Social and Technological Transformation of Farming Systems:

Diverging and Converging Pathways

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Workshop 5.8: Enabling innovation – the transformative (innovative) capacity of farmers and rural institutions

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The principle components of the workshop were formed around four main sub-themes, which participants were required to specify and rigorously interrogate in relation to farm innovators' and/or diversifiers' links with rural institutions and/or policy actors:

- the literature and the public policy environment's relationship/roles to farms' social and/or technological transformative capacity (e.g. theoretical or public policy deficits in understanding the relationships between these facets we well as advances made in relation to how these are realised on-farm);
- empirical evidence from on-farm of business innovation (agricultural or non-agricultural based) transformation process(es) (e.g. decision-making, networking, new or novel social or technological farm applications or management choices), the result of engagements with rural policy actors/institutions or as a departure from institutional influence to more market-based orientations;
- comparative examples of innovation as a transformative process from empirical farm-innovation based research within different policy jurisdictions (social, cultural, economic, political) – examples of territorial barriers, obstacles, impediments as well as facilitators (what works, what does not and how);
- evidence of social, economic, cultural or political innovative transformations – the effects (e.g. institutional restructuring, policy changes, regulation successes or failures) from public actor/institutional-based research on farmers' engagements with policy actors/institutions.

Taken together, these considerations pointed to a multi-scalar and multi-disciplinary analytic workshop that was grounded in network theory, but was also sensitive to the operation of local institutions, norms and conventions. The workshop framework was considered to be sufficiently flexible to account for research areas with high levels of innovative agricultural and non-agricultural transformations, as well as 'areas' and 'processes' where the phenomenon of innovation in both contexts is less apparent ('resistant areas and resistant processes'), or non-existent. We envisaged this workshop making a substantial contribution collectively to discussions of public policy processes inter alia, and in equal measure to the literature:

- Partnership governance/collaborative policy models (e.g. LEADER style initiatives – past and present);
- Scale of policy intervention or interfaces with farm households (bottom-up/top-down, lateral);
- Evaluating policy instruments (e.g. info sharing, capacity building/entrepreneurial capacity, regulation, market based instruments).

The workshop was intended to facilitate the critical examination of innovative on-farm business diversification as a dynamic, territorially embedded process. Evidence-based critical constructive criticism was encouraged. Papers could potentially involve farm businesses in transformative learning experiences that affect substantially their existing accumulation and reproduction strategies, as well as their methods and practices of environmental management. Unleashing these effects may require the presence of particular farm business and institutional attributes. The participants were encouraged to consider, identify and examine these

attributes, including local and regional differences both in the nature of these transformative effects, and in the local and regional policy approaches to business innovation and diversification in relation to environmental sustainability. These objectives, in the view of the convenor, were central to the workshop's contribution to the IFSA conference, and to the comprehensive vitality of knowledge on farming 'economies' required.

The workshop's conceptual framework drew upon network theory and new institutionalism. It enabled evidence of new business profiles in relation to local economic conditions, environmental possibilities and the interfaces with local/regional institutions and key political actions. Workshop analysis and discussion comprised quantitative survey evidence detailing qualitative case histories, in-depth interviews and other evidence from researchers' engagements with farmers and policy practitioners. This discursive format was intended to facilitate information sharing and the development of new approaches on innovation and business diversification, the environmental dimensions and the specific territorial farmer-institutional interface across a range of spaces and processes.

Participants who are interested in the development, application and interaction of policies and governance within agricultural systems and processes were invited to contribute to this workshop, if they considered that their research addresses issues and implications related to the above themes.

Step by step towards a reduction in antibiotics in French dairy cattle farms: a typology of trajectories of change based on learning and advice

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Abstract: Since 2011, French public policy has been encouraging a reduction in the use of antibiotics in animal farming. In this context, breeders have conducted initiatives for the reduction of antibiotics in their farms. The aim of this paper is to describe their trajectories and the management changes performed to achieve this goal. Our aim is to highlight the roles of private and public advisors in achieving a reduction in antibiotics. This study was based on semi-structured interviews conducted in spring 2015 with 14 French dairy cattle farmers, their veterinarians and advisors. We employed the concept of the "trajectory of change" to examine the comparison of the technical, economic, social and organisational determinants for the reduction in antibiotics. We built a model of demedicalisation trajectories inspired by a dynamic model developed by management sciences. Our hypothesis was that not only farmers' motivations and trigger events were critical to achieving a reduction in antibiotic use, but also farmers' requests for specific advisors. We identified three trajectories of change that include: the duration of the trajectory, the levels of antibiotic reduction, the learning processes, and the specific advisors. We identified three levels of transition: (i) direct without learning; (ii) direct with learning; and (iii) step by step with learning, and compared these results with the conceptual work of Hill and MacRae, "Efficiency, Substitution, redesign". Stakeholders involved in providing advice on practice changes may then build on the degree of transition of the farmer to ensure greater efficiency in their interactions.

Keywords: Antibiotics, change, learning, advice, dairy

Introduction

Antibioresistance (selection of bacteria resistant to a given antibiotic) is a public health issue that the WHO has described as a serious and growing threat. In France, the EcoAntibio plan, launched by the Ministry of Agriculture in 2011, is aimed at achieving a 25% reduction in antibiotic use in veterinary medicine in the next five years in order to reduce their contribution to antibioresistance and to preserve the therapeutic arsenal in human medicine for the coming years. In cattle, estimated exposure to antibiotics (ALEA) fell by 6.6% in 2013 in relation to 2012. However, this exposure has increased by 0.2% over the last five years.

Mastitis treatment is where the most antibiotics are used in dairy farming (Kuipers, 2015). In France, farmers apply treatment protocols defined by their veterinarians during the livestock health survey (BSE - *Bilan sanitaire d'élevage*). In their everyday work, farmers administer treatments themselves (intramammary or systemically), which they obtain at their pharmacy with a veterinary prescription. Lactation mastitis treatment using antibiotics is almost systematic and there is considerable scope for technical progress. Systematic intramammary antibiotic treatment in dry cows, even for those with a high probability of having good udder health, is also common practice in France. This attachment to antibiotic prevention is linked either to beliefs (antibiotics at drying off sound banal due to widespread words like "drying cream") ; or simply to the persistence of traditional practices, even though these have been qualified as "high risk" by ANSES and "to be abandoned in the future".

Alternate solutions exist. Some farmers may use teat inserts to help the udder to remain safe during the dry period or choose to treat only the cows whose probability to get mastitis is high. However, these may be difficult to implement; it is not enough to simply remove a specific procedure (antibiotic treatment). Farmers often need to reconsider their systems as a whole. However, Ministry of Agriculture demands in terms of reducing antibiotic use appear more as recommendations aimed at stakeholders in the agricultural sector than as proposals to enable the achievement of targets set. There are therefore no real incentives for demedicalisation and procedures undertaken are voluntary.

The goal of our study is to describe and understand the demedicalisation process on farms that have initiated it (early adopters). We apply the concept of the trajectory of change to describe this process. This approach makes it easier to understand the relationship systems between the different technical, economic, and sociological elements, among others. We estimate for instance the influence of the EcoAntibio plan that the Ministry of Agriculture launched in 2011 or of the advisors on these early adopters. We also seek to identify the involvement of the farmers' professional networks in these trajectories. We examine the support strategies to be provided to farmers wishing to reduce their antibiotic use. The long-term goal is to ensure more widespread adoption of this type of approach among cattle farmers.

Material and Methods

Semi-structured interviews with farmers and their animal health advisors

The study is based on 14 interviews with farmers conducted in spring 2015. The farmers interviewed were recruited by expert partners of the study and by telephone interviews among information relays (animal health association (*groupement de défense sanitaire*), veterinarian professional association (*groupement technique vétérinaire*), technicians, milk recording agencies (*contrôle laitier*) etc.). The criteria used to select them were a (subjective) decrease in antibiotic use, an interest in selective treatment at drying off, registrations to a training on alternative approaches. The goal of the study was to identify farmers' motivations for reducing their use of medical inputs and to rely on their own perceptions of this reduction on the farms in question. The aim was to observe demedicalisation trajectories within different farm systems. The hypothesis was that the farming system may favour or prevent the decrease in antibiotic use. We explored two trigger factors: the intensiveness of the farming system and the labellisation of outputs. The final sample includes five farmers in conventional farming systems in the Grand Ouest region of France, six farmers in organic farming systems in the Bretagne-

Pays de la Loire region and three farmers belonging to the Epoisses PDO in the Bourgogne region. We conducted semi-structured interviews using an interview grid with each farmer on their own farm and with their animal health advisors (veterinarians, technicians). The two-hour interviews focused on the context and history of the farm, on the diseases present on the farm and their management (especially antibiotic use), and finally on the farmer's information networks and resources.

Table 1 presents the current characteristics of farms surveyed that are relevant to understanding the trajectories of change. The situation of individuals (age, education, family situation, etc.), the way in which they carry out their work over time (work organisation, diversity of activities, etc.) and the regions in which they work are varied.

Table 1. Summary of characteristics of farms involved in demedicalisation trajectories

Bio/PDO/Conv farm, Dept	Year of installation, training	Nb AWU / herd size, other activities on farm	Stable, average, SCC tank (C/1000L)	Building - installation (construction, renovation)/ dairy cow breeds	Feed/ Evolution farming practices	Evolution pro network	Salient health event	Treatment: 1st intention mastitis/ Dry cows
Org 1 (1994) 44	1986, BEPA	4 / 85 dairy cows	7000 kg,	/**Crossbreeds**	**Pasture system** / suckled calves / Curative hoof trimming	1989, farmers' exchange group 1995, organic cooperative	1992, ill calves nursery	Homeo/ Homeo or antibiotics on cow with SCC <1 000 000 (1997)
Org 2 (2012) 35	1983, BTA	2 / 45 dairy cows, rural holiday cottages, production honey, jam, oil	6800 kg, 190 000	2006, Construction new building with solar panels 2014, dryer in barn/ **PH**	**Maize seed pasture system** / Grouped calving	CA and defence organization (GDS)	2002, slaughter of herd (BSE)	antibiotics/ selective dry off therapy
Org 3 (1992) 44	2009, BTSA	5 / 135 dairy cows	4700 kg, 170 000	Dryer in barn /**Crossbreeds**	**Pasture system** / Grouped calving , Curative trimming	Organic cooperative GAB	2010, milk quality	antibiotics/ selective dry off therapy
Org 4 (2009) 29	1996, BTSA	3 / 80 dairy cows, farm bread	5000 kg, 176 000	/**Crossbreeds**	**Pasture system** / Grouped calving , annual preventive trimming	CA farmers' group	2014, calf diarrhoea	aromatherapy/ selective dry off therapy
Org 5 (2002)	1996, BEP	2 / 50 dairy cows	6000 kg, 173 000	/**Crossbreeds**	**Pasture system** / Calving being grouped,	Dairy inspection - CA	2013, milk quality	Cider vinegar/ Homeo

