Research Article

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Understanding and Changing Farming, Food & Fiber Systems. The Organic Cotton Case in Mali and West Africa

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Abstract: Science should be capable of covering issues as diverse as farming systems, technology, innovation, climate change adaptation, poverty alleviation, extension, policy and practice, as they all relate to sustainable agriculture and development. Some years ago, the call for a new farming systems approach was raised to accommodate the principles of interdisciplinary, systems thinking and participatory research. Society calls for systems performance that provides stability and sustainability (SDGs!), multi-scale and territorial approaches and looks for solutions for critical issues such as employment, migration and inclusion/exclusion at the global level (World Society). We propose here a way in dealing with this complexity by addressing the mentioned problem from the communication and symbolic perspective, i.e. to consider the "object" within agricultural science but mainly observe the dedicated systems of communication. By using the concept of social systems, we can accommodate under it systems as diverse as farms, extension organizations, innovation patterns, (agricultural) sciences, policy and politics, farmer and indigenous knowledge, markets and value chains, but always in the form of communication. As such, we remain within a discipline with the potential to evolve towards a promising sub-discipline of agricultural sciences (or of sociology?). The relatively new farming approach of certified organic in combination with agroecology is relevant for family farms and small-scale entities. It depends much more on societal support for extension, technology development and policy coherence than commercial farms. Organic agriculture, with its standards, technological requirements and consumer preferences is nested in socio-economic and political networks, which makes it challenging for researchers to integrate the various components. This challenge applies particularly to countries with poorly developed institutions, weak organizations and within the context of poverty and rural exodus. We therefore use a unified approach under a single scientific system. This system observes, analyses and reports on communication aspects of involved (observed!) social systems (including networks and interactions) within the society of any given nation, including the realities of globalized markets. We are developing a case study based in Mali, in which we apply this method. The case is describing a planning process involving cotton farmers from the Sikasso region, the cotton industry, public and private extension systems, farmer organizations, local governments, the NARS (IER), FiBL, donors and the national institutions involved in climate change adaptation and food security. Various technological options of production (conventional, organic) and farming systems are available. The reflexive use of science dealing with human behavior may facilitate the pragmatic participation of researchers from various disciplines in addressing the uncertainties and opportunities that lie ahead of us and achieve the required impacts together with the practitioners.

Keywords: farming system, socio-ecological system, organic agriculture, communication, sociology, organic cotton, Mali, sustainable development

1 Introduction

Innovations are of capital importance for meeting current and future challenges in food, farming and the (natural) environment. Science and technological research is expected to contribute to common and classificatory frameworks (Ostrom, 2009), to their clarification and to provide practical solutions for stakeholders and institutions (Foley et al. 2011). Agricultural sciences, dealing with both biophysical (like soil degradation) and socio-economic or sociological phenomena (like farmer poverty), are particularly useful in providing both theoretical and practical insights, as they operate at the

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interface between natural, technological, economic and social systems and between different knowledge systems and policy arenas. The understanding of cotton and food systems depends to a high degree on the perspective of the observer/science (Alrøe and Noe 2014) and on the boundaries of the framework in space and time. This paper discusses the organic cotton system in Mali, including its social and natural environment, with the aim of presenting meaningful and still practical conclusions. The proposed framework integrates science, technology, policy, and practice to find better solutions to complex challenges (Banson et al. 2016; Harvey 2014), particularly to soil fertility, climate change adaptation, and poverty. The theoretical method applied will be explained in the first part (described in Nicolay 2015), proceeding with its application for the given case study in Mali before presenting conclusions going beyond this specific case. The theoretical part is required as an introduction of the applied frameworks and models and to unfold the complex structure of our given socio-ecological system and its hypothesized elements. The proposed structures cannot be reduced to few dimensions as suggested in other cases (Anderson, 2008; Kok et al. 2015; Leslie et al. 2015) or with concepts limited to farming systems (Vanlauwe et al. 2017).

2 Frameworks, theoretical background and models

Certain distinctions are required to be able to make observations (Luhmann 1995), as they provide the names of the objects and their relationships. Science explains events by applying abstract frameworks and models based on proposed distinctions. When the model proves useful, then it is thought to reflect the truth or reality. To clarify the scope of the present research, the following graphic description (Figure 1) is offered as an overarching framework, functioning here as an effective theory (Hawking and Mlodinow 2011) created to model observed phenomena without describing all of the underlying processes in detail (p.46). We have three overlapping sub-systems: Agriculture, Food and Food Security, each with four dimensions. Farming systems are conceptualized as a dimension within the Agriculture system, together with farming outputs (not yet in the form of food, but rather as crops, livestock, etc.) and natural conditions (like soil, water and weather). This system is embedded in non-human nature, but at the same time within the realm of human activities and society. Therefore we consider it a socio-ecological system, or

