the conducting of formal research. This leads to new innovations, which are then tested and scaled up through uptake pathways. Finally there is widespread adoption by target beneficiaries. The process ends by an evaluation stage, after which learning takes place and the whole cycle starts again”.

The ideology was the basis for the 19th century U.S. land grant system and the well-studied intensification of production through industrial-era technology, also known as the “green revolution”, that subsequently led to public investment across the world in deliberate mechanisms for positioning AKSTD as the champion of social change in agriculture and food (NRC, 2010). In the last century this led to the establishment of academic disciplines, national and international research systems and cooperative extension programs. Agricultural Modernization cut its institutional teeth in the United States and Europe, where extension services reached a large rural population that had access to formal education, credit, markets, and other pre-conditions required by the model. Nevertheless, its application in developing countries, for example via the Consultative Group of International Agriculture Research Centers and National Agricultural Research Centers (CGIAR-NARS) proved less successful (Ruttan, 1998; IAASTD, 2009). Similarly, “Training and Visit” system that dominated World Bank international policy for agricultural development between 1975 and 2000, shared similar fate (Anderson et al., 2006). According to Leeuwis (2004: 50-53), common problems with the expert-led approach included assumptions that:

- 1) specific technologies were universally applicable,
- 2) agriculture and markets were static,
- 3) socio-technical change was a linear process from researchers to extensionists to producers,
- 4) rural people largely were homogeneous,
- 5) locally progressive farmers and community leaders were capable of driving social change,
- and 6) farmers operated in isolation and were rational decision-makers.

Refinements

Concurrently, building on a long history of social movements in Europe, the US and the Global South, a number of grassroots development workers developed a tradition of people-centred development and community-based action (e.g., Freire, 1973; Horton, Bunch, 1982; Hope and Timmell, 1984; Horton and Freire, 1990). In practice, such approaches became heavily transformed in the hands of the AKSTD, leading to different forms of: farmer-led extension, action-research, and participatory approaches. While new actors came to the floor and processes became increasingly interactive, the central feature of technology transfer – i.e. expert-led, pre-conceived and -planned, unidirectional development – survived (Biggs, 2007).

More recently, agricultural development initiatives have attempted to address the shortcomings of earlier approaches through new communication architecture and interactive platforms. This has included new emphasis on strengthening Agricultural Innovation Systems (World Bank, 2011) and brokerage processes (Klerkx and Leeuwis, 2010).² While such approaches show much promise for improving existing management, they inevitably must involve existing actors and operate within the constraints of what possible within that environment. Thus, they are necessarily tied to a unidirectional process and operate with pre-conceived initiatives with partners “in the field” to “impact” beneficiaries located “on the ground”, albeit arguable with enhanced degrees of interaction and potentially greater sense of co-responsibility in processes and outcomes.

While we find continued usefulness in aspects of technology transfer and working with agricultural innovation systems, we believe that such approaches necessary operate within the flaws of Agricultural Modernization. Interested in finding ways of achieving more substantial institutional, we wish to look outside the existing regimes of modernization.

In search of alternatives

Several authors argue that space for change does not come about only (or even mainly) through deliberate processes of planning and intervention (Maffesoli, 1996; Castells, 2004; Aarts and Duing, 2006). Instead these studies show that societal change arises from ongoing societal interactions among actors – people, acting as individuals and in groups, in active pursuit of interests who creatively open up spaces for continuity and change. It involves actors operating as individuals and collectives outside the designs of formal institutional frameworks, even when this activity conflicts with enforced rules, regulations and procedures (Wagemans, 2002). So rather than being controlled and engineered, people in their roles as social agents -- acting relatively free of external controls -- perform societal change in processes of self-organisation (Nicolis, 1989). The term “self-organisation”, however, does not necessarily imply that change happens automatically in the absence of human intentionality. Rather, self-organization is often the unintended outcome of endless and infinitely dynamic intentional and purposeful activity (Sharpf, 1978; Aarts and Van Woerkum, 2002; Castells, 2004; Aarts, 2007).

The concept of self-organization has gained the attention of researchers from highly different theoretical traditions, including cognitive, behavioural, cultural and socio-biological systems perspectives but we find peoples’ self-organization so far to be largely unexplored and under-utilized opportunity in the reform of institutional frameworks. Where and how does

² See for example, “An International Workshop on Investing in and Strengthening Agricultural Innovation Systems”, 29 May – 1 June 2012. World Bank, Washington, DC (information available at: <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/0,,contentMDK:23219724~pagePK:210058~piPK:210062~theSitePK:336682,00.html>)

self-organization emerge as institutional counter movements, thereby opening up new possibilities and desirabilities for continuation and change? Where do they encounter and how do they interact with more formalized institutional processes of Modern Food? How can promising existing and imagined processes of self-organization be strengthened in favour of more sustainable futures?

Starting from the assumptions of multi-vocality and incommensurability, in this paper we look to family-level farming practice as a means of describing and analyzing the activity of self-organization. Based on the perspective of practice theory (Schatzki et. al 2001), our attention to “practice” in this paper de-emphasizes structures, systems, individuals or interactions. We view practice as embodied sets of activities that humans, simultaneously acting as individuals and in collectives, perform with varying degrees of commitment, competence and flair. Thus we prioritize the social act rather than on actors or events. More than just routines, we see practice as a continual process of organization and expression, as people, operating in situated socio-biological contexts of co-production, make a sense of the present through, knowingly or now, resolving interfaces between desirabilities and possibilities as well as possible histories and futures. Deemphasizing practice as the product of rationality, we appreciate that self-organization as expressed through peoples’ practices can generate both desirable and undesirable outcomes.

Drawing on Arce and Long (2000) and McGee (2004), we provide qualitative attention to three interactive social domains: knowledge, actors and space-sites. By “knowledge”, we do not mean just cognitive knowledge but also the feelings, experiences and skills gained through life experiences and stored in the physical landscape and built into the environment and social interactions. Experiential knowledge is produced in everyday life, but it is not yet routinely incorporated into the propositional (policy) knowledge of experts and policy-makers. Therefore, it is ignored from the understanding of Modern Food, representing a serious gap between food in concept and food in practice. By “actors”, we do not just mean individuals acting in self-interest. Individuals are not isolated from the social world of which they are part. Actor also signifies groups of people in their pursuit of collective interests in social networks. Actors’ actions are important agency resources for new identities and re-imagining ways of life within modernities constituting the contemporary world. “Sites” refers to the multiple contexts of human co-existence: the physical (fields, tables and towns) and even imaginary places (such as the virtual world of television and the internet), where social practices happen. Sites are places where, over time, networks of ambivalent orders (i.e., people, artefacts, and things) become “organized activities” or practices of peoples’ everyday life. These spaces can be part of development policies implementations, government and public co-ordination or part of more autonomous, less formalized civic action.