					Curative trimming			
Org 6, 22 (2003)	1989, BTS	3 / 66 dairy cows (increase up to 75)	7000 kg, >200 000	Dryer in barn/**Crossbreeds**	**Pasture system** / preventive and curative trimming	CIVAM GAB	2014, milk quality	Homeo/ selective dry off therapy
PDO a, 52 (2001)	1994, BEPA expertise cow/pig farming, Inseminator licence	2 / 44 dairy cows	6500 kg, 250 000	2000 new building/ **Montbéliardes**	**Pasture system** / Use of gloves in stalls	Another farm (natural farming approach, homeo aromatherapy)	? milk quality	aromatherapy/ selective dry off therapy
PDO b, 52 (2004)	1996, BTS AXE	8 / 70 dairy cows	7200 kg, > 350 000	2010, dryer in barn 2014, new milking room **Montbéliarde Brunes des Alpes**	**Pasture system** 2014, end Brunes des Alpes/ Gloves for milking/ mattress stalls		2012 milk quality	aromatherapy/ selective dry off therapy teat insert use
PDO c, 21 (2000)	1993, BAA	3 / 40 dairy cows, mustard seed cultivation	8000 kg,	**Montbéliarde Simmental**	2000, change breed (before PH), calving box, curative trimming	Neighbours, veterinarian	2007, Tuberculosis slaughter of herd	Ointment aromatherapy/ antibiotics
Conv 1, 49	2007, BTSA ACSE	2 / 74 dairy cows	7700 kg, 227 000	2009, new building **Normandes/PH**	**Pasture system (+maize)** 2013, milking hygiene, reforms 2014, veal boxes	Normande breed union, CIVAM	2007 to 2013 insufficient milk quality	aromatherapy (2014), antibiotics + phytotherapy
Conv 2, 56	1997, BEPA	2 / 90 dairy cows	8900 kg, 245 000	2012, Milking robot/ **PH**	**Pasture system (+maize)**	Group 12 farmers exchange +++, Defence	2008, FCO 2012, problems with	aromatherapy (2013), antibiotics

					2012, cell reforms, 2013 Test calf aromatherapy	organisation GDS - aromatherapy	robot installation	
Conv 3, 49	1999, BTSA	2.5 / 40 dairy cows + pig	10 300 kg, 115 000	2014, Stalls 40 places/**PH**	Clay (Org), 2015 biosafety separation male female calves, emptying nursery once a year	Cooperative, veterinary advice, CUMA	2012 IBR, before 2013 milk quality, 2014 calf diseases	antibiotics, selective dry off therapy (2011) teat insert use
Conv 4, 50	1991, BEPA	1.5 / 38 dairy cows	6000 kg, 217 000	2002 upgrading to building standards, 2009 dryer in barn /**Normandes**	**Pasture system** , add multi-vitamin complex end grass silage, 2013 end of trimming	Farmers' group	2004, milk quality	antibiotics
Conv 5, 35	2007, BAC pro	2 /53 dairy cows, + labelled chicken	7700 kg, 250 000	**Crossbreeds**	**Pasture system** , halved maize production in 5 years	Farmers' group- Obsalim	2010, parasitism	aromatherapy- Homeo- cider vinegar, antibiotics

Creating an indicator of the level of demedicalisation

Expert sampling and the lack of factual data on monitoring of antibiotic consumption in cattle farms have not enabled the quantitative definition of antibiotic consumption over time using an indicator. However, we propose the definition of a "qualitative indicator" of the level of antibiotic use between the different farmers, according to the practices described. We will thus verify the hypothesis of a range of different levels of antibiotic use within the demedicalisation trajectories. The five levels of this indicator correspond to the different uses described by farmers during their demedicalisation trajectory. Levels 0 and 1 concern the maintenance of preventive antibiotic uses, especially with the maintenance of the systematic use of antibiotics in dry dairy cows. Level 4 corresponds to a farmer in the organic farming sample who no longer uses antibiotics to treat mastitis. The different levels are described in more detail in the following Table 2.

<table>
<tr><td>Level of coherence towards demedicalisation</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td rowspan="2">Intrinsic motivations</td><td rowspan="2">No rationale towards reduced antibiotics use</td><td rowspan="2">Increasing the efficiency of farming practices in order to reduce antibiotics use AND/OR Substituting antibiotics for alternative methods</td><td>Reduction with no more systematic preventive uses. Rethinking dry cow practices</td><td>Antibiotics only for mammary pathologies and during veterinary intervention</td><td>Antibiotics only during veterinary intervention</td></tr>
<tr><td colspan="2">Mobilisation of decision-making support tool for dry cows</td></tr>
<tr><td>Extrinsic motivations</td><td colspan="3">No incentive measures to reduce antibiotics use</td><td colspan="2">Possible soft incentive measures which nevertheless require consideration of every treatment</td></tr>
</table>

Table 2. Levels of coherence of antibiotic use in our sample

Choosing an analysis method for trajectories of change

Where agriculture is concerned, it was Capillon in 1993 (Capillon, 1993) then Perrot in 1995 (Perrot, 1995) who first described farming trajectories with the goal of establishing typologies. But these first descriptions only compared initial states with final states through statistical analyses, without addressing the process of change itself.

In 1995, Girard established a method to model pasture feeding strategies for lactating herds of sheep. This modelling is based on a representation of farmers' actions, aimed at making these actions intelligible. The farmers' practices are studied according to their modalities (their implementation) and their arrangements, making it possible to highlight the strategy adopted. Madelrieux used this framework of analysis in 2002 to study land use changes by farmers seeking to resolve their labour problems. To establish these linkages, the tools for action mobilised to resolve the problem were first identified. Madelrieux thus proposed an analysis of trajectories through a representation of a chain reaction, which draws a causal link between events relative to the context, actions and indirect effects of actions (See Figure I). We adopted both Girard and Madelrieux's dynamic approaches to analyse the trajectories of the 14 farmers.

We seek to establish an external representation of the trajectory according to stakeholder accounts without judgement in relation to external norms. The analysis of cases conducted in this study results from the reconstruction by the farmers interviewed of the rationale for change on their farms in connection with herd health management and relationships with cattle farming sector stakeholders. In addition to farmers' motivations and trigger events for change, the goal of the analysis is to identify within these trajectories the tools mobilised that contributed to change. These tools, resulting in a reduction in antibiotic use, can be linked to the context, the professional or family circle, the training, the previous practice changes, the trigger events on the farm… This is how we determine what farmers believe (preferably in agreement with the scientific literature) has led to better health management on their farms with demedicalisation. The choice was made to integrate the farmers' network interventions to identify their role within the trajectory (consultation when implementing an action, for example). The framework for analysis is detailed below (See Table 3 and Figure 1 as an example).

Table 3. Key to the processes

Graphical representation	Key
Increase in somatic cell count	Problem encountered during the process
Conversion to organic farming	Trigger events
Overly integrated industrial vegetable sector (cessation of production)	Explanatory factor of the relationship between two elements (not used in Conv3 case study)
Implementation of selective dry cow treatment	Options or strategies chosen: for instance, the farmer aims at optimising the dairy production
Treatment of mastitis using essential oils	Actions enabling the process to unfold in response to a strategy or a specific problem on the farm
→	Manages; for instance more reforms aim at dealing with milk quality issue (See Figure I)
⇢	Possibly enables: for instance the use of a teat insert may help to achieve a selective treatment
⇒	Anticipated or non-anticipated consequence: for instance biosafety measures led to better health status
⬭	Adviser
▭	Date: for instance the parents retired in 1999.

Results and Discussion

Trigger events for trajectories

Even if reducing antibiotic use is a public and animal health issue, this change is not a priority for interviewees in view of all the changes taking place within a farm. Most often, actions are conducted with the goal of tackling a specific problem rather than of following a demedicalisation strategy. This means that the farmers are the first drivers of the change induced. Their motivations are based on their own strategy much more than on the institutional policy or on their advisors' recommendations. It is therefore the reflexivity of the farmer that enabled us to establish linkages between the different actions conducted within farms over time (to address problems or not) that resulted in demedicalisation.

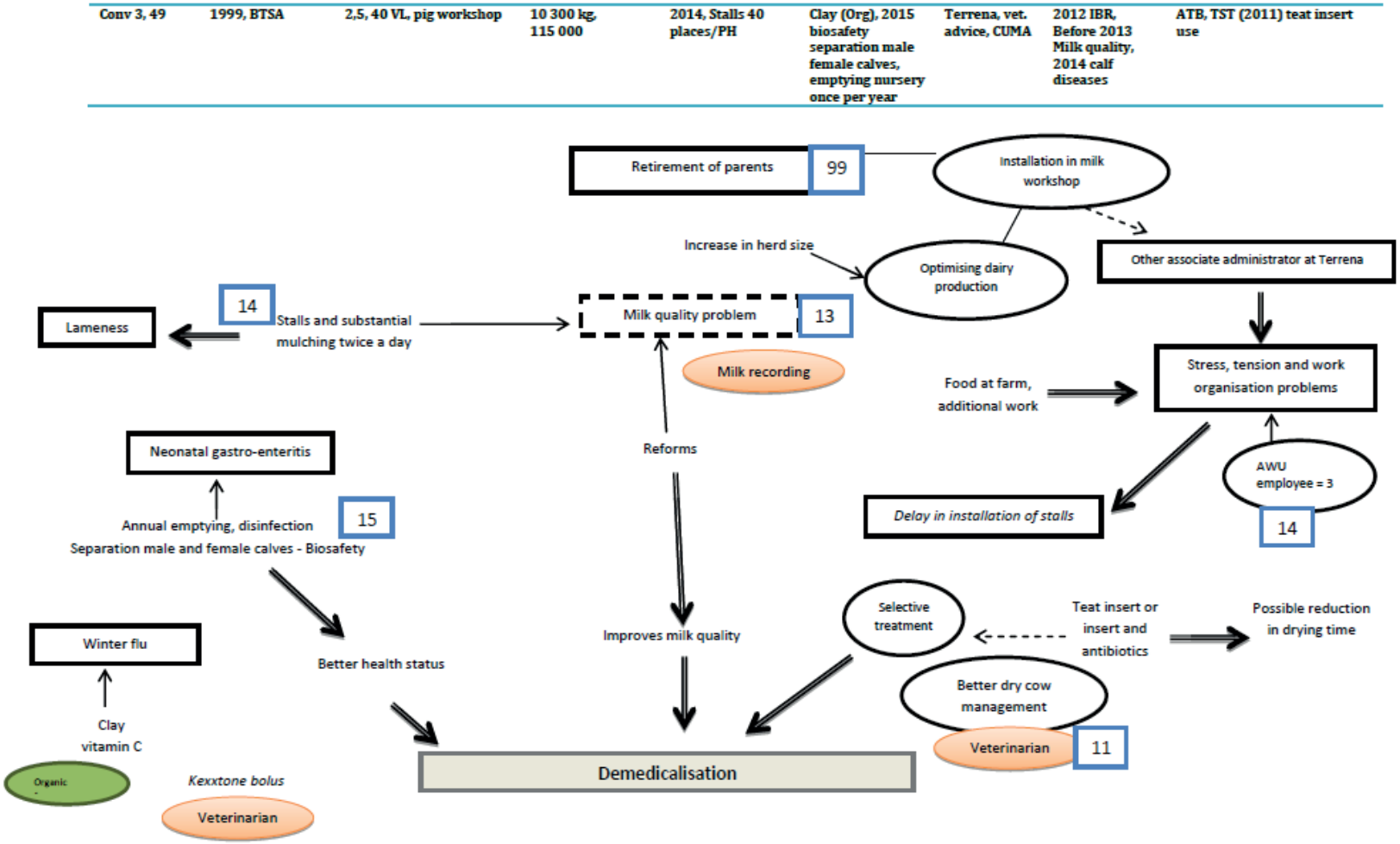
The tools used

The different tools activated by farmers leading to demedicalisation: are labour and work organisation (activities within the farm and external activities); farming practices and structural adjustments; and training and experimentation on alternatives to antibiotic treatment methods (Table 4).