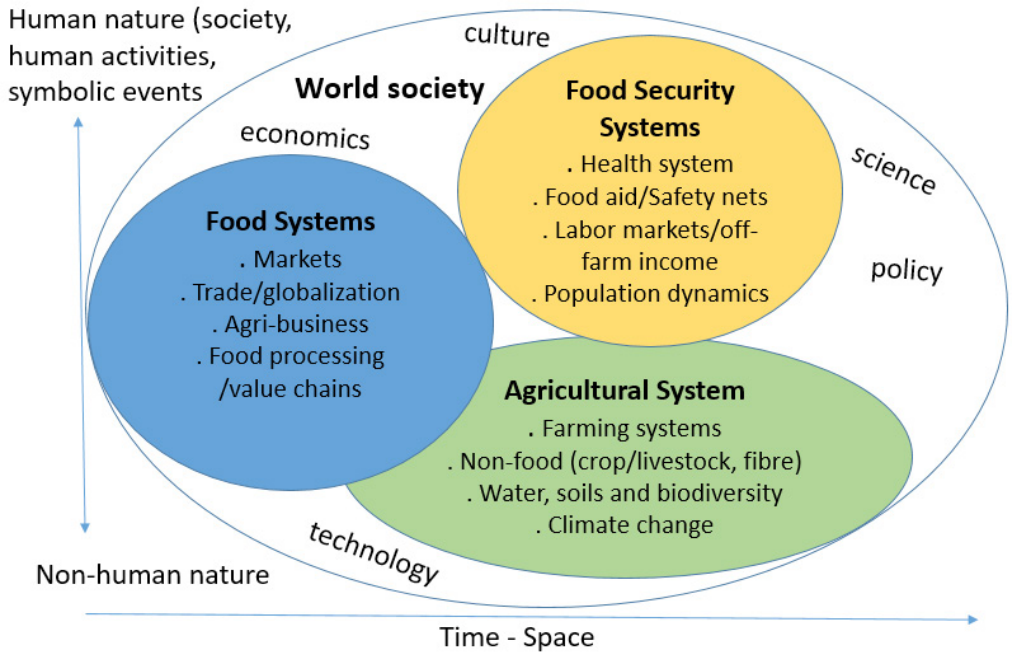

Figure 1: The three main sub-systems –i.e. Agriculture, Food and Food security- which are defining food and agriculture systems embedded in society- or short Food and Agriculture System in Society or FASS (adapted from Stephens, Jones, et al. 2017). This framework 1 describes the large objects. "Society" here includes material/bio-physical variables

SES (Folke et al. 2016). We define World Society in such a way that, apart from groups, communities, national societies and globalized institutions (as human-based constructs and communication events), it also includes natural phenomena that interact with humans. The other two systems, Food and Food Security, are less embedded in nature (bottom of y-axis) and more in the symbolic or mental space (Godelier 1986) of society (top of y-axis). Within Food Systems, which are here outside the Agriculture system, we mainly have dimensions of economic order (like markets and value chains). In Food Security Systems, which are highly relevant in most southern countries, we find institutions of predominantly social and political order dealing with health, safety nets, labor markets, off-farm income and population dynamics.

Critical to this definition of our overall framework (or set of distinctions) is the assumption (hypothesis) of a continuum between non-human natural and societal (human, society) phenomena as well as their position in a time and space dimension. World Society can be regarded as the general context for the social space, in which the three systems (Agriculture, Food, Food Security) have (co-) evolved for at least 70 years. To simplify, we may call the unit of these three systems Food and Agriculture System in Society, or FASS, and treat it as a framework (see more details in Nicolay 2015). It is by convention and its inner nature a socio-ecological system (SES). The FASS object provides, therefore, a very rough definition and grammar on "observing and understanding" the phenomena of Food and Agriculture systems in contemporary societies.

Biophysical (non-human nature) and societal (human-induced) phenomena and forces (Figure 2) determine "Agriculture and Food Systems" outcomes. They drive the Action Arena as external factors, the space in which actors search for solutions to solve specific problems. This arena than "produces" or "constructs" the FASS observable system outcomes, which we have distinguished into three main categories (or subsystems): (i) Food; (ii) Agriculture; and (iii) Food security sub-systems (Stephens et al. 2017). The perspective on outcomes (of FASS) will further focus our scope of research on practice. We hypothesize that a large and important number of observed phenomena associated with FASS emanate from mixed socio-ecological and societal drivers or variables (Nicolay 2015). Human observers and actors will usually transform the "purely" biophysical phenomena into practical knowledge (and so make it available to social scientists and practitioners). In such a form, they will become social phenomena (still as information) and be dealt with by agricultural researchers with socio-economic skills.

The cotton system in West Africa, used here as a concrete FASS case, includes food crops (mainly cereals), livestock, fiber production, climate change and soil degradation, markets and trade, fiber and food processing, food aid, labor markets and population dynamics as its main elements. What we still need to identify and define are the basic societal parameters or variables, which are here referred to as mega-structures, and their relationships, as they permit to empirically observe and understand value chains and industries (like cotton) from the sociological or social science perspective. They often exist at global level but always appear in figurations (Elias 1994; (Arnason 1987) and other manifestations at the farm, village, and local level. A simplified framework 3 is proposed here, based on (philosophical) political economics going back to K. Marx (1906) and adapted from Habermas (Band 2, p.251) (1985). This framework model (Figure 3) tries to explain the dynamics of the forces of production, i.e. the economy in relation to "society" and culture including ideology. The model takes into account that FASS systems are primarily economic by nature, with the prime function of producing goods and services for society.