The interactions between knowledge, actors and sites are clearly dynamic and complex, and not a simple and linear relationship of cause and effect. Thus knowledge, actors, and sites should not be approached as independent domains, nor are they simply determined by externally based structural conditions. Framing agriculture and food in this way connects people’s choices with the nature of human, physical and material co-existence, which is part of a constant process of constitution and reconstitution, consisting of a myriad of colluding and competing, convergent and divergent modernizations.

Self-organization necessarily requires an emphasis on empirical material and in particular situated knowledge. As such, for data we draw on a body of publications (Crissman et. al, 1998; Yanggen et. al, 2003) and graduate-level action-research studies conducted on Agricultural Modernization in Ecuador, in particular: Sherwood (2009) and Paredes (2010). Insights over on-going food policy is based on over ten years of reflective practice as one of the authors as a researcher-activist in Ecuador’s food movements since 1998 as well as the recent graduate research of Bekkering (2011) and Ongeval (in process).

Institutional crisis and the emergence counter-movements

Provided its natural endowments, generally educated population, infrastructure and market access to both Colombia and Ecuador, the Province of Carchi, Ecuador is potentially one of the most productive agricultural regions in the Andes and was chosen by the FAO/United Nations and Ministry of Agriculture as a “model” of Agricultural Modernization (Barsky, 1980: 186). Following agrarian reform and the arrival of industrial-era technology in the 1960s, potato farming there evolved to become a major source of livelihoods, dominating the modern landscape. On less than a quarter of the country’s area dedicated to the crop, in the 1990s Carchi came to produce about 40 percent of Ecuador’s yearly potato harvest. Nevertheless, today’s farming in Carchi does not just produce a lot of potatoes; it also has generated ecological disruptions and a costly public health epidemic.

The multi-disciplinary research raises serious concerns over the sustainability of food production as a result of its interactive effects on human health, the environment and productivity. Between 1990 and 2003, a number of national and international organizations worked with communities on projects to assess the role and effects of modern agriculture and to identify opportunities for reversing its harmful consequences. For example, tractors and total tillage are the leading cause of soil erosion, displacing some 80 t/ha each cropping season. Since the late 1990s, production by area and productivity began to level, followed by a decline (see figure 1). Meanwhile, two-thirds of the rural population – including men, women and children – suffer measurable neurological damage due to exposure to highly toxic pesticides (Cole et al., 2007). Economic studies have identified a relationship between pesticide exposure and low productivity. After automobile accidents, suicide by pesticide ingestion is the second leading cause of death in the province. The social effects of modern agriculture appear equally dramatic. Some fifty years after “successful” market integration and technification, farmers find themselves in a crisis they call “dollarisation,” tying them to increasingly volatile compensation for commodities, losses, and debt and the abandonment of agriculture.

Figure 1. Decline in potato productivity in Carchi (INIAP UVTT-Carchi) (figures in annex)

Upon arrival in Carchi in 1998, a farmer told Sherwood, “I don’t know if you believe in God, but I believe in pesticides” (Sherwood, 2009: 102). From a biophysical point of view, modern technology has enabled farmers to structurally break with nature, which has been useful for controlling certain crop pests, but over time such technology have carried unexpected costs in the form of social and environmental backlash. People and their communities describe being increasingly fragmented, both individually/socially (a sense of detachment) and collectively (a tendency towards valuing currency and the market over neighbour, neighbourhood, and community). These two phenomena interact to produce socio-biological decline characterized by increasing environmental and social uncertainties. Farmers express a growing sense of frustration as a result of their experiences. One participant seemed to represent many when he declared (p. 233), “We have done everything the *ingenieros* have told us to do, and look where we are.... We are going broke.”

Meanwhile, productivity has steadily declined due to a vicious combination of production problems, rising input costs and increasing variability in commodity prices. Crissman found that in the early 1990s, potato farmers in Carchi lost money on about 45% of their plantings. In 2004, that rate had increased to two-thirds (Paredes, 2010). Face with rising debt, a growing number of the intended beneficiaries of Agricultural Modernization was forced to abandon agriculture and migrate in search of work. At the national level, over half a million Ecuadorians, about half of which were from rural areas, emigrated between 1998 and 2004, with about 1.5 million presently living overseas (roughly 15% of the population) (UNFPA and FLACSO, 2006). Youth from rural communities in Carchi repeatedly joined armed guerrilla

movements in nearby Colombia (Sherwood, 2009). As a result, the turn of the twentieth century in resource-abundant Carchi was marked by the growth of three sectors: the landless labourer, the urban migrant and the guerrilla fighter.

Ecosystem decline and associated human health problems in Carchi can be summarised as a “pathology” of Agricultural Modernization (Ravetz, 2006). Tendencies are not mere externalities or accidents but dangers that increasingly have become the expected result of agricultural policy. Today, the dangers of agriculture technologies in Carchi are so far-reaching and generalized that it is no longer possible to blame any particular individual. The guilty party had become the “System”, with the State, via policy and regulatory frameworks, as the sanctioning agent. Dangers have not only emerged from the environmental world; they also have become an inner product of society itself – an internality.

Undesirable products of modern agriculture led to social and ecological outcomes that in turn sparked new directions of change. Growing public concern over a pesticide-induced epidemic in Carchi combined with explicit involvement government agencies MAG, SESA, INIAP, and the FAO raised questions over the ability of elected authorities to fulfil their public mandate. In November 2003, peasant leaders wrote a letter to Ecuador’s President Lucio Gutierrez demanding that Carchi be declared a zone of “agricultural emergency”, demanding solutions. Faced with falling potato prices, growing pest problems, and upset about health effects of pesticides, entire communities descended from the mountainsides to the Pan-American Highway in protest. On 5 December, they gave the President 24 hours to respond to their concerns, threatening to shut down Carchi indefinitely. Several days later, thousands of farmers blocked the Pan-American Highway, the single artery connecting Ecuador to Colombia. The strike grew to nearly 10,000 participants and carried on for more than one month, effectively closing commerce between Ecuador and Colombia.

In 2004, in *Dying to make a living*, a documentary on peoples’ protests over the harmful consequences of pesticides in Carchi, the reporter from the British Broadcasting System concluded, “The government says it does not have the research or the resources to take action on the most toxic pesticides, and the chemical companies say they cannot control how products are used in the field. So, it seems that the farmers will have to take measures to help themselves...”³ And so they did, as they always have – through processes of self-organization embedded in their daily practice.