Table 4. Inventory of actions activating the different tools

Tools	Actions
1/ Labour and work organisation	Distribution of tasks, observation of animals, meeting with associates, holidays
2/ Farming practices and structural adjustments	Feed management, good milking practice, bedding hygiene, genetics/breeding, nursery, biosafety, milking once a day
3/ Training and experimentation on alternatives to antibiotic treatment methods	Training with veterinarians, naturopaths, farm tests

Figure 1. Example modelling of a demedicalisation trajectory



The level of demedicalisation reached

Within the 14 demedicalisation trajectories observed, there is a high degree of variability in antibiotic use observed (Table 5). The duration of these trajectories differs; the longer they are the more robust the changes undertaken and the greater the reduction in antibiotic use. We also observe coherence between the highest levels of demedicalisation and a redesign of the farm system as a whole (farmers in organic systems or similar).

The main obstacles identified to the cessation of systematic treatments are high levels of risk aversion, the cost of teat inserts and to a certain extend the lack of advisory services. Farmers who limit antibiotic use to proven mammary pathologies have withdrawn from the productionist paradigm. However, they have at least maintained their margins due to the higher economic value of products (linked to certification) and to lower input costs.

Table 5. Levels of antibiotic use during the trajectory for the farmers interviewed

PDOc, Conv 1, Conv 2, Conv 4	0	1			
Org 4, Org 6, PDOa, PDOb, Conv 3	0	1	2		
Conv 5	0	1	No step	3	
Org 1, Org 2, Org 3	0	1	2	3	
Org 5	0	1	2	No step	4
Level	**No consideration**	**Efficiency and/or substitution**	**No more systematic treatments**	**Restricted antibiotics**	**Antibiotics only for veterinarian use**
Farms	**Level of demedicalisation observed over time (main steps)**				

The different demedicalisation trajectories: a typology

By associating the tools used by farmers over time, the different levels of antibiotic use identified since their installation and the trigger events, we have been able to highlight three types of demedicalisation trajectories within our sample (Table 6). We present them here according to Hill and MacRae's ESR nomenclature (Hill & MacRae, 1995) Five farmers in our sample are motivated by efficiency; 4 farmers in our sample adopted substitution practices ; and 4 farmers in our sample redesigned their farm system. There is no clear consistency between the farming system and the type of trajectory adopted. It seems that the intrinsic motivations as well as the trigger events determine the trajectory more than the farming system, or at least more than the labelling system. Some organic farms favour efficiency, whereas some conventional farmers may have implemented long term trajectories with a large reconversion of their farming system.

Table 6. Characteristics of the three types of trajectories of change: triggers, motivations, contributory factors

Type of trajectory	Triggers	Motivations	Contributory factors to demedicalisation	Method and type of support	Farms concerned	Level reached
Trajectory E (short) No learning	Milk quality problem Slaughter herds BSE – tuberculosis	Being coherent with one's conception of the job High quality milk – consumer Desire for technical> economic expertise	-Division of labour - process streamlining -Search for scientifically proven solutions -Entrepreneur profile -Expertise -Preference for expert opinions	One-off with monitoring +/- contractual relationship Veterinarian / technician Farmers – personalised advice	PDOc Org2 Org3 Conv3 Conv4	2 3 3 2 1
Trajectory S (medium) Direct with learning	High cost of treatments Installation of new farmer Organic conversion Press article	Economic Autonomy Values: "More natural treatments" Public health (antibioresistance)	-Context of development of training on alternative methods -Antibiotics substitution trials -Recomposition of work group -Broad consultation of professional group	One-off without monitoring Different training – generalist approach	PDOa Org6 Conv1 Conv2	2 2 1 1
Trajectory R (long) Progressive with learning	Economic crisis Installation of new farmer Organic conversion	Coherence between practice and conception of the job Reducing the workload Taste for innovation	-Support for conversion -Selective dry off therapy -Withdrawal from productionist paradigm (single milking practice) -Use of homoeopathy in private circle -Shared work approach: working time, organisation of tasks, experience of work, relationship work-income	Monitoring in monthly or bi-monthly groups (led by professional organisations) +/- formalised between farmers, farm visits, intra-group innovation	Org1 Org4 Org5 Conv5	2 2 4 3

Type of trajectory	Triggers	Motivations	Contributory factors to demedicalisation	Method and type of support	Farms concerned	Level reached
			-Construction through discussion groups between farmers			

Short trajectory without learning (5 farmers)
Short trajectories without learning are followed by farmers in relatively intensive systems or those with large farm structures. The search for efficiency is the main motivation for these farmers (5 out of 14). It is technique rather than the desire for economic gain that leads them to reduce their antibiotic use. The reduction in antibiotic use is a – sometimes unanticipated – consequence of meeting the technical objectives they have set themselves.

The trajectory followed can be described as direct without any phase of learning. It is of short duration from the trigger event identified, often a health problem (3 farmers faced milk quality problems, 2 had to deal with the culling of their cattle). The farmers then adopted new but often reversible practices. They improved their milking practices. They solved the bedding hygiene with some more sanitary emptying or a better mulching instead of new building (2 cases out of 5). As far as feed management is concerned, 3 farmers out of 5 introduced more pasture, one chose to invest to dry in barn. These changes lead to an improvement in the overall health of the herd.

Over the course of this trajectory, the farmers favour expert opinions and mobilise these experts from time to time. These farmers are demanding in terms of the information they receive, and this is why they choose advisors with recognised scientific expertise. Veterinarians and dairy inspection technicians are the preferred contacts, but they also lean on technical advisors or animal health associations. They use this information to improve their technique and their autonomy in terms of farm management. At first, the use of antibiotics is not called into question. The approach focuses on the efficiency of their uses and on preventing the emergence of the health problems encountered. Consequently, preference is given to technical adaptations of the management system already in place proposed by the veterinarian or the technician. The substitution of antibiotics for essential oils or homoeopathy is envisaged, but is not implemented by these farmers, who point to the lack of scientific proof of their effectiveness or of any well-defined protocol. They are demanding of the information used to conduct their demedicalisation trajectory.

The resolution of health problems requires continuous changes (structural investments, adaptation of practices), but changes are reversible enough so that the farmers encounter few risks. Thus, the trigger event enabled the change but the new situation produced is in continuity with the previous situation. A farmer said: "*You don't actually change your system, you adapt it […] You do a bit more prevention, but you don't revolutionise everything*". Antibiotic reduction is primarily achieved through withdrawal, by reducing the incidence of cattle diseases or by implementing selective treatments in dry cows for some farmers. Another farmer made this comment: "*But then you could say we're not stupid, if you have a healthy cow that has never had mastitis, if you use a teat insert, then you block the entrance for all possible infections during the dry period, and that will have the same effect*". (Further to information meeting at veterinary surgery). However, other farmers maintain this preventive antibiotic practice in dry cows since it does "no harm".

Direct trajectory with learning (4 farmers)
In the direct trajectory with learning, the aim is clearly to have antibiotic use decrease. This implies connecting the longer term with the short term, enabling a bifurcation in the farm trajectory. The path chosen by these 4 farmers is demedicalisation by substitution; although all of them improved the health status of the cattle through a better feed management (all),

new building (2 cases out of 4), a better mulching (1 case), or better reproduction management (1 case), there is no link in their recollection between this improvement and decrease in antibiotic use . Within this trajectory, we first observe a reorganisation of activity (new work organisation, recent installation, additional AWU, etc.), and this is the first tool mobilised. Work organisation enables these farmers to find time for training and to conduct experiments and test different alternative methods to antibiotic therapy (the use of homoeopathic products or essential oils for instance (Joly et al., 2016). Only the substitution helps them remove antibiotics, probably because it seems less risky to them to replace a product with another than to fully withdraw it.

Only one farmer consulted on that topic with his veterinarian, who was involved in homeopathic products, which is rather rare in France. These farmers thus mobilise a network of organisations that propose training on complementary medicine. "*Two years ago I asked the GDS* (animal health protection group) *if any training was available*". It could also be an association to promote organic farming, or a professional association. One out of 4 learnt on press. They undertake training to improve their skills and seek advice to coproduce solutions to achieve the goals they have set themselves. They assert their independence and seek to control the costs of medical inputs.

Two farmer profiles emerge within the direct trajectory with learning according to motivations for conducting these tests. These motivations are either economic (price of antibiotics, milk withdrawal period after treatment, etc.), or linked to their beliefs or system of values. These farmers wish "more natural treatment" and rely on animal immunity. They wish to participate to the decrease of human antibiotic resistance. They seek for a greater meaning to their job and consider that increasing observation of animals to be able to take care of them if they are ill, is part of this meaning. "*From the outset my reasons were not economic […] It was a choice: we already wanted to use different treatments [whether we earn as much money or not]*". However, the cost of antibiotics and the desire for autonomy in farm management (by reducing all types of inputs) are also strong, deep-rooted incentives in all these farmers. "*It would have been four times more expensive than antibiotics, maybe…*". "*We never throw away any milk, since we don't use antibiotics*".

Moreover, even if zootechnical changes are made at the same time, the substitution of antibiotics for alternative products is what farmers say reduces their consumption of antibiotics: "*We haven't changed anything in terms of farming techniques*". The learning required is primarily done in connection with professional organisations, then within the private sphere through the tests conducted. The protocols proposed during training do not always suit farmers, who adapt them or turn to other substitution methods. The implementation of these alternative methods brings about a shift in the framework for action (timing of intervention, period of observation) and the evaluation of disease treatment (recovery time). The tests make this transition possible. However, the changes made during this trajectory are highly reversible and in periods of crisis or stress, allopathic solutions often take precedence, as they make farmers more secure in their choice of action, and they limit risk-taking. The farmers then came back to their usual veterinarians to help them find solutions to milk quality (2 out of 4 farmers) or to get better efficacy than alternative medicine (notably 1 farmer).

Progressive trajectory with learning (4 farmers)

The progressive trajectory with learning concerns farms that were in intensive systems and which, by taking advantage of a conversion or by signing up to a charter, have changed their system and shifted to an extensive system, which was not necessarily the case for the others. The cut off in antibiotic use is then a consequence of a major change on the farm.

The new practices have improved the health status, for instance on neonatal gastroenteritis "*We simply changed, because in the previous system, when cows calved, we removed calves immediately after birth*". "*When calves are able to follow, they join the herd and find themselves with the other cows in the herd*". This trajectory obliges farmers to regularly test new cultivation techniques (with a view to improving feed for dairy cattle). The 4 of them reduce corn in the ration of dairy cows and raise pasture. They have all carried out crossbreeding to improve the overall health of the herd by making the animals more resistant. This type of management relies on feed autonomy and the hardiness of animals, which results in a withdrawal from the productionist paradigm and therefore in demedicalisation. One of them even milks only once a day. The progressive trajectory with learning takes place over a long period (7 to 22 years), is progressive and requires learning. The added value of production linked to certification is one advantage of adopting this type of trajectory.

Thus, over the course of this trajectory, the whole farm management system is modified in terms of work organisation, practices and treatment methods (the three tools identified are mobilised). These changes conducted over the long term make it possible to reduce medical inputs and inevitably lead to a reduction in dairy production. These are gradual but irreversible changes. The goal for these farmers is therefore to reduce costs in order to maintain or increase margins. But this goal cannot be dissociated from happiness at work, the enhancement of their work, or quality of life among which is spare time.

The progressive trajectory with learning is based on a redesign of the system which makes it possible to obtain healthier animals, according to farmers, and therefore to reduce antibiotic use. "*There are no more young calves to take into the nursery. So we sorted out all the health problems in one go and since we did that, we have hardly ever needed to see the vet to treat a calf*". However, it is still associated with the use of alternative methods for which learning is achieved in conjunction with practice changes. Today, their learning linked to the use of alternative methods and practices to antibiotics has ended or is about to end.