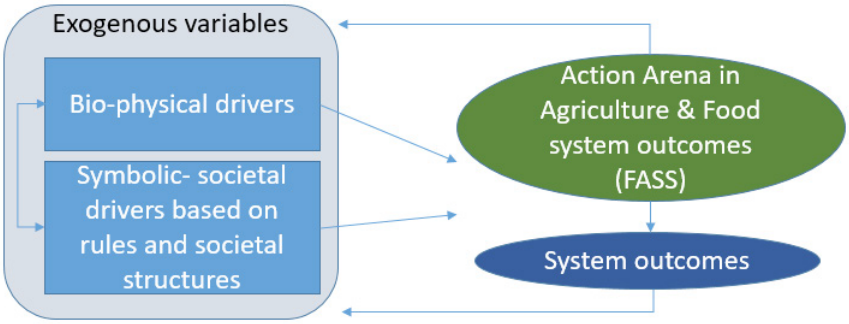

Figure 2: Simplified model of the drivers and Food and Agriculture systems in society (adapted from Ostrom 2005). This frame-work 2 describes the three main phases happening in the main objects (drivers, action arena, system outcomes)

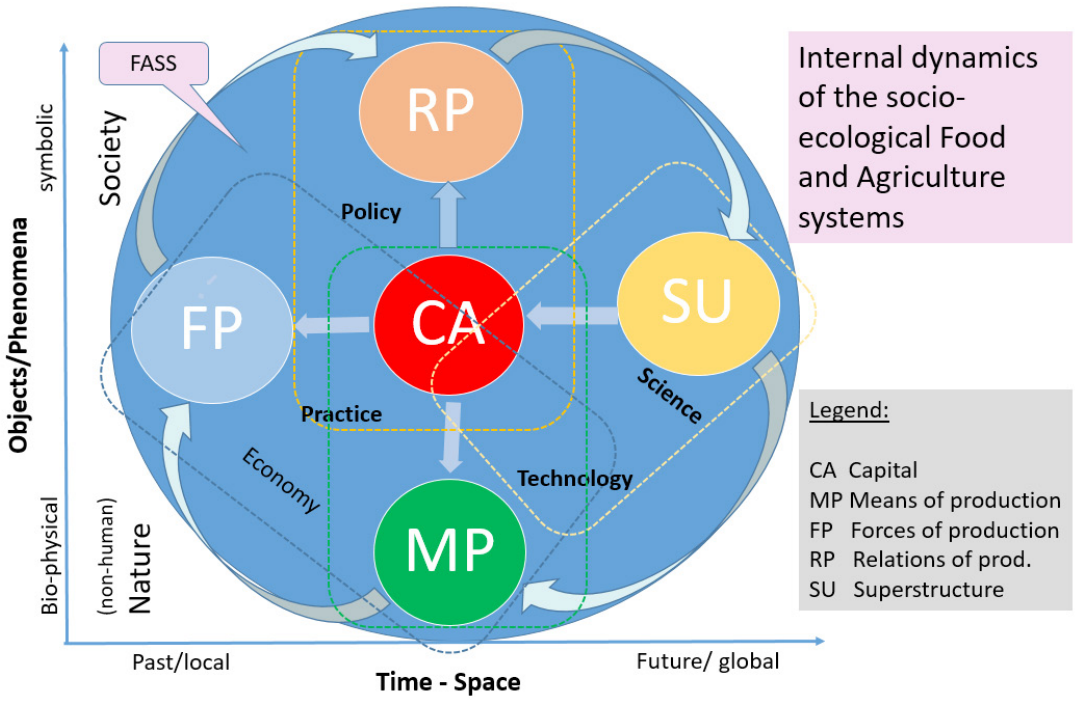

Figure 3: The dynamic relationship between the five mega-structures Capital (CA), Means of production (MP), Forces of production (FP), Relations of production (RP) and Superstructure (SU) within time-space and the gradients defined by material and symbolic matter. This framework 3 describes the dynamic cycle of the mega-structures within FASS

The base of FASS lies in the material origins of the means of production, mainly (fertile) soil, available water resources and seed. The various forms of Capital (CA) together with the Means of production (MP) determine the Forces of production (FP). The FP contain material and symbolic/mental elements, which we can empirically observe and interpret. The next step in this model leads from FP to the Relations of production (RP), which we can characterize in the form of social systems as organizations and the political systems involved (mainly within national setups). The above elements constitute the Base of FASS. What remains is the Superstructure (SU) characterizing cultural and ideological patterns, including science, law and mass media, all of which are relevant social systems shaping FASS. The Superstructure then co-produces CA and further influences the MP (like increase/decrease of soil fertility).

This framework model (Figure 3) provides a simplified explanation for the movement, cause-effect and feedback mechanisms inside the highly complex and encompassing body of knowledge and FASS case studies. Note that information (as events), and information processing structures (in the form of rules and institutions), constitute the main elements of the model. Specific realities are, however, much more complex and include feedback loops, particularly shaping the inner sub-systems and relationships. For this purpose, it is proposed to use the variables shown in Table 1, with the five mega-structures (MP, CA, FP, RP and SU) as first tier, their core parameters forming the second tier and the variables affecting the core parameters representing the third tier. Table 1 has evolved out of research conducted in Africa since the 1990s (Nicolay 2013b, 2015; Nicolay et al. 2014; Sodjinou et al. 2015). What is new here is the re-discovery and inclusion of the mega-structures MP, CA, FP, RP and SU. This framework model necessitates the integration of natural and social science disciplines (including humanities, agronomy, farming system research, agro-economy, political sciences, sociology, history, anthropology and systems theory just to mention the most prominent ones). A previous paper (Nicolay 2015) developed in detail the evolution and construction of the theoretical body providing the framework model (Alexander 2013; Bergson 1911; Bourdieu 1994; Elias 1994; Godelier 1986; Latour 2005; Luhmann 1995; Peirce 1958; Vico et al. 1999 (1744); Wittgenstein 2010 (1953); Ziegler 2011). It is understood that the overall FASS framework was developed dialectically through interactions and observations at field level on the case study of a cotton project in West Africa, involving discussions with farmers, advisers/extensionists, researchers and other practitioners for the sector and societies (see details in Nicolay 2015).