Actors mobilize knowledge resources to open up new spaces of interaction, where new actors were brought on board to collide, collude, and collaborate over causes. Provided the tenacity of an age-old limited tillage system, *wachu rozado* (see box 1) as well as growing concern over pesticide technology (see box 2), it is clear that alternative practices are not simply lying on the margins, waiting to be disappeared by the growing influence of the dominant norm. In both the *wachu rozado* and the pesticide case, policy went against the interests of sustainability. Despite the thousands of hectares of *wachu rozado* that remain on the surrounding hillsides of the region and the well-known problems of soil erosion, the production systems lies off the radar screen of expert-led development in Ecuador. Ten years following promising results in its initial exploratory studies, INIAP and CIP had no research activity on the system. In this case, the problem was not “farmer adoption” of expert technology, but rather “expert adoption” of farmer technology. Through their strategic framing of *wachu rozado*, researchers have declared it “incompatible with modern agriculture” and therefore “impractical” and “unproductive” (INIAP and CIP, 2003). Nevertheless, they cannot deny that despite some 60 years of public policy in favour of mechanized, total tillage, *wachu rozado* tenaciously holds on to the surrounding hillsides. In the case of pesticides, the problem had less to do with a lack of safe use and more with

³ BBC. 2004. *Dying to Make a Living*. A two-part World Service series on Globalization and pesticides. Aired worldwide; available at: www.bbc.co.uk/worldservice/specials/1646_dying/

policy that supported certain alternatives over others. As reported in Yanggen et al. (2004) and Cole et al. (2007), this experience and its implications for finding time-tested means of decreasing exposure to pesticides was shared widely with the scientific community in Ecuador. Nevertheless, representatives from the National Agricultural Research Institute (INIAP), the Ministry of Agriculture (MAGAP), the Food and Agriculture Organization (FAO), and industry diversely described the approach as “unscientific” and “impractical. Further analysis found the in fact the approach went against established ways of organizing, thinking and doing in AKSTD (Sherwood and Paredes, submitted).

Box 1. *Wachu rozado*: a pre-Colombia conservation tillage potato system (in annex)

Box 2. Farming styles as counter-tendencies in potato production: addressing harmful consequences of modern technology (Paredes, 2010) (in annex)

Rather, they can be seen as part of an active resistance movement, firmly rooted in the politics of identity and expression. Lying outside the bounds of the nation-state or industry, these actors often generated agenda that went against officialised government programmes. In fact, the identities of these actors – the sub-political – were often tied to their ability to publicly challenge government, regulatory agencies, research institutions, and international corporations.

As experienced elsewhere (e.g., Giménez and Shattuck, 2011), promising food movements in Ecuador do not just lay outside the protection of law, they are commonly the target of law and public sanction. Industry representatives, government officials, and the media were quick to label sub-political actors “controversial” and “radical”. For example, during protests over the Free Trade Agreement in Ecuador, which included negotiations over agrochemical imports, the Ministry of Government decided to target NGOs as organizations that “manipulated the Indians,” thereby encouraging further strikes and protests. As matters intensified, the government threatened to revoke diplomatic visas of international staff and change the tax-free status of NGOs.⁴ In March 2006, several foreigners attending the protests were arrested and deported from the country. It became clear that the certain government agencies (as well as the US State Department) had grown intolerant of dissent to their policies. Nevertheless, individuals in counter-movements did not act alone. They were part of broad international networks of people operating at the grassroots level who shared a common history of concerns and identity around sub-politics. Quickly common agenda was identified, information was exchanged, and activity was coordinated by e-mail and telephone. Press reels and publications were written together and there was collaboration on efforts to reach the popular media. The aim was to influence the policies of bilateral donors and international organizations and movements, such as CIP, FAO, and the World Bank as well as the regional agenda of the Humanist Movement in Europe and Latin America. While strategies sometimes focused on countries, they also targeted farmers, consumers, and the media.

Meanwhile, following the worst economic crisis in the country’s history and five failed governments in as many years, in 2007 the Ecuador people voted to dissolve the government and re-write the country’s constitution. After decades of frustrating attempts to shift national policy away from Agricultural Modernization, many civil society organizations came together for radical change to shift the agenda of agriculture as production to the broader platform of food. An informal network of some 150 organizations dedicated to ideals of agroecology, the *Colectivo de Agroecología*, joined force with urban-based consumer

⁴ In 2005, the network of international NGOs operating in Ecuador hired a team of lawyers to counter the government’s proposed revisions to established legal contracts with international agencies. Concerns were outlined in the document, “Legal regime for NGOs in Ecuador: analysis of the proposed legal agreement,” VGYLEX Abogados, 6 June 2006, 4 pp.

groups, farmers and first nations to intervene in favour of a pioneering constitutional mandate for “food sovereignty”. As per the resulting 2008 Constitution, food sovereignty is based on a the multi-dimensional context of agricultural production, emphasizing the “social purpose” of land as a means of equitable, democratic social development and natural resource conservation in favour of biodiversity (article 276, 282, 334 and 400), equitable food distribution and commercialization (article 335), and ample access to culturally appropriate food and a health diet, in particular by means of native crops, animals, and other food sources (articles 13 and 281).⁵ This activity led to the National Assembly to create the Plurinational and Intercultural Conference on Food Sovereignty (COPIISA) -- a government-supported, civil society-led entity mandated with the task of putting food sovereignty into motion.⁶

Following approval of the 2008 Constitution, the *Colectivo* worked to support putting food sovereignty into practice through legislation. Beginning in 2009, the *Colectivo* and its partners worked with COPIISA to study promising farming practices and hold public debates and consultations involving over 500 organizations in every province of the country. In March 2012, COPIISA handed the National Assembly the draft Law of Food Sovereignty⁷, which was based on time-tested means of enhancing biodiversity, local seed management, and the practice of agroecology. The scientific communities responded aggressively, with the Director of the National Research Service (INIAP) submitting a detailed 28-page letter to the President of Ecuador arguing that the law was “unscientific”.⁸ The Director of INIAP disqualified the law, arguing that he [and ostensibly not people in their roles as farmers and consumers] was the “ultimate authority” of agriculture and food in Ecuador. He argued that in attempting to integrate agro-biodiversity, seed management, and biologically based production “violated scientific categorization” and that the country’s food security depended on proper scientific control and certification of crop genetic resources, their utilization in production, and the determination of “ valid farming practice”.

States legitimize the “externalities” of technologies through their system of civilized controls and regulation. Nevertheless, the actual life-world of a regulatory agency is not just composed of its civilized mechanisms of control, but also the unwritten outcomes of what it sanctions. Through its regulatory system, Ecuador granted permission to pesticide companies to introduce toxins into the environment (Sherwood and Paredes, submitted). The destruction of soils, the erosion of biological resources, the contamination of the environment, the poisoning of its public and even obesity are, in essence, “shadow effects”. The socio-technical regime achieves this by means of reference to established norms and regulatory agency sanctioning. The shadow effects of technology regulation are not mere “externalities” of the system, but intrinsic elements of it. In summary, it was not the tractor, pesticides, genetically modified organisms or processed foods that degrade the environment and harm peoples’ health. It is technology linked to the notion of effective regulatory mechanisms that forms the basis of power. In this way, the image of regulation against harmful technologies becomes complicit in sustaining the continuation of that very technology.