They are willing to implement any new technique enabling them to improve their work organisation, their economic performances and their technical skills. They lean on training, but wish to go further. One of them has travelled to England and to New Zealand to get some insight into other farming systems. However, they break away from veterinarians, who they only call upon in an emergency, when their technical skills are required. They rely rather on the robustness of their animals and on their own capacities. A farmer related that he got angry at his associate when they called the vet for a simple medical act he could have performed himself. The farmers following a long-term trajectory explain (the vets do also) that their system of value is far from the vets' one. The farmers complain that the vets would use only allopathy. For their part, the vets resent the farmers intervening too late "*He lets his cows die*", because of their confidence in the robustness of their animals. In some cases, vets consider that a system of values too oriented towards nature regulation comes into conflict with the management of the welfare of animals.

These farmers mobilise a limited circle to accompany them, and are often part of small groups of farmers with which they share the same experiences. The 4 farmers participate in a farmers' group. Two groups were totally independent. One of these group was generated by a chamber of agriculture and was composed of 6 intensive farms and 6 extensive farms, for which the performances were compared. One group was focused on feed and accompanied by a private advisor. In each case, this reference group has followed them at the beginning of the trajectory with a subsequent detachment in the more advanced trajectories. This investment in a peer group enables them to keep abreast of emerging innovations in their environment - the decrease in antibiotic use being a withdrawal innovation - and to debate about them (Darré, 1996). The farmers involved feel confident in each other's point of view because they share the same constraints; they feel involved in the dynamic thanks to the group's benevolent attention. At this stage of redesign, the change is robust.

Discussion

This exploratory study was conducted on a small sample of farmers, all selected for a successful medical input reduction process: a decrease in antibiotic use, an interest in selective treatment at drying off, registration to training on alternative approaches was used to select them. The design of the study voluntarily included in this sample farmers from different farming systems (organic, PDO, conventional). We found that both intrinsic motivations and trigger events determine the change concerning the decrease in antibiotic use. As far as motivations are concerned, none of the farmers mentioned extrinsic ones; the national Eco-antibio plan is not considered a major factor for change for instance. It is however useful to note that the dairy sector is less integrated than others and that there has been no incitation of the sector yet on reduction of antibiotic use.

We note in our results that Hill and MacRae's framework on intrinsic motivations (Hill & MacRae, 1995) can be largely applied to our description of trajectories. The levers for reduction of antibiotic use are consistent with the ones for other changes in agriculture; antibiotics are not considered differently to any other input or production practice, although they are medicines. The progressive trajectory with learning combines the redesign of farm systems, which is the main motivation in decision-making, with the substitution of medical inputs, which is a modality of its content. The direct trajectory with learning combines motivations of efficiency and substitution and is the only one where the decrease in antibiotic consumption is a stated objective. The short trajectory without learning presents motivations of efficiency; the decision to reduce antibiotic use often comes from a health problem, the solving of which allows for the drop in antibiotic use.

There is no clear consistency between the labelling system adopted by the farmers and the trajectory followed, although the organic farming is more represented on the redesign side. In some cases, decisions occur when there is an urgent issue to solve (culling twice, quality of milk or mortality of calves 5 times each, lameness 4 times, too large an amount of work 3 times). The motivations for decision-making are also therefore to be found in the urgency of the situation (Vera, 1993). Crisis could then be used to implement new practices, if well known by advisors.

The point with our results is that we are able to combine the intrinsic motivations of farmers, the trajectory they adopted, the level of reduction in antibiotic use they reached, and the type of advice and information source chosen by farmers. Indeed the first results obtained by this

study enable us to validate our underlying hypothesis on the correlation between the type of motivations and trajectory of change adopted by the farmers on the one hand and the type of advice adopted by farmers. These initial findings provide avenues for research for animal health advisors according to the type of trajectory adopted by farmers.

For farmers motivated by efficiency in a short trajectory without learning, veterinarians and technicians are mobilised as scientifically recognised experts, in a relationship of personalised advice and monitoring with their clients; the advisors could mobilise on the selective treatment of dry cows, for example.

Farmers concerned by a direct trajectory with learning compromise between economics and the meaning of their job. They really wish to decrease their consumption of antibiotics, but can't imagine merely withdrawing antibiotics. They rely mainly on the substitution of antibiotics by alternative methods and are more likely to undertake training provided by public organisations than to contact their close advisors. We haven't yet any idea whether they would prefer their usual advisors if they also used alternative medicine. Indeed, homeopathy or phytotherapy have not been taught to vets yet in France because the scientific proof of their efficacy is considered poor. But the fact is that farmers remain alone after the training to implement new practices on their farms. Useful tools in this precise context would be top institutionalised feedback and good practice frameworks on the use of alternative medicines, especially essential oils, for which the protocols used and results are really disparate.

Farmers undergoing reconversion to conservation agriculture rely on their networks and intra-group innovation (Goulet & Vinck, 2012). Fostering communication between groups of farmers could be one avenue for sharing good practice. One of the difficulties consists of effectively reconciling the different advisory modalities and stakeholders in a collective approach to the reduction of antibiotic use in the dairy cattle sector.

Our results are then consistent with the literature on innovation in agriculture. Further research could be conducted to see to what extent our findings would be transferable to late adopters, according to their intrinsic motivations. The level of reduction is ironically lower on farms where the decrease in antibiotic use is one of the stated objectives. The lower use is observed on farms with a complete redesign, which have long term trajectories behind them. Considering the different levels reached, there could be a hierarchy in terms of policy to reach either the farmers who would reduce the most (efficient ones or farmers on reconversion) and/or the others. This statement also suggests that antibiotics' policy could be more successful if included in a broader animal health improvement objective.

Conclusion

In this article, we used semi-structured interviews to study the antibiotic reduction trajectories of 14 French dairy cattle farmers. The practices implemented are the withdrawal of antibiotic use, substitution for alternative treatment methods and the complete redesign of the farm system. There has been no strong incentive in the dairy sector until now and the motivations of farmers are mainly intrinsic or situational. These practices are part of trajectories motivated by the search for efficiency, substitution or redesign, but also by the immediate response to a health problem. We note a correlation between the learning processes, the advice and training mobilised, and the motivations of the trajectory, but none with the labelling system.

We thus distinguish three types of trajectories: (i) the short trajectory without learning is characterised by a principal motivation of efficiency and a high reliance on usual animal health advisors; the withdrawal of antibiotics is a consequence of the solution brought to a health or economical issue; (ii) the farmers in the direct trajectory with learning whose motivations are clearly the decrease in antibiotic use through a substitution with alternative methods, with reliance on institutional training (at least in a context where usual advisors lack competencies about alternate practices); and (iii) a trajectory involving the redesign of the farm system as the main motivation in which farmers rely on their own social network. The level of reduction is ironically lower on farms where the decrease in antibiotic use is one of the stated objectives; this statement suggests that indirect processes may be more efficient than direct ones. On top of that, trigger events are a real lever for change and should be included in the strategic reflection.

The description of these three trajectories of farmers who were the first drivers of change opens up avenues for the future adaptation of advice or public policy on reduction of antibiotic use in the dairy sector. This research shows that there is no unique way to induce this change, in terms of practices as well as in terms of decision-making. A mutual adjustment between farms, institutions and advisors is needed.

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Renewable energy transitions – lessons learned from rural pilot regions and communities in southwestern Germany

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Abstract: The paper explores the implications of renewable energy and bio-economy strategies for rural communities and farmers' roles. Focusing on two administrative districts in southwestern Germany, we discuss the related developments in a low-carbon economy transition perspective. The regional initiatives related to renewable energy are cross-sectoral in scope, and rely on effective multi-actor partnerships and (co-)learning networks, governance thus playing a central role. Farmers feature as pioneers in innovations such as the cultivation of alternative energy crops, the advancement of technology, and as providers and keepers of resources such as land, biomass and knowledge. Cross-sectoral and cross-scale integration requires learning and facilitation, e.g. in the form of network management. The Federal Ministry of Agriculture funded management and coordination in 25 German bio-energy pilot regions over the period 2009-2015. Support included knowledge exchange among actors interested in, for example, setting up a local heating system based on renewable energy sources and the establishment of so-called 'bio-energy villages'. These function as small 'innovation cells' providing models far beyond the local level. The transitions associated are located at the interface between agricultural and wider economic and community-level development. Contributing to improved agriculture-society relations and rural areas' enhanced attractiveness as places to live and work (not least for younger people), the bio-energy villages potentially to some extent help to counteract rural demographic change. Findings also support the view that a stronger integration of different sectoral policies and funding mechanisms contributes to a harmonisation between renewable energy and bio-economy strategies and broader rural development goals.

Keywords: Bio-economy, bio-energy villages, low-carbon economy, multi-actor networks, pilot schemes, renewable energy transition

Introduction and Background

Research questions and methodology

New and innovative agriculture-oriented activities based on renewable resources adopted by farmers and other rural actors require learning processes to acquire (e.g. technical) knowledge as well as adequate governance structures (necessitating organisational expertise). In the case study building the basis of this paper, such activities are being picked up as a response to shifting framework conditions going along with agricultural and rural structural change as well as volatile policies (Peter et al., 2015). Among such policies, the implications of German national renewable energy and bio-economy strategies for rural communities and farmers' roles are explored. We focus on two administrative districts in southwestern Germany, discussing the related developments from a low-carbon economy transition perspective.

The emphasis is on bio-energy, specifically on-farm biogas production, although there are additional relevant sources of renewable energy in the study region. The biogas technology is central in community-related developments such as 'bio-energy villages'. Historically, the initial association of biogas production with animal husbandry through the primary objective of manure processing makes the two administrative districts - where animal husbandry is an important agricultural sub-sector - especially relevant as a case study region. Moreover, biogas is well suited as an example of a long-standing evolution in terms of technology, actors and institutions.

The paper is based on a case study carried out in the EU FP7 project 'Rethinking the links between farm modernisation, rural development and resilience in a world of increasing demands and finite resources' (RETHINK, 2013-2016). The German case study carried out between 2014 and 2015 entailed expert interviews and in-depth desktop analysis. In this paper, findings on agriculture-oriented activities rooted in renewable resources are related to wider current debates on the transition towards a low-carbon economy and sustainability in the bio-economy (see below).

Overarching EU- and national-level strategies relevant to bio-energy

As stated in the European Commission's strategy 'Innovating for Sustainable Growth: A Bioeconomy for Europe', the 'Europe 2020 Strategy calls for a bioeconomy as a key element for smart and green growth in Europe' (EC, 2012:2; EC, 2010). Here, the bio-economy approach is defined as encompassing "*the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy"* (EC, 2012, p.3).

Bio-economy - and bio-energy, as one of its 'key sectors' (Global Bioeconomy Summit, 2015, p.4) - are named as innovative fields to potentially contribute to an overall 'transition to sustainable agriculture and forestry' by the European Economic and Social Committee (EESC, 2014, p.4). The widely present bio-economy concept is increasingly being critically discussed, albeit lacking an unanimously shared definition and being subject to various competing interests. It is connected to a range of policy spheres - including industry and energy, agriculture and fisheries, climate and environment, research and development - as well as strategies. Likewise, access to biomass - be it timber, green waste, manure, or energy crops - is linked with the interests of various actors and subject to regulations at the interface of several sectors (Peter et al., 2015).

In Germany, strategies on bio-economy policy and bio-economy research are pursued by the Federal Ministry of Food and Agriculture and the Federal Ministry of Education and Research, building on the national sustainability strategy (BMEL, 2014; BMBF, 2010).