Table 1: Framework of exogenous variables (elements) of Food and Agriculture systems in society, including five mega-structures (1st tier variables), 18 2nd tier and 99 3rd variables

#	1st tier	2nd tier	3rd tier variables						
1	MP	population	pop density	demo. structure					
2		infrastructure	health infr	roads infra	schools infr	water infra	markets infra	credit infra	processing inf.
3		farming system	land and soil quality	other assets farm	labour farms	farm income	markets farm	investments farm	Ag structure
4	CA	human capital	age	health	knowledge	dignity	food security	labor availab.	well-being hum.
5		economic capital	legal property	agr. markets	investments	farm type	assets eco.	poverty	
6		financial capital	% HH with cred. Access	incomes (HH, oth)					
7		social capital	customs/habits	trust	education (status)	networks	urban centers	movements	
8		cultural capital	languages	values	norms, rules	innovations	myths	ritual	collect. memory
9		symbolic capital	influence	rigths	territoriality	governance			
10	FP	Creativity	fantasy	laugh (inst.)	technol. knowledge	theatre	attentiveness	contempory art	obedience
11		social interaction	wordsOfmouth com.	Household/family	local communities	clans and tribes	gender (s.i.)	migration	global (s.i.)
12		Economy[f]	Ag sector	Industry (incl. Food)	Services (Eco)	land market	production (Eco)	consumption	land (Eco)
13	RP	organizations	associations (org)	religious org	enterprises (SME, TNC)	CBO/NGO	extension org	public (state, IO)	
14		Politics[f]	coherent ag pol	coh. rural dev pol.	security	leadership (Pol)	governance (L,N,R,G)		
15	SU	Education[f]	learning society	basic literacy	socio-cultural edu.	formal education			
16		Law[f]	property rights	land tenure	human rights	labor rights	customary law	policy framework	
17		Mass media[f]	radio access	TV access	mob. phones applic.	internet/ soc.m	print m. access		
18		Research/Science[f]	ag and social sciences	ag research	innovations (Res)	higher edu. (Res)	farmer research		

MP Means of Production; CA Capital; FP Forces of production; RP Relations of Production; SU Superstructure; f stands for function system as a highly complex social system (Luhmann 1995). The 2nd var. 11-18 are social systems

In a first step, the relevant 3rd tier variables are identified, and appropriate indicators selected. The measurement will be done on agreed indicators for each relevant variable (see more in methodology below). This process requires a defined procedure, as most variables are socially constructed rules embedded in human language, and as such, they lack clarity and require interpretation (Ostrom 2005). Below we try to clarify the proposed procedure with the concept of an Innovation Platform. This framework model (including theory and its application) goes further than the current farming systems approach and shares the appreciation and usefulness for systems thinking, interdisciplinarity and participatory research (Darnhofer et al. 2012). The proposed mega-structures with their 2nd tier variables bring in elements of the research process which in most cases only serve as context and fall out of the Action Arena. Systems theory does not include context, but rather environment (Luhmann 1995). By setting the boundaries against the larger society (and the "world") in the form of FASS (Figure 1, Figure 3) and by including the proposed elements (or variables) of Food and Agriculture systems in Society (Table 1), all elements within the (socio-ecological) system are part of the FASS system (and so the object of our research). The rest will be considered as the environment. Following Luhmann (1995), there are three distinct environments of FASS when dealing with social systems defined as communication: psychic, social (aspects that are not included in FASS, such as non-food/fiber economy, general welfare politics, religion, military, financial industry, entertainment etc.) and natural (as non-human nature).

This set of frameworks has the advantage of coping with relatively complex socio-ecological systems, from the farm level down to local community levels, with globalized actors and institutions from the World Society level. Landscape dimensions are included and can be addressed by appropriate "zooming" of the perspective. The integration of communication aspects through "function social systems" (Luhmann) with material aspects (capitals, means of production) allows the "zooming" of material flows, system performance and productivity aspects. The highly differentiated food systems in contemporary economies and societies with organic food and production chains (Constance et al. 2013) can be analyzed by considering the interferences with conventional production figurations (Elias 1978) and related social systems. Family farms, which are poorly captured by national statistics but provide the primary form of production worldwide (Graeub et al. 2016) can be analyzed in relation to relevant factors (like credit, extension, research, policies, migration etc.). Pertinent other strategies and policy recommendations at the global level (CFS 2015, 2016) may be better monitored and critically assessed by integrating the various higher level tier variables (1st, 2nd) and putting them into context. Finally, scientific disciplines should be seen as what they are: not static holders of truth, but as dynamic systems of communication (Stichweh, 1996). By including research outcomes as indicators of scientific variables (as a "function social system"), dialogues between researchers of the various disciplines, practitioners, market players and policy makers may be organized into specific

innovation platforms (Nicolay 2016 b) and provide practical solutions.