Influencing seemingly dominant regimes

⁵ Available at: <http://www.mmrree.gob.ec/ministerio/constituciones/2008.pdf>

⁶ For examples see the COPIISA website: <http://www.soberaniaalimentaria.gob.ec/pacha/>

⁷ Ley Orgánica del Régimen de Soberanía Alimentaria: La propuesta campesina e indígena. 2009. Asamblea Nacional: Republica del Ecuador Comisión Legislativa y de Fiscalización. (http://asambleanacional.gov.ec/blogs/soberania_alimentaria).

⁸ Letter from Julio César Delgado, Director General of INIAP, to Rafael Correa Delgado, President of Ecuador, 12 May 2012 (INAIP-DG-0320).

We started this paper by wondering how institutional change comes about when institutions have gotten themselves so deeply embedded in government and economy that they become effectively naturalised and thus, difficult or impossible to influence or supplant. We wanted to know how new institutional possibilities emerge and take social hold in such seemingly closed and intractable circumstances. The recent experience in agricultural policy in Ecuador shows that AKSTD that endlessly spins-off technologically induced risks can undermine its own institutional legitimacy (Sherwood, 2009), thereby opening up space for self-organization and the arrival of what Beck (1992) describes as sub-political movements – emergent networks of civil society organized for the purposes lying off the radar screen of everyday politics. Over time, such forms of self-organisation can grow to challenge, change and even become an alternative to dominant institutional frameworks.

More specifically, our analysis shows that the institutional framework of modern agriculture in Ecuador represents a theatre of socio-environmental decline, risk and violence, behind which the institutions of AKSTD and Modern Food can no longer hide. Public perception of the “bads” is beginning to outweigh its “goods”, and the crisis appears to be deepening and diversifying in creative, previously unimaginable and highly intractable forms. What first appeared to be a success, turned into a problem of its own making. Beck (1992) describes this self-destructive feature of industrial-era society as “organised irresponsibility”.

Ironically, the continued “success” of AKSTD in perpetuating public policy in an era of growing public awareness of socio-environmental decline appears to be opening up new spaces for change (Sherwood and Paredes, submitted). Over the last 15 years, a number of sub-political forms -- farmer, agroecology and urban-based food movements -- have risen to confront Modern Food and challenge the existing order. These included charismatic individuals, such as farmer leaders and progressive professionals, as well as organizations, such as national NGOs (EcoPar, Randi-Randi, Acción Ecológica), international NGOs (Heifer Project International, Agronomists and Veterinarians without Borders) networks (the Carchi Consortium, MACRENA, the Pesticide Action Network), and less formally structured social movements (the Humanists). While the NGOs were more vulnerable to the whims of donors and thematic- and time-bound projects, local leaders, networks, and movements demonstrated greater flexibility in questioning the established order as well as in sustaining positions over longer periods of time (Sherwood et al., 2012). As the contradictions of Modern Food in Ecuador became increasingly apparent, social movements have grown in size, diversity of activity and influence to the point where they have begun to inform and shape public bureaucracy, for example through re-writing elements of the constitution and framing public debates around the need for alternative human organization.⁹

If reflexivity is the recognition that all perspectives are culturally conditioned and contingent (Delanty, 2006), then the self-organisation initiatives can be understood as the reflexive response to the formal AKSTD institutions. Peoples’ self-organization in Ecuador has exposed the gulf between institutions of Science and Government and the realities of the new modernity – global degradation of soils and water, erosion of agrobiodiversity, pesticide poisoning, obesity, global warming and climate change. As experienced in the survival of *wachu rozado*, growing concern over pesticides and the successful efforts to place people at the centre of food policy. In making public the concerns in Carchi, relationships were forged with social networks organized around the confrontation of similar circumstances elsewhere in Ecuador and Latin America as well as Central America, Africa, and Asia. Beyond being part of local sub-politics, the organisation became part of what Beck (2001: 276) describes as “the new constellation of global sub-politics.” Marginalised and estranged by country-level bureaucracy, the emergence of global sub-politics appeared to represent a growing

⁹ See the activity of Ecuador’s lively food sovereignty movement that has championed new mandates in the country’s 2008 constitution and ensuing laws, including the recent Agrobiodiversity, Seeds, and Agroecology legislation (available at: <http://www.soberaniaalimentaria.gob.ec/pacha/>).

liberalizing and emancipating force, opening up new spaces of social interaction, and making alternative realities visible. As such new possibilities for change were envisioned that could previously not even be imagined. What started out as a new belief system has now become a new reality that has deepened and diversified, taking agriculture in Ecuador into new pathways of social change.

Re- thinking institutional change

The institutional change around agriculture and food in Ecuador is quite different from what we would expect to see on the basis of the international calls for institutional change in AKSTD (IAASTD, 2009; NRC, 2010; GO-Science, 2011). The references to institutional change involve expectations of change either from within existing institutions or it emphasizes involvement of existing institutions to be a necessary pre-requisite. In addition to that it assumes that such change can be deliberately organized. In contrary, in Ecuador we find that institutional change originated from outside formal institutional frameworks. Furthermore the forms of self organisation and subsequent institutional change were only partially intended and anticipated, for example, with regard to the banning of highly toxic pesticides and the 2008 Constitution and subsequent legislation. So instead of thinking about institutional change as coming about through deliberate processes of planning and intervention, our case shows that institutional change only (or even mainly) arose out of self-organized initiatives, whether the dominant institutional framework liked it or not. In line with Wagemans (2002), it shows that existing institutional frameworks were questionable points of departure when searching for such fundamental change. Because of self-referentiality, citizens could not rely on existing institutional frameworks to offer solutions to problems that were an inner product of these same institutional frameworks.

Secondly, literature on institutional change draws on designs and metaphors that emphasize rationality, pre-planning, universality, singularity and thus coherency (for example, World Bank, 2011). Our results show us a process of self-organization that was not rational, not designed or planned, situated, multiple and thus not necessarily coherent. So instead of thinking about institutional change as a unidirectional process, our case showed that institutional change is a messy and unpredictable process, which no method - however refined - will manage to master completely.

Third of all, literature on institutional change imagines the knowledgeable scientist as the catalyst of new possibilities of change of existing institutions. Our results show that institutional change in AKSTD came about despite the self-organized initiatives being ignored and sometimes even actively opposed by scientists. This requires us to re-think Science and the role of scientists in processes of institutional change.