The 'Road Map for a Low-Carbon Economy by 2050', aiming at a reduction of EU domestic emissions by 80% by the year 2050 as compared to the baseline year of 1990, is an associated strategy of relevance (EC, 2011). Among its milestones throughout this transition process, it refers to agriculture as a sector 'potentially at some risk of carbon leakage' (EC, 2011, p.10). Furthermore, the aim of 'raising land use productivity sustainably' is to entail, amongst others, 'bio-gasification of organic manure' (EC, 2011, p.9). The 'shift towards a low carbon and climate resilient economy' is also present in the Rural Development Regulation (EU) No 1305/2013 (Publications Office of the European Union, 2013).

Evolution of strategic and legal framework relevant to renewable energy in Germany

The German renewable energy sector is highly policy-dependent. In the year 2000, the Renewable Energy Law (*Erneuerbare-Energien-Gesetz* – EEG) was introduced, establishing 20-year feed-in tariffs for energy from renewable sources. Its forerunner, the Electricity Feed-in Law (*Stromeinspeisungsgesetz* – StromEinspG) of 1991 introduced a minimum compensation for electricity from renewable sources fed into the grid, making biogas technology relevant for energy production while previously it had been mainly used for processing manure into fertiliser. The years following the EEG's introduction saw the launch of the national 'Energy Turnaround' policy framework. An expansion of the feed-in compensation by a so-called '*Nawaro'* bonus for renewable materials including manure within the scope of the EEG's first amendment in 2004 led to rapid growth in energy crop cultivation (Bruns et al., 2009). 2009's second amendment again led to a clear increase in biogas digesters as the feed-in allowance for power from biogas was raised, the *'Nawaro'* bonus being extended to also apply to a parallel use of various substrates (Umweltbundesamt, 2010). A resultant acceleration of development in the biogas sector also took place in the case study region, characterised by animal husbandry. With the stalling of the 20-year feed-in guarantee approaching, operators need to consider their perspective. However, there are also more short-term market changes and policy volatility. The capacity for responding to change necessitates access to information among the actors concerned and is central within the concept of resilience at the core of the RETHINK project (Peter et al., 2015).

Within the 'Energy Turnaround' framework, in 2010 the 'Energy Concept 2050' (*Energiekonzept 2050*) was enacted by the German state government with the overall objective of achieving an energy supply mostly from renewable sources by 2050. In 2011, an acceleration of the change process was agreed on as a consequence of the Fukushima nuclear catastrophe. The EEG's third amendment in 2012 led, amongst others, to a facilitation of operating 'mini' biogas plants with up to 75 kW, encouraging the setting-up of farmer-operated plants for the purpose of using on-farm biomass. However, meanwhile a point of uncertainty has been reached, with farmers facing the decision whether to risk additional investment into renewable energy activities or not (Peter et al., 2015).

Sutherland et al. (2015/2015a) trace back energy transitions across several decades, from the 'pioneering phase' as early as the 1950s to a 'contestation phase' marked by the 2007 global food crisis. They also include a detailed account of the development of biogas in Germany in terms of technology, actors involved and institutional frameworks.

Regional renewable energy transitions – the example of two administrative districts in southwestern Germany

Key characteristics of the regional agriculture

Located in southwestern Germany, the adjacent administrative districts of Hohenlohekreis and Schwäbisch Hall (SHA) are involved in a range of activities related to renewable energy. Hohenlohekreis was part of the 'Hohenlohe-Odenwald-Tauber Bio-energy Region' (H-O-T) in the national 'Bio-energy Regions' programme (BR) initiated by the Federal Ministry for Consumer Protection, Food and Agriculture (2009-2015). Support was provided for the establishment of regional networks in the field of bio-energy in 25 model regions throughout Germany. These networks could partly build on structures created during the 'Regional Action - Shaping Rural Futures' programme (2002-2007) for which so-called 'regional partnerships' had provided the organisational basis. Both districts had been part of the latter programme,

which - amongst other thematic fields - had covered renewable energy as an important market regarding an environment-friendly and sustainable use of natural resources and regarding wider sustainable rural development. In 2006, the SHA district government had committed to the objective of reaching a share of 100% electricity and heat supply from regional renewable sources within the context of a '100% Renewable Energy Regions' project. Although the district did not participate in the BR programme, involvement in renewable energy activities is high (Peter et al., 2015).

The case study region is classified as a rural area with some trends towards densification (BBSR, 2014a), and in 2012 on average had a population density of 132.2 inhabitants per sq km, below the federal-state average (Statist. Ämter d. Bundes und der Länder, 2015).

Since the 1970s, the region has experienced fast economic development. Outside the farming sector, the regional economy is characterised by a traditional craft sector, and small- and medium-sized enterprises mainly in the fields of engineering, food and wood industries and automotive suppliers, amongst others (Peter et al., 2015). In 2012, in both districts, the share of employment in the primary and secondary sectors was above the average of the federal state, while the shares of the tertiary sector were below-average (see Table 1).

Table 1. Selected figures on the case study region's economy (2011/12)

Region	2012					2011
	Primary sector's share of employ-ment (%)	Secondary sector's …	Tertiary sector's …	Knowledge-intensive, business-oriented services' …	Unemploy-ment rate	GVA farming / forestry / fisheries (%)
Hohenlohekreis admin. district	0.9%	48.4%	50.8%	4.6%	2.8%	1.6%
SHA admin. district	0.6%	44.7%	54.7%	10.2%	3.3%	1.7%
Federal state Ø (Ba.-Württ.)	0.4%	37.8%	61.8%	11.1%	4.1%	0.5%
National Ø	0.8%	30.2%	69.0%	10.5%	7.1%	0.8%

(Source: BBSR, 2014b; Statist. Ämter d. Bundes und der Länder, 2015; authors' compilation)

In both districts the share of utilised agricultural area (UAA) related to the total surface area in 2011 was above 55% (see Table 2). This is above-average as compared to the federal-state (45.7%) and national levels (52.3%) (Statist. Ämter d. Bundes und der Länder, 2015). In 2010, the average farm size in the region was 35.5 ha UAA. Animal husbandry is relevant especially in SHA (26.5%, as compared to 13.7% in Hohenlohekreis). A share of 22.9% of farms in Hohenlohekreis and of 16.2% in SHA pursue a combination of mixed farming and animal husbandry (Statistisches Landesamt Baden-Württemberg, 2014). The manure available from this type of farming plays an important role as a substrate for biogas production.

Table 2. Selected figures on the case study region's agricultural sector (2010/11)

		Hohenlohekreis admin. distr.	SHA admin. distr.
% share of UAA related to total surface area (2011)		57.2%	55.3%
Total number of farms		1,229	2,031
% share of full-time farms		39.5%	46.0%
Farm size structures:	Average total size (ha UAA)	33.5 ha	37.6 ha
	% share of farms < 20 ha UAA	52.9%	40.0%
	% share of farms 20 to < 50 ha UAA	24.2%	32.3%
	% share of farms 50+ ha UAA	22.7%	27.7%
	% share of farms 100+ ha UAA	0%	0%
% share of production types:	Arable farming	15.7%	10.5%
	Horticulture	1.3%	0.9%
	Permanent cultures	25.7%	0.4%
	Forage growing	20.6%	45.4%
	Animal husbandry	13.7%	26.5%
	Mixed farming and animal husbandry	22.9%	16.2%

(Source: Statist. Ämter d. Bundes und der Länder, 2015; Statistisches Landesamt Baden-Württemberg, 2014; authors' compilation)

Key renewable energy activities under support

Strengthened rural communities and improved agriculture-society relations – the example of 'bio-energy villages'

In the study region, non-energetic biomass use plays a subordinate role. The use of timber as a construction material, for example, is an exception to this rule (see aspect of cascading biomass use below). The most relevant bio-energy value-added chains include, first of all, biogas, and - additionally - energy wood pellets or chips, and short rotation plantations. In addition, 'energy tourism' has expanded. However, there is also concern voiced by regional stakeholders regarding renewable energy facilities (e.g. wind turbines) affecting the characteristic (cultural) landscape, not being convinced of a positive reframing of the visual impact of such infrastructures through thematic tourist routes. It is argued that renewable energy tourism is only a niche so far, with the majority of tourists still looking for 'classic' leisure activities (Peter et al., 2015).

So-called 'bio-energy villages' following the objective of a 100% renewable energy supply are central projects of the Bio-energy Region. Their activities had become independent from support already during the programme phase. Initially, H-O-T had facilitated knowledge exchange, e.g. during meetings for actors interested in setting up a local heating system. The villages follow the principle of community-based energy production using local resources for

covering local demand. While farmers are involved, they are not necessarily the initiators of activities (Figure 1). Cross-sectoral linkages are exemplified by ‘energy tourism’ offers such as bicycle tracks from one bio-energy village to another and guided tours on ‘transparent’ bio-energy production.

From the regional stakeholders’ point of view, bio-energy villages have considerably contributed to mobilising enormous community spirit, improved agriculture-society relations, and contributed to the attractiveness of villages as places to live and work. The villages have proven vital as experimenting and innovation cells with an impact as models beyond the local level, and - at a larger scale - contribute to the transition towards a low-carbon economy.

The bio-energy village of Untermaßholderbach (Hohenlohekreis) exemplifies such a development process: the pioneering farmer operating a biogas plant on the outskirts as an additional pillar of farm income had initially been considered an ‘outsider’ by the population who were suspicious regarding his initiative to establish a local heating network. Assuming he was acting exclusively for his own profit, the potential benefit for the village as a whole was not realised at first. When facilitators from the Bio-energy Region’s office started moderating the process with an open citizens’ council as the first step, views changed and a joint village-wide project was initiated. The process started in 2010 and has been sustained by a core team of eight citizens who also form the managing team of a civil law association founded in 2011 and carrying the local heating system. Almost all of the village’s citizens are participating as shareholders. Meanwhile almost the whole village sources its heat from the local network based on residual heat from biogas production; a cooperative plant for wood chip production was built in order to cover peaks in demand during winter, and the village has developed into a zero-emission municipality.

Renewable electricity is sourced from the local biogas plant and from photovoltaic devices. The village which completed the ‘Energy Turnaround’ envisaged by the national government at the local level and was awarded ‘bio-energy village of the year’ in 2014 serves as a model far beyond the local level, with professional visitors, students and tourists from the region, neighbouring urban centres and even delegations from abroad. With a population of only 110 and lacking e.g. educational infrastructure, the small municipality has nonetheless become an example of sustainability, future orientation, and environmental awareness. Because of the high demand for guided tours, people from the village are being trained as ‘bio-energy guides’. According to regional stakeholders, this development process would not have been feasible without the Bio-energy Region’s supportive structure (Peter et al., 2015; Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016c).