From this framework and set of theories, we may now deduct assumptions and propositions describing the context of our case study of organic cotton in Mali:

- We consider all elements of the factors (both biophysical and societal) as material and/or symbolic and objective, i.e. observable relatively independent of a subjective observer. We make a distinction between "objective" and "true". "Objective" means that a given fact can be identified independent of the observer/researcher, whereby "true" refers to a proposition that can't be negated by any argument
- We call the integration of biophysical and societal phenomena of FASS a socio-ecological system. We propose a framework with 18 parameters (or second tier variables). The trend of such systems goes in the direction of differentiation and expansion (but they may also collapse)
- All Food and Agricultural systems are dynamic, contingent (i.e. not entirely deterministic as they are based on rules and not on laws) and move constantly. Their boundaries and internal processes and specific dynamics need to be decided on and interpreted by agreement of the observers (as no independent observers exist)
- Food and Agriculture (F&A) systems by convention constitute a super-sector (including at least agriculture, nutrition, social security, trade and natural environment) within the economy and society (both national and worldwide). In most cases, the non-economic characteristics of the sector are neglected in both research and practice
- We differentiate the F&A systems into various industries. Our object of interest is the cotton industry, particularly cotton production in Mali, and its relationship with soil fertility, food and nutrition security and climate change adaptation
- I define our object of interest as a concrete, observable and dynamic object constituted or constructed by natural (biophysical) and social (societal, including human, cultural, economic, technological, social and political phenomena) elements or factors and always by human actions. We want to understand system failures to improve their performance and resilience
- System failures are normative, but objective, i.e., concrete and debatable. The fact that various interpretations are possible does not mean that they should not be an object for science and research (this applies as well in quantum physics)

  Action and knowledge (at an individual level), and socio-ecological system behavior and information content (at the societal level) are in real life interwoven and inseparable. This is true when searching for knowledge (which requires action) as well for the appropriate actions (which should be based on knowledge). We call the integration of action and knowledge good practice. We hypothesize that a mass of good practice (by individuals) can lead to an increase of order and "good behavior" by socio-ecological systems.

3 The methodology of the application of the "Unified Approach."

The framework and theoretical background of our method are based on socio-ecological systems (SES). We use the set of variables within the three tiers: the five mega-structures (1st), the parameters (and dimensions) of the 2nd tier and the 3rd tier variables as described above. By applying this rather abstract method in a concrete case study using data collected on various projects over about two years, the intention is to not only to make the FASS-model concrete and empirically testable, but to use it at a later stage to make predictions. The complexity and variability (in time and space) of our object requires application at the case level to provide meaningful, i.e. actionable, knowledge. The application has dual aims: (i) to produce useful insights into the dynamics and understanding of the case study - here the organic cotton system in Mali and how it could be addressed by various stakeholders from production, advice, research and policy making - and how the advantages and disadvantages of the conventional cotton system could be assessed. The stakeholders involved in this area may be particularly interested in this question; and (ii) to test and further improve the theory presented above related to both its logic and clarity of presentation, as well as its potential use as a toolbox to be applied in completely different FASS settings.

The real desire to promote the case of organic cotton in Mali and West Africa, based on past research and development work since the 1990s, offered the opportunity to refine and test the framework and application of the theory (see above) and to use this knowledge for both action and research. This "desire" provides at the same time the limits of the research, including the content and actors involved. Since early 2017, the author has worked with collaborators on a project with the working title "Organic Cotton Coalition West Africa", aiming to improve the conditions for utilizing sustainable forms of cotton systems for the people, the various social communities (including the state) and the natural environment. The

actors involved are therefore the representatives of organic and fairtrade cotton producers from Africa, some representatives of ginning companies, textile producers, researchers and officials from government and NGO. At the same time, the author is involved in four other Research for Development projects associated with the nexus "soil fertility- climate change adaptation- value chains/cotton- food security" (ORM4Soil, Yamsys, ProEcoAfrica/EOAI and Mercator Mali). Insights from these projects were flowing into the data collection as well into methodological refinements.

The Fourth Conference on Organic Agriculture for West Africa, held from the 5-6th December 2017, allowed for further data collection and testing of some assumptions about the state of the industry as well conditions within the involved organizations, networks and programs. The matrix with the five mega-structures, the 2nd tier and its 3rd tier variables (see Table 1) was used as the tool for observing, understanding and collecting the primary information. Various feedback received at the conference workshop led to the list of agreed indicators for each 2nd tier variable. The sources of information and the significance were not statistically assessed.

4 Results in the case of organic cotton systems and F&A systems in Mali

Applying the theoretical framework outlined above to a real-life event, specifically the process or project of "Organic Cotton Coalition West Africa" and including the milestone of the Bamako conference, the first results consisted in formulating basic questions for the object of research, the "organic cotton case study of Mali and West Africa":

1. How can jointly-developed integrated solutions in organic cotton be implemented to overcome the problems or adverse outcomes of the current FASS system?
2. How can dialogue among science, practice and policy decision makers be encouraged?