We want to reflect a bit more on this last issue. As Beck and Grande (2010:411) explain, a century-wide gulf exists between “the threats, opportunities and conflict dynamics of border transcending, radicalized modernization in the twenty-first century and the ideas, institutions and structures of industrial capitalism and national state authority rooted in the nineteenth century.” In fact, rather than look to experts for a way out of the modern predicament of ecosystem decline, a growing body of literature has come to acknowledge the place of expert-based development and Modern Food at the centre of crises in countries across the planet. To highlight a number of the problems we find underlying the logic of expert institutions:

- Preoccupation with the norm: a focus on central tendencies rather than outliers and extreme events
- Existence of isolation: belief that different sectors do not interact or, if they do, those interactions are not important for affecting change

- Power of rationality: expectation that social change is incremental and linear
- Human as supernatural – an objective of some optimal state of a system, usually human conceived and managed, that will deliver sustainable development.
- The social world is researchable, measurable and understandable: as far as the world is not researchable, we simply exclude reality and instead increase our knowledge of an increasingly reduced reality.

As a result of this belief system, in its attempts to address the ecosystem crisis, expert-based development inevitably becomes self-referential and self-reinforcing. After a half-century in Ecuador, the institutions of AKSTD have turned in on themselves to the point where they are less a source of solutions and more a source of second-generation problems, such as major soil degradation, erosion of agrobiodiversity, pesticide poisoning, obesity (Sherwood, 2009). Over the long run, the effects of past solutions have become far worse than the original problems they intended to address. When faced with such contradictions, however, rather than shift course, the institutions of AKSTD essentially are calling for more of the same – more expert-based solutions. This is true in the present-day debates over food policy Ecuador but also the debates of the international community (Feldman and Biggs, 2012).

If AKSTD lies at the centre of present-day ecosystem predicament (Röling, 2000), can we reasonably expect it to get us out? A central problem of Science in general and Modern Food in particular lies in the process of Science itself – its social distance from the people who depend on the products and processes that has put into motion and who benefit and suffer from its unanticipated and unpredictable, but nonetheless very real and enduring consequences that can no longer be ignored (Beck, 2001). Forged from the conception of Science in the 17th Century, Science depends on solutions steeped in knowledge and power that is in constant growth and advancement, supplanting the ignorance and impotence of the commoners – people conceived in roles as producers, middle people and consumers (Ravetz, 2006). In order to overcome the modern predicament of ecosystem challenge, much of which is deeply rooted in AKSTD Science itself, there is growing consensus that a more promising future depends on a new direction.

We live in a period where AKSTD is necessary, but it is not enough for solutions. For us, the first step towards more promising futures depends not on bridging the gap between 19th Century notions of Science and the State, but by all together bypassing it. Any reform will need to be part of a general reform of the way we see and act in relation to each other and the surrounding world. As per the perspective of this article, we find hope that in many ways AKSTD has never existed outside society, in the sense that scientists are denizens of households, communities and social networks that reach and connect into other parts of society, including the food system and its consequences.

In line with Law (2008, 2009) we feel that if the institutional change is non-coherent, then methods that seek and describe it as coherent are making a mess of doing so. We are in need of methods for knowing and enacting disorder, context, difference and non-coherence. This requires methods that do not simplify and allow us to deal with specificity and situated action. We cannot work “in general”, because there is no “in general”. What remain are specific sites, practices, and then, the specificities of those practices. If we want to understand how realities are done or to explore their politics, then we have to attend carefully to practices and ask how they come to be (Law 2008; 2009).

What is needed here is not a mere replacement of a certain dominant tendency, but its reversal. As argued in Lefebvre (1991: 26), this requires a shift away from the end product of Science (i.e., the technological artefact) to the productive activity of Science itself, which in turn leads us to give attention to the social space of production. In this paper, we have described this as the practice of policy, which we view as not exclusive to dominant formal

institutions but rather it includes the daily activity of people operating as individuals and in social networks. In particular, we have called attention to the promising, non-violent forms of social organization that have emerged in response to the harmful consequences of Modern Food.

With regard to the role of scientists we feel that it is important to make visible existing alternatives to dominant institutional frameworks. If the world is discursively heterogeneous and non-coherent, then we are moved to the conclusion that different social realities co-exist, intersect and interact. Shedding light on neglected or hidden realities is a potentially important role for scientists because it enables us to imagine different futures that were, so far, deliberately denied or even forbidden and thus outside the scope of our imagination. This implies that scientists need to go looking for gaps and subaltern realities (Law, 2011). It requires engagement with and upon difference, to make differences. Instead of acting on notions of a norm and commonality, we need to start looking for social deviances and disjunctions – cracks! We need to search out the rich diversity of performances and practices in distinct situations, places and contexts, suggesting multiple productions and co-constructions of the real – effectively, new possibilities and desirabilities (Law, 2007). If different realities are being enacted and sustained in different practices, then we may hope to make a political difference by making some realities visible, whilst chipping away at others. For if there are multiple realities then these may be played off against one another. Importantly, some will be preferable to others (though such judgements are themselves likely to be complex). Articulation renders normativities discussable and contestable in ways that open up the possibility of change (Law, 2011).

The trajectory of Modern Food has depended on the success of scientists as entrepreneurs - - indiscriminately mixing economic, political, natural, and cultural claims to the truth (Sherwood, 2009). At any given time, an alliance appears as a mature structure, consolidated around particular positions. Upon becoming overly consolidated and rigid, however, the regime becomes vulnerable to competing interests. The increasingly hard-to-deny “bads” of modern technology exposes conflicts between expert discourse and local experience, leading to rising degrees of discontent and questioning of scientific claims of authority. For example, the arrival of social movements and NGOs as a collective sub-political actor organized around ideals of food sovereignty has become an influential force in Ecuador. Ironically, it appears that the extraordinary success of AKSTD as a dominant socio-technical regime, followed by its institutional entrenchment around its own constructed truths and ideals provided the pre-conditions for its demise and future transition. The pertinent question no longer seems to be whether AKSTD Science in the context of Modern Food will survive, but how and when alternatives movements will supplant it.

References

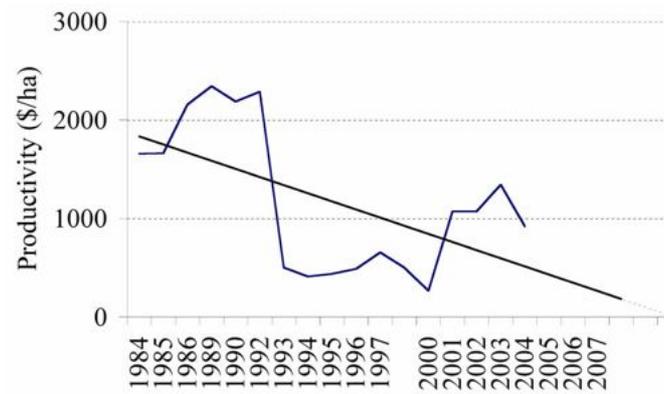
- Aarts, M.N.C. and C.M.J. Van Woerkum (2002). Dealing with uncertainty in solving complex problems. In: Leeuwis, C. and R. Pyburn (eds). 2002. *Wheelbarrows Full of Frogs: Social Learning in Rural Resource Management*. Royal Van Gorcum, Assen, The Netherlands. pp. 421-435
- Aarts, N. 2007. Self-organization in public space: of open networks and closed communities. Paper presented at MOPAN conference ‘Learning for Interdependence’, Leuven, 28-29 June.
- Aarts, N. and R. During. 2006. Zelforganisatie en ruimtegebruik. Van open netwerken en gesloten gemeenschappen. Innovatienetwerk, Utrecht, NL.
- Anderson, J., G. Feder and S. Ganguly. 2006. The Rise and Fall of Training and Visit Extension: An Asian Mini-drama with an African Epilogue. *World Bank Policy Research Working Paper*, 3928. World Bank, Washington, DC. 30 pp. (available at:

- <http://givebetter.net/files/DWDA%202009/Interventions/Agriculture/The%20rise%20and%20fall%20of%20training%20and%20visit%20extension.pdf>
- Arce, A. and N. Long, 2000. *Anthropology, Development and Modernities: Exploring Discourses, Counter-tendencies and Violence*. London and New York, Routledge.
- Bach, B.K. 2007. Theoretical interpretations of the growth in organic agriculture: agricultural modernization or an organic treadmill? *Society and Natural Resources: An International Journal*, 20(3): 229-244.
- Badham, J, M.W. Blome, R.D. Semba, K. Kraemer. 2010. Castel Gandolfo Workshop: An introduction to the impact of climate change, the economic crisis, and the increase in the food prices on malnutrition. *The Journal of Nutrition*, 140(1):132–5.
- Barsky, O. 1980. Los terratenientes serranos y el debate político previo al dictado de la ley de reforma agraria de 1964 en el Ecuador. In: O. Barsky, et al. (eds.). *Ecuador: Cambios en el Agro Serrano*. Facultad Latinoamericana de Ciencias Sociales (FLACSO), Quito, Ecuador, pp. 133-206.
- Beck, U. 1992. *Risk Society: Towards a New Modernity*. Sage Publications, London, UK.
- Beck, U. 2000. Risk Society revisited: theory, politics, and research programmes. In: B. Adam, U. Beck, and J. Van Loon (eds.). *The Risk Society and Beyond: Critical Issues for Social Theory*. Sage Publications, London, UK, pp. 211-229.
- Beck, U. 2001. Ecological questions in a framework of manufactured uncertainties. In: S. Seidman and J.C. Alexander (eds.). *The New Social Theory Reader*. Routledge, London, UK, pp. 267-275.
- Beck, U. and E. Grande. 2010. Varieties of second modernity: the cosmopolitan turn in social and political theory and research. *British Journal of Sociology*, 61(3): 409-443.
- Biggs, S. 2007. Building on the positive: an actor innovation systems approach to finding and promoting pro poor natural resources institutional and technical innovations. *International Journal of Agricultural Resources, Governance and Ecology*, 6(2): 144-164.
- Bunch, R. 1982. *Two Ears of Corn: A Guide to People-centred Agricultural Development*. World Neighbors, Oklahoma City, OK.
- Castells, M. 2004 [1997]. *The Power of Identity. The Information Age: Economy, Society and Culture*. Blackwell, Cambridge, UK. Vol. II.
- Chambers, R., A. Pacey and L.A. Thrupp. 1990. *Farmer First: Farmer Innovation and Agricultural Research*. Intermediate Technology Publications, London, UK.
- Clark, J.R.A. 2005. The 'New Associationalism' in agricultura: agro-food diversification and multifunctional production logics. *Journal of Economic Geography*, 5(4): 475-498.
- Conway, G.R. 1997. *The Doubly Green Revolution*. Penguin Books, London, UK.
- Crissman, C.C., J.M. Antle, and S.M. Capalbo (eds.). 1998. *Economic, environmental, and health tradeoffs in agriculture: pesticides and the sustainability of Andean potato production*, Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Feldman, S. and S. Biggs. 2012. The politics of international assessments: The IAASTD process, reception and significance. *Agrarian Change*, 12(1): 141-169.
- Foley, J.A. R. DeFries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.H. Helkowski, T. Holloway, E.A. Howard, C.J. Kucharik, C. Monfreda, J.A. Patz, I.C. Prentice, N. Ramankutty and P.K. Snyder. 2005. Global Consequences of Land Use. *Science*, 309(5734): 570-574.
- Fonte, S. and S. Vanek. 2012. Pathways to Agroecological Intensification of Soil Fertility Management by Smallholder Farmers in the Andean Highlands. Report and Recommendations for the McKnight Foundation. 79 pp. (available at: http://mcknight.ccrp.cornell.edu/program_docs/general/Soil%20Fertility%20in%20the%20Andes.Final%20Report+Recommendations.Dec.5.2011.pdf)
- Freire, P. 1973. *Education for Critical Consciousness*. Continuum Publishing, New York, NY.
- McGee, R., 2004. Unpacking Policy: Knowledge, Actors and Spaces. In K. Brock, R. McGee, and J. Gaventa (eds), *Unpacking Policy: Knowledge, Actors, and Spaces in Poverty Reduction in Uganda and Nigera*, Fountain Publishers, Kampala, p. 1-26.