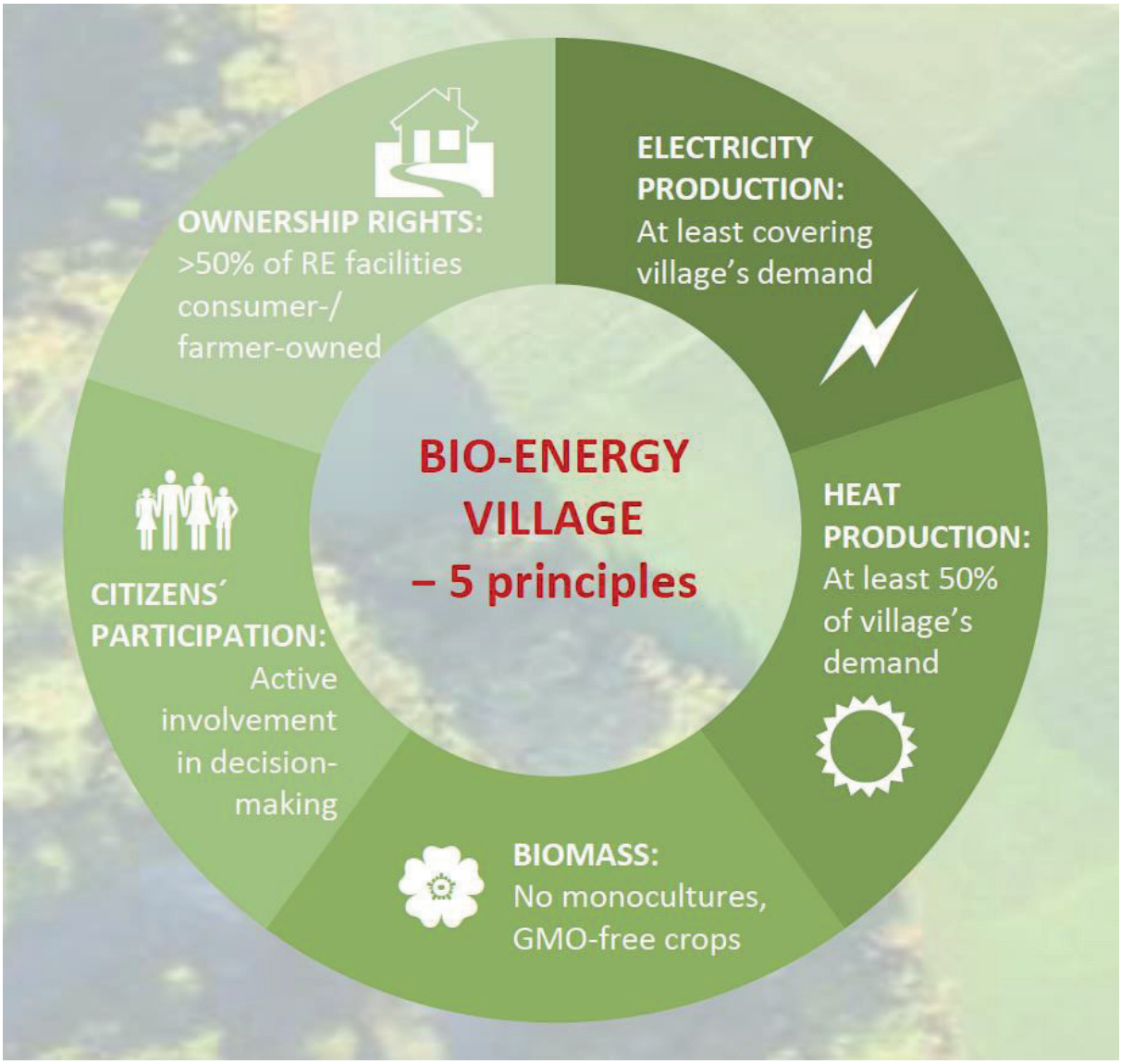

Figure 1. Key features of bio-energy villages

(Source: based on Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016d; modified and translated by authors)

Multi-actor partnerships and (co-)learning processes

Combination of different knowledge sources

In order to achieve the objectives of the initiatives and funding schemes introduced above, learning and related governance processes are central.

As a general finding, the integration of various knowledge types and sources as well as forms of learning is vital. This includes farmers' practical knowledge, vocational schools and universities, and research institutions as well as farmers' associations and machinery rings,

agricultural administration, and the federal-state level Ministry of Rural Areas (MLR) with its capacities for disseminating information. Forms of learning encompass both unilateral science-to-practice 'knowledge transfer' as well as mutual learning within multi-actor networks, driven by moderating bodies. From stakeholders' viewpoint it is crucial to have research and education institutions within the region as this creates *'a competitive advantage as compared to other regions that need to permanently buy that knowledge from external sources'* (Peter et al., 2015, p. 38).

Farmers' experiential knowledge is likely to be exchanged among themselves as they prefer on-demand practical information which is e.g. gained by a visit to a neighbouring farmer running a biogas plant. At this visit, the benefit of mutual learning is valued more highly than the potential risk of losing a competitive advantage. Businesses manufacturing renewable energy facilities also serve as exchange agents among farmers.

In recent years renewable energy has increased in importance on the schedules of regional agricultural vocational schools.

Farmers' associations are important as consultants regarding detailed questions on technology or business management. Together with machinery rings, they are the central source of expert information on issues related to on-farm renewable energy, e.g. with regard to setting up a biogas digester or a wind turbine.

The Bio-energy Region's management to some extent plays a moderating or 'bridging' role in knowledge exchange in the field of material flow management and bio-energy. It facilitates farmers' access to knowledge by bundling and regularly spreading information (e.g. providing advice for farmers on concepts for the use of residual heat from biogas plants).

There are also some relevant federal-state-level scientific institutions to be named, such as a research body in a neighbouring administrative district, a 'Bio-energy Research Platform' engaged in multi-disciplinary cooperation and 'technology and knowledge transfer' on (energetic) biomass use (Peter et al., 2015), as well as the 'Bioeconomy Research Baden Württemberg' programme covering 'sustainable and flexible value chains of biogas production' (Bahrs & Angenendt, 2015).

The role of farmers in the regional multi-actor network

The multi-actor (learning) network studied encompasses farmers, but also actors from forestry, craft, education and research, as well as tourism, amongst others. Farmers play a part as protagonists of new agricultural activities, pioneers in innovations, as well as providers and keepers of various (in)tangible resources. In interaction with the other rural actors, farmers thus vitally contribute to opening up a future perspective for their rural region (Peter et al., 2015). Two success stories from the study region illustrate how 'energy farmers' innovate in the biogas sector based on a sustainable use of place-based resources such as land, biomass, and knowledge, by cultivating alternative energy crops and developing new approaches to processing of residuals from biogas plants. These examples correspond with the regional practice-oriented and hands-on mentality and openness for cooperation (Peter et al., 2015).

In the bio-energy village of Siebeneich (Hohenlohekreis) with a population of 200, a diversified farmer who also runs a butcher's shop and gastronomy services pioneered in the cultivation of Chinese reed (*Miscanthus giganteus*) on two hectares of arable land. Chips of the reed can be used in woodchip heating systems. A high willingness to innovate combined with a motivation to induce change are named as important drivers behind the story, The conversion from heating oil to Miscanthus considerably helps reduce heating costs: the amount needed based on heating oil for one month suffices for a whole year based on the alternative energy crop. What has turned into a 'success story' is the result of an intense learning process lasting about three years. This was based on practical testing and experience as 'there was no one there to ask how it is done', starting from sourcing the plants to questions of planting and raising them in the field. Meanwhile, the farmer's success is a model for others to follow in Miscanthus cultivation (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016a).

Another pioneering farmer from the municipality of Kupferzell (Hohenlohekreis) invested ten years' time experimenting before working out a method of producing fertiliser pellets from the digestate of his biogas plant. The idea is not to cultivate energy crops, but to use residual materials as substrate, such as fruit waste from juice producers, vegetable waste from wholesale trading centres, and on-farm residuals from his own arable land, in addition to manure from pig fattening. In line with the idea of a circular economy, the point according to the farmer is: *"this is how the circle closes - from nature for nature.*" The product has been certified organic according to EU regulations and is being marketed via regional horticultural centres and flower shops. The motivation behind the development had been to diversify in order to become less dependent on animal husbandry, in the face of pressures from the global agri-markets. The enterprise also has a community dimension as the on-farm biogas plant also supplies waste heat to a business company and 20 households via the local grid. As the farmer states, *"the local people really like this"* (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016b).

Such pioneering initiatives correspond to history, with small-scale agricultural holdings in the Federal States of Bavaria and Baden-Württemberg being the 'cradle' of on-farm biogas plants during the pioneer phase at the national level in the 1970s to 1990s (Umweltbundesamt, 2010).

Renewable energy contributing to diversification at farm level and of the regional economy as a whole

In the regional energy mix, on-farm biogas, wind and photovoltaic energy generation play a central role. The related initiatives are cross-sectoral in scope (albeit limited in the range of sectors involved), and rely on effective multi-actor partnerships and (co-)learning networks. Governance thus plays a central role. The transitions associated are located at the interface between agricultural and wider economic and community-level development. This is exemplified for instance by value-added chains integrating energy production with 'energy tourism' as in the bio-energy villages.

A certain level of diversity can be considered a key feature of resilient agricultural systems. This applies to various levels, including on-farm, the agricultural sector as a whole, as well as the overall regional economy. Several pillars of income help to expand the repertoire of responding to changing framework conditions (see examples in section on multi-actor partnerships) (Peter et al., 2015).

On the one hand, activities related to renewable energy in the case study region can be stated to unfold relevance for wider economic and community-level development. 'Interface activities' such as 'energy tourism' are an example of cross-sectorality, and ownership and decision-making patterns related to the bio-energy villages contribute to empowerment and inclusiveness. The prospects for younger people's job opportunities created by the rise of the wider related developments help to enhance rural areas' attractiveness, thus potentially benefiting demographic structures. On the other hand, however, a focus of funding schemes on the topic of renewable energy, and bio-energy in particular, can be argued to constitute a limitation regarding the rural development process as a whole (Peter et al., 2015).

Looking at the policy landscape, the case study suggests the need for a better integration of various funding schemes. For instance, the limitations of the Bio-energy Regions' non-investive support might be compensated for given the opportunity of a combination with other, investment, funding sources. Agricultural-sector funding (e.g. a programme on renewable material flows) and for rural areas as a whole (e.g. LEADER) are not integrated, due to 'departmental' separation and the prohibition of parallel funding from various sources (Peter et al., 2015).

Contextualising case study findings in wider debates on the transition towards a low-carbon economy and a sustainable bio-economy

The findings from the German case study region presented in the previous sections can be contextualised in current broader debates on the transition towards a low-carbon economy and a sustainable bio-economy. It can be concluded that the activities studied widely correspond to features discussed as requirements for a 'sustainable bio-economy'. In spite of a thematic focus as opposed to a thematically more differentiated rural development approach, the bio-energy activities studied mostly provide an example of an 'eco-economy' as discussed by Marsden (2012), e.g. with regard to on-farm energy production, community-owned biogas digesters and bio-energy villages using local CHP from nearby plants, and the sustainable use of regional biomass (Peter et al., 2015).

On the one hand, bio-economy and sustainable development are being associated in strategic documents. At the level of the case study, this view is exemplified by a status report entitled 'Bioeconomy – Baden-Württemberg's path towards a sustainable future' (Biopro Baden-Württemberg GmbH, 2013). On the other hand, resource efficiency and a low-carbon and circular economy are concepts discussed as necessary preconditions to a sustainable bio-economy yet to be established.

Although it is being stated that 'the bio-economy' links well to the realisation of a range of UN Sustainable Development Goals (SDGs) (United Nations, 2016; German Bioeconomy Council, 2015), it is conceded that a 'sustainable bio-economy' carried by society at large yet needs to be defined, alongside ecological and social sustainability criteria enabling its assessment (Global Bioeconomy Summit, 2015; German Bioeconomy Council, 2015). This would help "*render bioeconomy a venture based on a widely shared vision of a sustainable future" (*Global Bioeconomy Summit, 2015, p.3). From this point of view, it is agreed that *"bioeconomy as such is not inherently sustainable"* (Global Bioeconomy Summit, 2015, p.4), and sustainability aspects remain to be incorporated in bio-economy-related policies (German Bioeconomy Council, 2015). Nonetheless, a 'communiqué' resulting from the first Global Bioeconomy Summit hosted by the German government's Bioeconomy Council in November 2015 in Berlin cites as a generally accepted definition of bio-economy "*the knowledge-based production and*

utilisation of biological resources, innovative biological processes and principles to sustainably provide goods and services across all economic sectors" (Global Bioeconomy Summit, 2015, p.4; authors' underlining). The document contains recommendations developed by an International Advisory Committee on how the bio-economy could be designed in order to 'work for sustainable development', including the formulation of basic principles and measures. An integrated approach to a bio-economy policy is advocated, being in line with the recommendation derived from the German Baden-Württemberg case study for a stronger integration of various policy fields instead of a sectoral focus and thematic fragmentation among various funding schemes (Peter et al., 2015). The Standing Committee of Agricultural Research (SCAR) in its 2014-15 foresight exercise addresses the "*transition to a sustainable European bioeconomy",* the development of a *"paradigm of a competitive bioeconomy fundamentally framed by the need for sustainability"* (Kovacs [ed.], 2015, p.7).