The discussions held led to the assumption that instances of failure (or adverse outcomes; see Figure 2) in the case of the cotton system in Mali are due to the following factors: low productivity of cotton production; poverty of producers; soil degradation and declining yields; uncertainty about how programs are coping with climate change; unemployment and low labor wages; health problems due to pesticide application in the cotton fields; global textile companies having difficulties in finding organic cotton lint on the world market; food insecurity; social unrest; poverty and failed state (see more in Table 2).

Sustainable, agro-ecological and mainly organic forms of cotton production embedded in supportive institutions and programs have the potential to reduce these failures. However, organic agriculture still lacks the required support by policy makers and business partners to be adopted, particularly in the cotton industry. This industry may take more time to be widely adopted, as it has only been in Mali for 10-20 years (see more in Table 3).

First of all, we should regard the structure and organization of the organic (and Fairtrade) cotton production in Mali as an innovation system, with the potential to increase economic performance (through a premium price). Then, secondly, it should be seen as an opportunity to improve the the ecological resilience of the system (thanks to the absence of synthetic pesticides and soil-harming urea, and the replacement of synthetic nitrate applications by organic matter in the form of manure or compost). Finally, it contributes to social development, thanks to the relatively high degree of organization of the organic cotton producer cooperatives and the strict production standards (controlled by the annual certification inspections). However, less than 2-3 % of cotton production is organic.

From the author's point of view, the conditions of the "Mali-Cotton-FASS" are as follows: (i) Low or in most cases declining soil fertility in cotton farms over the last 20 to 30 years; the aim is to address this critical feature within the MP through finding and debating a practical and feasible approach. (ii) Some of the stakeholders (including the author) aim to address the issue through the newly launched Cotton Coalition for Organic and Fairtrade (CCBE). The following organizations discussed and agreed on this idea before the December conference in Bamako: Aproca, FENABE, Helvetas (all based in Mali), some organizations from Senegal, Burkina Faso and Benin, as well ecos and FiBL in Switzerland and Fairtrade International. (iii) The main learnings during the Mali mission (bilateral meetings with partner organizations, the 2-day conference) in December were:

- The national structure of the CCBE will be designed as a loose network. A formal construction would not work due to bureaucratic hurdles
- The coalition should stick to the formal organic standards. Any mixture or combination of other standards (like Better Cotton Initiative (BCI) or Cotton made in Africa (CmiA)) would disturb the involved

actors and their programs in the already highly differentiated process of the industry-based value chain reaching brands and main markets in northern countries, and so would unnecessarily increase complexity
- Farmer organizations expect to be the core players within the CCBE, while at the same time, they are in tough financial and organizational situations
- The Action Arena can be enriched in future by Innovation platforms (Nicolay 2016b), organized in local regions (like Sikasso) or at national level including the primary stakeholders (farmer organizations, Aproca, CMDT, IER as research body, the local textile industry (SME), financial and technical partners and policy makers) or even at regional level
- The regional organization of CCBE, involving stakeholders from Senegal, Burkina Faso and Benin as well brands and industry players could empower the Mali structure and enhance its self-organizing nature (Ostrom 2005; Luhmann 1995)

The CCBE was then discussed in a working group (a functional ad-hoc innovation platform) over two days, composed of over 30 regional participants and the relevant stakeholders from Mali in place (CMDT, Ministry, AProCA, FENABE, NGOs, IER, parliamentarians (which are also cotton producers)). The participants decided to launch the CCBE within four countries: Mali, Senegal, Burkina Faso and Benin.

Below, findings related to (a) problems and (b) assets of the given organic cotton (FASS) in the form of narratives organized within the 2nd tier variables are presented. Within the cotton industry, the following problems were hypothesized after collecting the data (Table 2): apart from the problematic weaknesses linked to available financial capital for investments in organic cotton and the weak position of the producer organizations and lack of trust in organic production by the policy makers, the lack of a holistic or integrated vision of the "case study" (poor imagination, lack of creativity) poses a risk.

The new vision of the coalition (CCBE) has become a leading asset and driver for change in the landscape of promoting organic cotton systems in Mali and West Africa. It reveals the importance of ideas and symbolic entities in shaping socio-ecological systems and the decisiveness of actions related to it. Table 3 lists the main assets for change.

The (verifiable) data so far suggests that nothing should impede per se the creation of the CCBE and that this network or organization could substantially change the landscape of cotton FASS in Mali through influencing and co-constructing the required figuration of the cotton system and so enhancing the conditions for soil fertility enhancement and climate change adaptation.

The following reasons for involving the public sector in the CCBE were highlighted in the discussions of the conference: (i) the public role on soil fertility as a national and global public good, which cannot be left to market forces and to the sole responsibility of the individual farmers; (ii) the employment issue, because organic cotton and organic farming are labor intensive, substituting imported inputs (mineral fertilizers and synthetic pesticides) through local knowledge and farmer skills by local resources, resulting in more employment in the framework of family farms than conventional farming (under the condition that it is at least as profitable); (iii) biodiversity, because many insects and birds have returned to fields and villages with dominantly organic farming replacing conventional farming in cotton areas in Mali; (iv) industrialization, because increased processing of cotton through SME and artisanal industries, and combining it with high quality and cultural elements, will create new sustainable textile industries in the region. We could add the additional benefits for healthy and more available nutrition and better food security. The framework model (particularly Figure 3) already provides the structure to the answer on the practicability of integrating practice, science and policy-making. The conceptual differentiation of the various steps of the FASS process clearly outline the responsibilities and strengths of the three stakeholder groups: practice is dealing mainly with elements within CA and MP, science within the SU and policy-making in the fields of politics, which dominates the RP structure. The involvement of semi-autonomous national chapters, reinforced by the Regional Economic Union (ECOWAS) and supported by clients and partners at the global level, all organized within the Coalition, should be feasible. The primary challenge will be finding the financial capital under pro-African governance conditions (Nubukpo 2011) for such an operation and linked to that the skills and practice of communicating the issues at stake.