- Giménez, E.H. and A. Shattuck, 2011. 'Food Crises, Food Regimes and Food Movements: Rumbblings of Reform or Tides of Transformation?' *The Journal of Peasant Studies*, 38(1): 109-144.
- Godfray, H.C.J., J.R. Beddington, I.R. Crute, L. Haddad, D. Lawrence, J.F. Muir, J. Pretty, S. Robinson, S.M. Thomas, and C. Toulmin. 2010. Food Security: The Challenge of Feeding 9 Billion People. *Science*, 327(5967): 812-818.
- GO-Science. 2011. *Foresight: The Future of Food and Farming*. Final Project Report. The United Kingdom's Government Office for Science, London. (available at: <http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/11-546-future-of-food-and-farming-report.pdf>).
- Holt-Gimenez, E. (ed.) 2011. *Food Movements Unite*. Food First Institute for Food and Development Policy, Oakland, CA.
- Hope, A. and S. Timmel. 1984. *Training for Transformation: A Handbook for Community Workers*. Mambo Press, Gweru, Zimbabwe.
- Horton, M. and P. Freire. 1990. *We Make The Road by Walking: Conversations on Education and Social Change*. Temple University Press, Philadelphia, PA.
- IPCC. 2007. Climate change: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change (eds Parry M. L., Canziani O. F., Palutikof J., van der Linden P. J., Hanson C. E.). Cambridge, UK: Cambridge University Press. See <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-intro.pdf>.
- Klerkx, L. and C. Leeuwis. 2008. Balancing multiple interests: embedding innovation intermediation in the agricultural knowledge infrastructure. *Technovation*, 28(6): 364-378.
- Klerkx, L., N. Aarts, C. Leeuwis. 2010. Adaptive management in agricultural innovation systems: the interaction between innovation networks and their environment. *Agricultural Systems*, 103(6): 390-400.
- Law, J. 2007. Making a Mess with Method. In: W. Outhwaite and S.P. Turner (eds), *The Sage Handbook of Social Science Methodology*. Sage, Beverly Hills and London, pp 595-606.
- Law, J. 2008. The Materials of STS, version of 9th April 2009, available at <http://www.heterogeneities.net/publications/Law2008MaterialsofSTS.pdf>, (downloaded on 30th June 2012).
- Law, J. 2009. 'Collateral Realities', version of 29th December 2009, available at <http://www.heterogeneities.net/publications/Law2009CollateralRealities.pdf> (downloaded on 30th June 2012).
- Law, J. 2011. Knowledge Places: or Putting STS in Its Place. Plenary paper prepared for delivery at National Yang Ming University, Taipei, Taiwan 4th November, 2011.
- Leeuwis, C. (with contributions by A. Van den Ban) 2004. *Communication for Rural Innovation: Rethinking Agricultural Extension*. Blackwell Science, Oxford, UK.
- Leeuwis, C., N. Aarts. 2011. Rethinking Communication in Innovation Processes: Creating Space for Change in Complex Systems *Journal of agricultural education and extension* 17 (1), 21 – 36.
- Maffesoli, M. 1996. *The Time of the Tribes: The Decline of Individualism in Mass Society*. Sage, London, UK.
- Nicolis, G. 1989. *Self-organised Criticality: Emergent Complex Behaviour in Physical and Biological Systems*. Cambridge University Press, Cambridge, UK.
- Normander, Bo. 2012. Biodiversity: Compating the Sixth Mass Extinction. *State of the World*. WorldWatch Institute, Part 2, 169-176, DOI: 10.5822/978-1-61091-045-3_15.
- Ongeval, K. van. In process. *Que Rico Es!: Bringing Forth Food Sovereignty in Ecuador*. MSc. Thesis, Wageningen University, The Netherlands.
- Paredes, M. 2012. *Peasants, Potatoes and Pesticides: Heterogeneity in the Context of Agricultural Modernization in the Highland Andes of Ecuador*. PhD dissertation, Wageningen University, Wageningen, The Netherlands.

- Ploeg, J.D. van der. 2003. *The Virtual Farmer: Past, Present, and Future of the Dutch Peasantry*. Royal van Gorcum Assen, The Netherlands.
- Popkin, B. 2007. Global nutrition dynamics: the works is shifting rapidly toward a diet linked with noncommunicable diseases. *American Journal of Clinical Nutrition*, 84: 289-98.
- Potter, C. .1998. *Against the Grain: Agri-environmental Reform in the United States and Europe*, CABI, UK.
- Pretty, J.N. .1995. *Regenerating Agriculture: Policies and Practice for Sustainability and Self-Reliance*. Earthscan Press, London, UK and National Academy Press, Washington, DC.
- Pretty, J., C. Brett, D. Gee, R. Hine, C. Mason, J. Morison, M. Rayment, G. Van Der Bijl and T. Dobbs. 2001. Policy Challenges and Priorities for Internalizing the Externalities of Modern Agriculture, *Journal of Environmental Planning and Management*, 44:2, 263-283.
- Ravetz, J.R. 2006. Post-normal Science and the complexity of transition towards sustainability. *Ecological Complexity*, 3(4): 275-284.
- Röling, N. 2000. Gateway to the global barden: beta/gamma science for dealing with ecological rationality. Keynote speech, Hopper Lecture Series, IDRC, 24 October, Ottawa, CA.
- Royal Society of London. 2009. *Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture*. Royal Society, London, UK.
- Ruttan, V. 1989. The International Agricultural Research System. In: L. Compton (ed.). *The Transformation of International Agricultural Research and Development*. Lynne Rienner Publishers, Boulder, CO and London, UK, pp. 173-205.
- Scharpf, F.W. 1978. Interorganizational policy studies: issues, concepts and perspectives. In: Hanf and F.W. Scharpf (eds.). *Interorganizational Policy Making: Limits to Coordination and Central Control*. Sage, London, UK. pp. 345-370.
- Schatzki, T.R., K. Knorr-Cetina, and E. von Savigny (eds), 2001. *The Practice Turn in Contemporary Theory*. Routledge: London, UK.
- Sherwood, S. 2009. Learning from Carchi: Agricultural Modernization and the Production of Decline. PhD dissertation, Wageningen University, The Netherlands.
- Sherwood, S. and M. Paredes. (submitted May 2012). Dynamics of Perpetuation: Politics of Keeping Highly Toxic Pesticides on the Market in Ecuador. *Nature and Culture*.
- Sherwood, S., M. Schut, C. Leeuwis. 2012. Learning in the Social Wild: Farmer Field Schools and the politics of Agricultural Science and Development in Ecuador. In: H.R., Ojha, A. Hall, R. Sulaiman (eds.). *Adaptive Collaborative Approaches in Natural Resources Governance: Rethinking Participation, Learning and Innovation*. Routledge: London, UK, 102-137.
- Sherwood, S., A. Arce, P. Berti, E. Bekkering, R. Borja, and P. Oyarzun. (submitted, May 2012). From pesticides to obesity: rise of non-communicable diseases and food counter-movements in Ecuador. *Food Policy*.
- Turnhout, E.; Bommel, S. van; Aarts, M.N.C. .2010. How Participation Creates Citizens: Participatory Governance as Performative Practice. *Ecology and Society*, 15(4): 26-41.
- UNFPA and FLACSO. 2006. *Ecuador: Las Cifras de la Migración Nacional*. Quito, Ecuador.
- Yanggen, D., C. Crissman, and P. Espinosa, (eds.). 2003. *Los Plaguicidas: Impactos en Producción, Salud y Medio Ambiente en Carchi, Ecuador*. CIP, INIAP, and Abya-Yala, Quito, Ecuador.
- Yanggen, D., D.C. Cole, C. Crissman, and S. Sherwood. 2004. Pesticide use in commercial potato production: reflections on research and intervention efforts towards greater ecosystem health in Northern Ecuador. *EcoHealth: Ecosystem Approaches to Human Health*, 1(2): 72-84.
- Wagemans, M. 2002. Institutional conditions for transformations: A plea for policy making from the perspective of constructivism. In: C. Leeuwis, C. and R. Pyburn (eds), *Wheelbarrows Full of Frogs. Social Learning in Rural Resource Management*. Koninklijke van Gorcum, Assen, NL. pp. 245-258.

World Bank, 2011. *Agricultural Innovation Systems: An Investment Sourcebook*. World Bank, Washington, DC.