With regard to the bio-economy's knowledge basis, the Commission in its related strategy refers to the relevance of 'local and tacit knowledge' alongside a variety of scientific disciplines associated with the range of sectors involved. This variety is named as a precondition to the sectors' 'strong innovation potential' (EC, 2012, p.3). Also in the case study region, a combination of knowledge sources was found favourable, ranging from farmers' practical knowledge to scientific knowledge produced in research institutions (Peter et al., 2015; see section on multi-actor partnerships).

According to the EESC, the "*development of sustainably produced biomass should take place within a clearly defined policy framework, respecting limits on production and use, social aspects and biodiversity [...] to ensure the further evolution of the bioeconomy in a way that can bring social, economic and environmental benefits"* (EESC 2014, p.8). In relation to resource efficiency, sustainable use and generation of added value, and also with a view to the competing interests linked to biomass, the concept of a cascading use is of relevance. Being an element of a circular economy, cascading use 'in itself does not avoid waste, but it is among the principles of the circular economy that there is "no waste"' (Kovacs [ed.], 2015). The success story of the fertiliser pellets produced by the Hohenlohekreis biogas farmer is an example of this (Bioenergieregion Hohenlohe-Odenwald-Tauber GmbH, 2016b). In the case study region in general, a more sophisticated, cascade use of biomass beyond energetic use is subject to ongoing research. For instance, regional timber is being used as energy wood for combustion on the one hand, while there are other interests underlining the high value of timber as a construction material (Peter et al., 2015). In addition to the pointed 'no waste' claim, the circularity principles include avoiding negative impacts of consumable goods on the biosphere and enhanced reusability of durable goods, as well as the use of renewable energy (Kovacs [ed.], 2015).

A related strategic EU document was issued in 2015 - 'Closing the loop – An EU action plan for the Circular Economy' - after a 2014 forerunner had been withdrawn. It contains reference to the energetic use of 'biological resources' and states the bio-economy's potential to contribute to the circular economy by providing 'alternatives to fossil-based products and energy'. It also picks up the issue of interest conflicts, underlining that *"using biological resources requires attention to their lifecycle environmental impacts and sustainable sourcing. The multiple possibilities for their use can also generate competition for them and create pressure on land-use"*. And further: "*In a circular economy, a cascading use of renewable resources, with several reuse and recycling cycles, should be encouraged where appropriate."* The Commission is announced to 'promote synergies with the circular economy when

examining the sustainability of bioenergy under the Energy Union'. The role of farmers and rural areas is not explicitly mentioned in the document (EC, 2015, p.17). The issue of interest conflicts is also broached by SCAR, who state a critical clash of food and biomass demands, as well as a decline in biodiversity and ecosystem services (Kovacs [ed.], 2015).

In line with the idea of the interrelation of the concepts, the term of a 'circular bio-economy' is being coined and used, for instance, in the context of the European Innovation Partnership on Agricultural Sustainability and Productivity (EIP-AGRI, 2016). In a recent publication, the EIP quotes the Institute for European Environmental Policy (IEEP), stating that "*ensuring that farmers and foresters benefit from circular activities is critical to their engagement and to the long-term sustainability of circular bio-economy in practice".* Moreover, on the role of agriculture and forestry: *"The 'circular bio-economy' is one where farmers and foresters take a leading role in developing the bio-economy and making it more sustainable by integrating circular activities and natural cycles into existing and new practices"* (EIP-AGRI, 2016:1).

'Carbon-neutrality' and its potential to 'considerably contribute to decarbonisation', are named among the beneficial features of the bio-economy, while the blurred definition of the concept shaped by diverse interests is not neglected (Global Bioeconomy Summit, 2015, p.2; German Bioeconomy Council, 2015, p.7). However, this potential is yet to be realised by moving *"toward a resource efficient and low-carbon economy"* (German Bioeconomy Council, 2015, p.7).

The above-named 'communiqué's' intention to contribute to a 'global agenda' is also relevant for the case study region, reflecting a 'neo-endogenous' approach to rural development acknowledging the interplay of the local to global levels as 'key determinants' of a wider rural development in which a 'competitive farming sector is not a prerequisite for viable rural areas' (Hubbard & Gorton, 2009, p.94). In this perspective, in order to pursue sustainable development, global approaches are required in complementation to bio-economy strategies' adaptation to national- or regional-level conditions (German Bioeconomy Council, 2015). In line with this, regarding the role of farmers, the bio-economy development is expected to make rural areas less dependent on agriculture, but help establish 'new bioeconomy value webs' (Global Bioeconomy Summit, 2015, p.4). In the case study region, criticism of a rural development approach focused too narrowly on farming instead of a more integrated line was voiced by stakeholders; from this point of view, multifunctional and diversified farming should go alongside a more cross-sectoral approach (Peter et al., 2015). At the level of production systems, the importance of diversity is also echoed by SCAR's bio-economy understanding, stating that these "*should be diverse, using context-specific practices at different scales and producing a diversity of outputs. As diversity is key to resilience, innovations in the bioeconomy should be developed to foster diversity rather than limit it."* (Kovacs [ed.], 2015, p.16)

Conclusions

While the longer-term success of the German 'Energy Turnaround' and of EU-level strategies remains to be seen, and concepts such as the 'bio-economy' face contestation, the bio-energy activities in the case study region can be stated to have successfully contributed to the transition towards a low-carbon economy at the local and regional levels.

A limitation to this positive resume is constituted by the fact that a more integrated rural development might be overshadowed by a narrow thematic focus. Advocating a more integrated rural development approach also has implications for the role of farmers and the

agricultural sector, making them part of multi-actor networks and cross-sectoral value chains. Looking at the governance processes identified in the case study, on the ‘strong’ side, broad integrated rural development processes as implemented in the Bio-energy Region’s forerunner scheme, Regional Action, appear favourable in terms of including various thematic fields and actors’ aspirations in a cross-sectoral perspective. On the ‘weak’ side, the stronger thematic focus of the Bio-energy Region - in spite of its cross-sectoral implications - limits the range of actors getting together (including non-farmers, actors not involved in bio-energy) and sharing their knowledge within a network (Peter et al., 2015).

Case study findings also support the view that a stronger integration of different sectoral policies and support schemes would contribute to a harmonisation between renewable energy and bio-economy strategies, and broader rural development goals.

Given the policy dependence of the renewable energy sector, the long-term sustainability of the initiatives that were started within the policy frameworks introduced in the case study region remains to be seen. Network management in particular has proven a vital component of such schemes, and its long-term funding should be regarded favourably in order to ensure the lasting of the processes and structures established within the framework of pilot programmes. While rural funding schemes can be considered vital in promoting innovative concepts (exemplified in the paper by a connection of renewable energy and tourism, or the cultivation of alternative energy crops), their ‘mainstreaming’ beyond the beneficiary regions remains an important open question.

Returning to the RETHINK project’s core questions, ‘rethinking’ the modernisation of farms and rural areas in the case study refers to valorising renewable resources sustainably and adapted to local and regional conditions. New forms of governance play a vital role in this development process, notably expressed in new actor network constellations. The activities studied exemplify responses to agricultural and rural structural change - i.e. being innovative (e.g. by entering new fields such as ‘energy farming’) and flexible (e.g. by relying on more than one pillar of farm income).

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Analysis of indigenous institutions for collective action in fostering co-operation for sustainable land use among pastoral communities of Ogun State, Nigeria

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Abstract: Indigenous institutions have been perceived as the nested structures crafted to regulate access to natural resources among different rural users. Therefore, there is a need to bring to the fore the contribution of indigenous institutions in promoting collective action in the effort at fostering co-operation and collaboration among settled Fulani Agro-pastoralists in Ogun State, Nigeria. The leadership institutions in pastoral communities were found to be involved in the process of making authoritative decisions in respect of land access and sustainable use of natural resources in pastoral communities. This form of collective action becomes important as it fosters a good relationship between the pastoral groups and their hosts. Securing sustainable land resources access and use for cattle and crop production in pastoral communities is dependent on the prevalence of strong local institutions for collective action (co-operation and collaboration). Purposive sampling technique was used to select 435 respondents. Data were collected using a Semi-structured Interview Guide. Fulani respondents maintained that some of the challenges facing them were loose collaboration/contradiction between statutory and indigenous institutions, intrusion of migratory pastoralists (*Bororo*), illegal entry of new herders and lack of policy support by government to settle Fulani agro-pastoralists. The Spearman-rho correlation analysis revealed that there were significant relationships ($p< 0.01$) between local rules ($r=0.252$), leadership institution ($r=0.234$) and conflict management. The study concludes that negotiation and self-regulation are important collective action processes in promoting co-operation in the pursuit of mutually beneficial goals for gaining access to land, as well as ensuring sustainable use of the biophysical environment for food security and poverty reduction. Therefore it is recommended that the leadership institutions should be strengthened and indigenous rules be formalised among different users to enhance their effectiveness in fostering co-operation and reducing biophysical deterioration.

Keywords: Fulani agro-pastoralists, indigenous institutions, collective action, co-operative, sustainable land use.

Introduction

In recent years much attention has been focused on the need for wise use of land which connotes sustainable land use of land in rural society, especially in the unique crop-livestock mixed production system where the increased demand for land is occasioned by the need to make available foods of crop and animal origin to ensure food security and generate income on a sustainable basis. In many parts of the world, particularly in Ogun State, Nigeria where agricultural land is used for mixed crop-livestock production, there appears to occur intense competition for and an intensification of land use necessitating co-operation, collaboration and sustainable land use among settled agro pastoralists and their host Yoruba communities (Omotayo, 2003, Fabusoro et al*.,* 2008). Consequently, a key concern in the long run is the

sustainability of the land resources in this mixed crop-livestock production system without compromising peaceful coexistence of land resource users.

Indigenous institutions are locally developed rules, regulations, values and informal arrangements (such as leadership) that are regarded as adaptive solutions to resource management problems at the grass-roots level. In various ways, leadership institutions, collective action and land use interact to affect the operation of rural households in developing countries. Leadership in local communities is about governance and governance involves the process of making authoritative decisions in relation to who gets what, when, where and how. Since land resources are the dominant factors of production in a crop-livestock production system, leadership primarily revolves around management of land use. Therefore, when local leadership is weak, such weakness may not permit co-operation that can foster sustainable land use. Ostrom (2000) affirms that the propensity of groups to act in their collective or joint interest in promoting co-operation and collaboration is dependent to a large extent on the development and growth of local leadership institutions. These indigenous institutions promote mutual trust, reciprocity and fairness on which collective action is based in rural communities for sustainable land use.