The following actions will refine the understanding of our FASS, and at the same time redirect the efforts of the promoters of the CCBE. A set of innovation platforms (IP) will help to operationalize the coalition by channeling the various interests. It is assumed that the national IP in Mali, based on the emerging regional IP of the Sikasso region, initiated in May 2017, or in Burkina Faso will stimulate the launch of the corresponding IPs in Senegal and Benin. If this succeeds before 2020, then this case study has very good potential to contribute at the same time to soil fertility enhancement in the cotton belt of West Africa (benefiting over two million cotton-farming

Table 2: Hypothesized problematic variables and facts based on a first assessment

MP	**population**	Often too low density in rural towns
	infrastructure	Lack of local market infrastructure, ginning industries are sub-optimal
	farming system	Degraded soils, poor mechanisation, lack of farm labor, poor farm income, lack of domestic markets, poor investments on farms, too many small farms; lack of tractors;
CA	**human capital**	Poor knowledge on modern technologies; food insecurity (23% of regional population still suffering hunger); many (farmer) leaders narrowed by short-term visions and just pecuniary interests
	economic capital	Poverty; FENABE members have just 0.7 ha cotton area per farm; less than 1% of cotton is produced organically; costs of certification (organic) often still too high; poor farming households are the norm;
	financial capital	Poor incomes (producers, consumers, central state, territorialities); lack of credit facilities; critical financial bases of farmer organizations; delay of payments to cotton producers by CMDT (Compagnie Malienne pour le Développement du Textile), particularly to organic producers (jeopardizing production plans); BNDA (national bank) not farmer-friendly enough;
	social capital	Lack of mutual trust outside small traditional communities; CMDT monopoly on cotton marketing sometimes missused to sell organic cotton as conventional, leading to losses for the orgnaic producers;
	cultural capital	Language barrier between franco-and anglophone West Africans reduces regional cooperation; greed against sustainable processes;
	symbolic capital	Limited rights at local level vs national level, governance
FP	**Creativity**	Very poor development in appropriate technology for the masses of farmers; disconnection between the creative sector (artists) and the peasants; lack of fantasy (or courage) to move the bureaucracies; skills level
	social interaction	Weak class conscience leading to poor working and peasant class organisational degree; poor rights for youth; neglected women rights; reduced cooperation between conventional and organic farmers; uncontrolled migration into the capital (Bamako) and towards Europe due to unattractive working and livelihood conditions
	Economy[f]	Underperforming ag sector (land and labor productivity), lack of processing industry for textiles, lack of services in the private sector, dominance of the textile manufacturers and brands, fragmentation of the cotton industry; gold mining with its promise for quick profit as a challenge for farming; Mali has no influence on the cotton market, but sells about 95% of its raw product;
RP	**organizations**	Weak producer organizations (like UNSCPC, APCAM, AOPP, FENABE) with poor governance; fragmentation of farmer movement; high dependence on iNGO for organizing organic standards; extension only institutionalized and effective for cotton and cereals, for the rest mainly project driven and dependent on foreign interests; CmiA standard limits support to 3 ha farms; CCBE without financial resources (as per Jan 2018); rather poor organization of the organic sector; WAfroNet as regional structure still very weak; like-mided organizations have to establish a cooperation framework to defend their common interests; hierarchy with CMDT reduces performance and innovation;
	Politics[f]	Lack of production-industrialization links; dependency on foreign countries; lack of supportive measures for innovation in farming (extension, research, measures at custom level to better protect the emerging national systems of production); civil war in the North (part of regional conflict involving all neighbors and beyond); intransparent agriculture policy making processes and negligence of organic farming; strong increase in (perceived) corruption since 2016; CMDT finances are not transparent; organic farmers are not taken serious;
SU	**Education**[f]	Poor learning society; lack of farmer schools; sub-optimal education on contemporary issues related to well-being and peace;
	Law[f]	Property rights for large societal segments not given (allochthons, i.e. peasants migrated into existing villages and not benefitting the rights of the indegenous; women)
	Mass media[f]	Poor internet competency and capacities impedes better and affordable information provision to producers; about 12% of the population is online (BBC 2016); critical journalists are not save anymore (reduced press freedom since the 2012 crises in the North);media is not a forth power in Mali;
	Research/Science[f]	Poor public budget support for agricultural research, farmer research not fully supported; weak cooperation between bio-physical and social scientists and researchers; research has not yet succeeded in communicating
Bio-physical		Climate change impact; soil and land degradation and often declining soil fertility conditions (acidity, low SOM) on arable land leading to lower yields and higher input costs

f stands for function system as a highly complex social system (Luhmann 1995).

families). Further, it will contribute to the adaptation (and even mitigation) of climate change through enhanced organic matter content in the soils (we hope to reach over 100'000 ha), and finally, it will promote organic and agro-ecological farming and with that food security and better nutrition-related performance, wealth creation and achievement of the SDGs. In such a way, the dialogue between science, practice and policy-makers can be structured and encouraged, and the realities of organic cotton in Mali, as well the agriculture and food sectors, the local textile industry and rural development conditions (FASS) will be positively changed with subsequent actions towards the aims of SDG.