Figures and boxes**Figure 1.** Decline in potato productivity in Carchi (INIAP UVTT-Carchi)

Box 1. *Wachu rozado*: a pre-Colombia conservation tillage potato system

The term *wachu rozado* is a mixture of the Kichwa word *wachu*, meaning furrow, and the Spanish *rozar*, to cut; literally, *wachu rozado* means “cut furrow”. It is a pre-Colombian limited tillage system for roots and tubers that appears to have developed in moist highland páramo region of the northern Andes. *Wachu rozado* involves cutting and folding over two parallel rows of sod towards one another. The potato crop is cultivated where the line of folded over sod flats meet. Farmers claim that *wachu rozado* is more productive than conventional tillage. They also report that it reduces soil erosion, and that plants have less problems with late blight. Farmers observe that harvested potatoes are cleaner and have less incidence of damage due to the Andean weevil and potato scab disease. Initial studies confirm what farmers had been saying all along (INIAP and CIP, 2003). Economic analysis demonstrated that *wachu rozado* can be seen as more cost-effective than hand tillage and comparable in cost to conventional mechanized tillage (figure 2). It is also an important source of employment, demanding 25 more labour days/cropping season than conventional tillage. Soil displacement under *wachu rozado* is considerably less than under conventional tillage (about 15 vs. 40 t/ha) (figure 3). Additionally, *wachu rozado* produces 'cleaner' potato tubers – dirt-free and with less *Rhizoctonia* and Andean weevil damage. Apparently, the 'heating up' of the sod mat in decomposition was antagonistic to soil pests. Research trials shows that under equal fertilization regimes *wachu rozado* out-produces conventional tillage (24.13 vs. 19.52 t/ha), most likely due to increased mycorrhizae development and improved phosphorus uptake. Under *wachu rozado* the potato crop grows on a high ridge and has better drainage than with conventional tillage, leading to lower relative humidity around the plant. As a result, comparative trials find less severity of late blight infection (AUDPC of 471.44 for *wachu rozado* vs. 629.55 conventional tillage). *Wachu rozado* proves to be both highly productive and resource conserving -- a rare combination, leading a McKnight Foundation report to conclude that this farmer-developed innovation represented a hidden opportunity for improving soil management in the Andes (Fonte and Vanek, 2012).

Figure 2. Soil displacement in conventional tillage versus *wachu rozado* (INIAP-CIP, 2003)

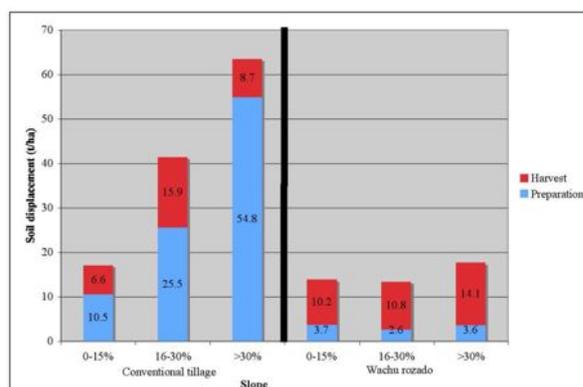
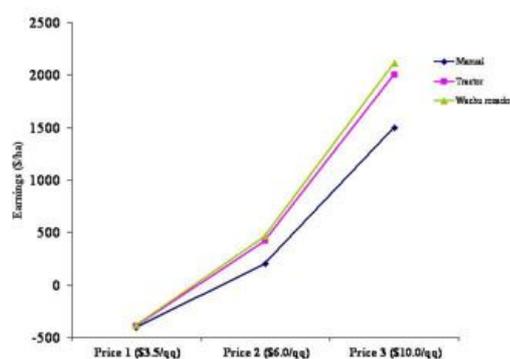


Figure 3. Productivity of hand cultivation, conventional tillage and *wachu rozado* (INIAP-CIP, 2003)



Box 2. Farming styles as counter-tendencies in potato production: addressing harmful consequences of modern technology (Paredes, 2010)

Paredes shows how agricultural modernization is part of a an endlessly negotiated process that is continuously transformed through peasant farming practices and social networking. It begins with a study of the historical process of agrarian reform by means of an examination of the life experiences of local actors. It goes on to explore how traditional practices have given way to agricultural modernization, a change that has been attended by significant consequences for human health. Exploring the subtle relationships between farming practice and markets, technology, and the structuring of labour, Paredes identified four dominant style categories: Tradicionales (traditional farmers), Seguros (pragmatic farmers), Arriesgados (high risk-takers) and Experimentadores (experimenters). Particular farming styles performed differently, in terms of technological self-sufficiency and market dependence (figure 4) with important implications on sustainability. As a result of human health concerns over pesticide poisonings, Paredes looked at significant variations across the different farming styles (figure 5), with certain styles (the Seguros and Tradicionales) showing far less exposure to pesticides. The problem was not a lack of alternatives, but rather policy in favour of certain styles over other possibilities.

Figure 4. Self-sufiency and market-dependence of different farming styles (Paredes, 2010)

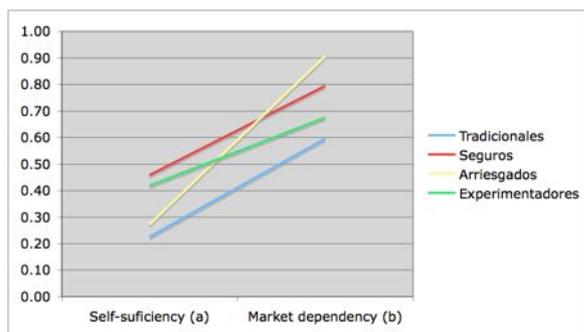
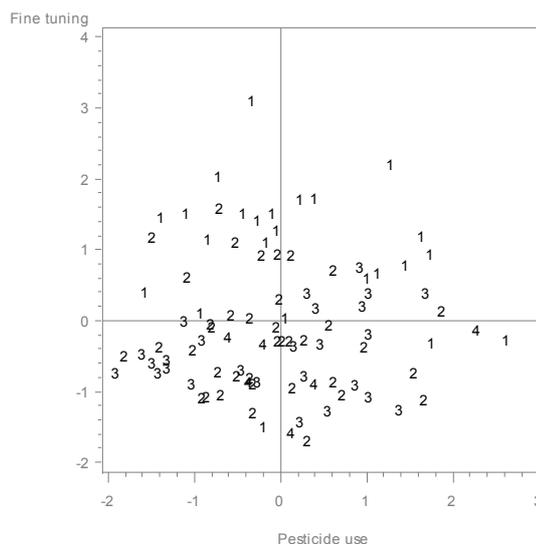


Figure 5. Scatter plot of farmers' factor scores on pesticide use versus fine-tuning (Paredes, 2010)



1= Tradicionales, 2 = Seguros, 3 = Arriesgados, 4 = Experimentadores