Table 3: Hypothesized asset variables or positive facts based on a first assessment

MP	**population**	
	infrastructure	Ginning factories incl. Cotton-villages to factory roads
	farming system	Large potential to increase organic production in: cotton, sesame, fonio, soja, mango and shea butter; the soil fertility as a main limiting factor and biggest comparative advantage against conventional farming;
CA	**human capital**	Potential farmer leaders with long-term visions and integrity; the youth has now better job opportunities than 20 years ago; farmer training and capacity building will transform in sector performance; mobile phones empower in principle the farmers;
	economic capital	1 t/ha yield potential for organic cotton; food crops of the cotton farmers (to be promoted in farming systems); domestic processing by SME of cotton; organic standards as a quality assurance; Mali cotton is competitive and of excellent quality;
	financial capital	Premium for organic cotton (about 20%); financial partners supporting sustainable agriculture incl. organic cotton systems; cotton in the sub-region provides a 2.5 Bio $ market (1.8 Mio t @ 1400 $) and over 2 Mio jobs; potential of improvement by BNDA (national agricultural bank);
	social capital	Various farmer organisations (and particularly FENABE for the organic sub-sector); social coherence in villages; close cooperation between ecological and organic organisations; 7000 cooperatives under CMDT (owning 20% of CMDT);
	cultural capital	Organic and fairtrade label; easy cooperation among French speaking West Africans;
	symbolic capital	Push for a governance on soil fertility (nationally organized) launched by the industry and the producers; the organic stakeholders formulate the 5% organic cotton market share target; WAfronet supports CCBE at regional level;
FP	**Creativity**	Know-how on participatory and integrated research within the organic stakeholders; organic farming with its SOM enhancing principle and strong cooperatives to address climate change; Mobile phones as a productive technology; more partnership based cooperation among the various stakeholders (mainly between public and private/farmer level); local knowledge and creativity of textile designers;
	social interaction	Establish communication channels among organic cotton industry stakeholders (within and outside Mali); CCBE project (launched in Dec 2017); IPs as engines to drive innovation; mobile phones improve communication within the sector;
	Economy[f]	Growing markets for organic cotton; >400'000 cotton producers; agriculture as the economic backbone of Mali; domestic textile industry with huge potential;
RP	**organizations**	Aproca; CMDT; FENABE; UEMOA (as facilitator for a regional IP); CCBE; various IPs (Innovation platforms); potential members of national IP dealing with soil fertility: AOPP, UNSCPC, IER, CMDT, regional reps; various promising projects/programs (incl. AEB/EOAI); economic dynamics in Koutiala (center of the cotton industry); CNOP; REMATREX (textile industry for domestic market); AFD, FiBL, Helvetas, ecos, IFOAM and other
	Politics[f]	Cotton is a strategic export commodity; potentially participatory and inclusive policy making with vibrant interprofessional and civic movement; local textile industry exists; The new 5-year plan of CMDT (2018-22) foresees the target of 3000 t organic cotton; UEMOA supports the 4 country-based CCBE; Sikasso region in principle committed to support a new cooperation culture based on soil-farmers-cotton economy;
SU	**Education**[f]	Conferences and trainings on the requirements for a successful CCBE for leaders on all levels (the EOA conference in Bamako as an asset);
	Law[f]	Loi d'orientation agricole (No 06-045, 6.9.2006);
	Mass media[f]	ORTM with weekly farmer broadcasts; over 300 radio stations; Facebook as top platform followed by Twitter (BBC 2016);
	Research/Science[f]	IER with good potential and IER-CRRA in Sikasso as competence center for cotton and agroforestry research;
Bio-physical		Natural conditions allowing non-irrigated cotton production

f stands for function system as a highly complex social system (Luhmann 1995).

5 Conclusion

Highly complex systems tend to hide internal order and suggest features that are more chaotic. This is also true in the field of contemporary food, fiber and agriculture systems, which embed all farms producing cotton in Mali. Using a case study in organic cotton in Mali, we have tried to show the usefulness of the FASS-framework and its related theories and models in reading facts and building new social imaginariesfor society and its environments and interpreting farming systems from within its realities. Agricultural sciences, or the sociology of food and agriculture systems (including food and nutrition security), need newly adapted models and procedures to cope with highly differentiated systems and realities, transcending fields, landscapes, nations and even continents. It becomes apparent that communication, and therefore the conscious way of using language and information, holding dialogues before acting and mutually looking for solutions within a holistic system of relevant parameters (variables) becomes a promising way to go. The reflexive use of science dealing with human behavior

(i.e. being conscious of its influence on action), and the acceptance that it is part of society and not outside of it, may facilitate the pragmatic participation of researchers in the various disciplines in addressing the uncertainties and opportunities that lie ahead of us. The launched CCBE has the potential to evolve out of the constructed Action Area and produce some of the intended impacts: improved soil fertility, better adaptation to climate change, better ecological resilience, and stronger producer organizations with better negotiation powers within the cotton and related food industries, and finally a better acceptance of organic farming in the context of SDGs.

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