Environmental sustainability connotes that natural resource users should be concerned about the impacts their activities today will exert on the environment without compromising the ability of the future generations to meet their own needs (Stockholm Environmental Institute, SEI, 2001). A sustainable environment is one that has the capacity to secure a better quality of life for everyone, now and for generations to come. This is because such an environment has the capacity to cope with and recover from stress and shocks and provide opportunities for the next generation. Therefore, environmental sustainability is achieved when the productivity of life supporting natural resources is conserved or enhanced for use by future generations. This can be accomplished through collective action fostered by local institutions and governance structure for the management of natural resources; which is the focus of this study. One way of doing this is for societies to create leadership institutions that can regulate household livelihood strategies and outcomes, by providing orderly access to and use of natural resources, streamlining expectations, sources of income, promoting peaceful co-existence, reducing vulnerability and mitigating adverse consequences of biophysical degradation and social relations. In Ogun State Nigeria, as population grows and pressure on land resources increases, lack of co-operation concerning land use is common in pastoral communities.

The broad objective of this study is to analyse the relevance of indigenous institutions (locally crafted rules, regulations and informal social control mechanism such as leadership in various pastoral communities) for collective action in fostering co-operation for sustainable land use among pastoral communities in Ogun State. The specific objectives of the study are to:

a. identify the personal characteristics of the respondents (agro-pastoralists and host communities);
b. investigate local institutions and collective action functions in the study area;
c. identify the forms of collective action in fostering co-operation for sustainable land use among pastoral communities;
d. examine processes and tools for building collective action by leadership institutions in pastoral communities;
e. identify collection action problems and institutional challenges.

Materials and Methods

Ogun State was created in 1976 and lies within the southern part of the country neighboured by Oyo, Ondo and Lagos. The State which has Abeokuta as its headquarters lies between longitude 2º 2' and 3º 55' E and latitudes 7º 01' and 7º 18' N with an annual growth rate of 3 percent per annum. The land area is 1,640,926 square kilometres. The Ogun State projected population as at year 2006 was 4,054,272 (National Population Commission, 2006). The vegetation in Ogun State ranges from derived savannah to rain forests. Its land area consists of natural resources such as forest reserves, rivers, rock mineral deposits and an ocean front, as well as extensive fertile soil suitable for the cultivation of a wide range of equatorial, tropical and savannah crops.

A multi-stage sampling technique was used to select the respondents (household heads) for this study. Purposively sampling technique was used to select four Local Government Areas (Imeko-Afon, Yewa North, Odeda and Abeokuta North). Fourteen pastoral Fulani communities were purposively selected within the four Local Government Areas. In addition, 320 Fulani pastoralists and 115 Yoruba host farmers were selected by simple random sampling from the 14 communities.

Data collection procedure

Primary data for the study were collected through the use of a semi-structured interview schedule. Focus Group Discussions were conducted in all the communities to elicit information on indigenous institution, leadership structure, land-use management and collective action. Secondary data from literature were also sourced. Data were analysed using descriptive statistics such as frequency count, percentage, and mean.

Results and Discussion

Personal and background information of respondents

The result of the analysis in Table 1 shows the distribution of respondents according to personal characteristics. Using Fabusoro (2009) age classification, 68.2% and 66.7% of the Fulani household heads and Yoruba farmers respectively were between the ages of 31–60 years. Farmers within this age bracket constitute the majority of people engaging in agricultural production in developing countries (FAO, 1997). The result shows that 20.9% of Fulani pastoralists and 27.8% of the host Yoruba farmers were above 60 years of age. The results also revealed that 10.9% of Fulani heads of household were less than 30 years of age while 5.2% of the population of Yoruba farmers' heads of household were less than 30 years of age. The mean age of the Fulani household heads was 51.57 years as compared with the mean age of the Yoruba farmers which was 56 years. The findings shown in Table 1 indicate that 83.7% and 94.8% of settled Fulani agro-pastoralists and host Yoruba farmers respectively were married. It was found that being married as a status is a crucial socio-economic factor determining whether the man could be allocated land for farming and grazing and the roles he could be assigned to play especially among the settled Fulani agro-pastoralists (Desalegn, et al., 2007). It was observed that 35.9% of Fulani agro-pastoralists and 47.0% of Yoruba farmers' population respectively had no formal education. Almost half (49.4%) of the members of Fulani agro-pastoralist respondents had Quranic Education while the majority (85.3%) of Fulani agro-pastoral household heads had no western education. Only 14.7% of the members of the Fulani respondents had western education while 53.0% of Yoruba farmers' had western education. The mean household sizes for settled Fulani agro-pastoralist and Yoruba farmers'

head of households was found to be 9.80 and 7.62 respectively. The need for this large household size is occasioned by their livelihoods which is the main income generating activity among the Fulani. The respondents engaged in different occupations.

Table 1. Background and production characteristics of respondents

Variables	Fulani		Farmer	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Age (years)				
Older (>60)	67	20.9	32	27.8
Old (51-60)	117	36.6	25	21.2
Mid age (31-50)	101	31.6	52	45.5
Young (<=30)	35	10.9	6	5.2
Mean	**51.57**		**Mean**	**56.00**
Marital status				
Single	21	6.6	4	3.5
Married	268	83.8	109	94.8
Divorced	16	5.0	1	0.9
Separated	15	4/7	1	0.9
Education attainment				
No formal education	115	35.9	54	47.0
Quaranic education	138	49.4	-	-
Adult education	17	5.3	18	15.7
Primary education	23	7.2	19	16.5
Secondary education	5	1.6	17	14.8
Tertiary education	2	0.6	7	6.1
Household size				
Large (>10)	170	53.2	21	18.3
Medium (6-10)	100	31.3	67	58.3
Small (<6)	50	15.6	27	23.5
Mean	**9.80**		**Mean**	**7.62**

Source: Field Survey, (2013)

Figure 1a and 1b indicate that 95.6% and 92.2% of the Fulani and host communities' members engaged in pastoralism and farming respectively, while very few were involved in both non-farm and off-farm activities. These findings indicate that the two major occupations prevalent in the study area were pastoralism and farming.

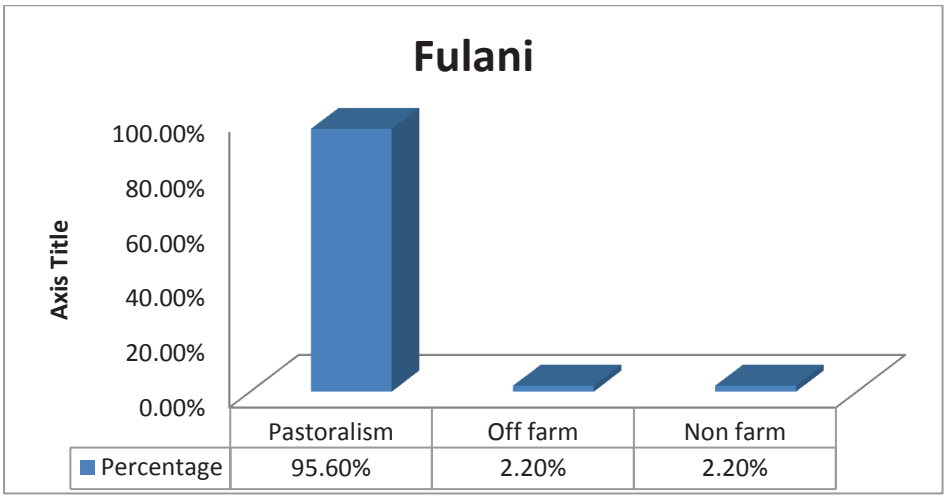

Figure 1a. Livelihood patterns of settled agro pastoralists

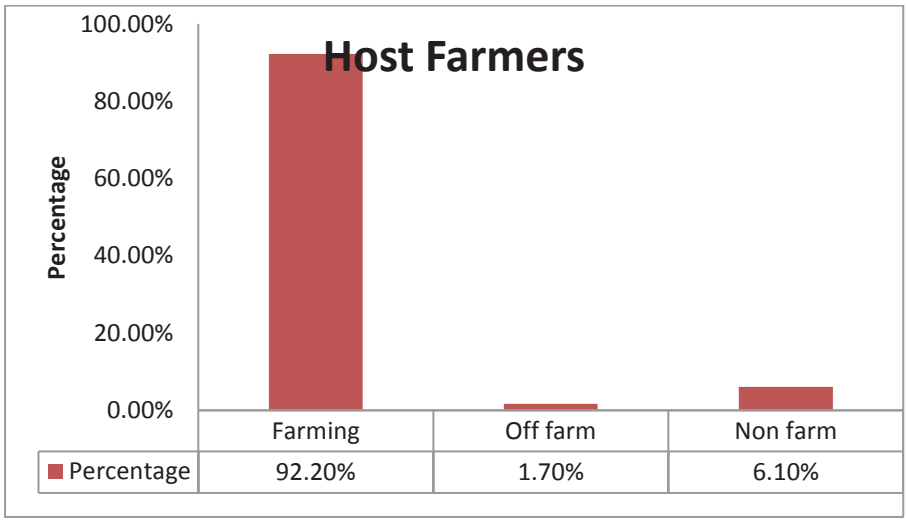

Figure 1b. Livelihood patterns of host farmers

Local institutions and collective action functions

At various pastoral communities in the study locations, investigation reveals that through meetings with various stakeholders (Yoruba farmers and Migrant *Bororos*), and the establishment of monitoring teams, pastoral leadership institutions were able to build collective action for land use and natural resource management. The investigative teams usually consist of members of pastoral groups who are well versed in the regulations for grazing as well as those who could speak the host community language. According to information obtained from the pastoralists in the study locations, the leadership institutions (Fulani Traditional Council, FTC, headed by *Sarkin Fulani/Seriki*) consisting of the foremost elders of the community, such

as the Imam, *Mawdo*, engaged in other collective action issues such as funds generation through the payment of dues, levies and other sundry payments.

Based on the FGDs held with the pastoralists, it was observed that *Ardo/Seriki/Sarkin* Fulani and its council members play a significant role in the establishment of lay down regulations for grazing and access to water. The authority held by the leadership institutions in playing the role in pastoral communities is derived from their position in the FTC and indigenous systems of *doka* (law), *sharia* (justice) and *aldu* (custom). The leadership institutions in pastoral communities were found to be involved in the process of making authoritative decisions in respect of who gets what, when, where and how. Specific regulations identified to have been enacted by FTC which are collective action tools for building collective action in the management of co-operation for sustainable land use among pastoral communities are as follows:

i. Farming activities were discouraged along designated cattle routes;
ii. Under age pastoralists were not allowed to graze cattle without being subjected to watch and supervision by their parents or family heads or elderly pastoralists;
iii. Herdsmen were not to drink alcohol or use any hard drug or stimulant while grazing cattle on field;
iv. In the course of negotiating for compensation for crop damage, whatever amount the farmer mentions, the Fulani is obliged to pay, especially if the negotiation is being conducted on the very farm that was destroyed by the encroaching cattle;
v. Pastoralists were not to graze any field under cultivation;
vi. Even after harvesting, permission of the field owner was required before grazing such land;
vii. In communities where water was relatively scarce during the dry season like Iwoye ketu, Afon, Otapele, Oloka, Imala Tibo, Atokun and Olodo, pastoralists were encouraged to use water from open sources during the rainy season in order to preserve that in excavated ponds;
viii. There exist rules restricting cattle from directly entering the water sources (ponds) by fencing off the ponds and making them drink water hauled into troughs made from clay and wood;
ix. During the dry season pastoralists were directed by FTC to shift their herds to more distant water sources in order to preserve water near the homestead for human use;
x. Rights to gain access to and use water in the pond are given by FTC to the pastoralists only if they have participated in tasks linked with excavation, cleaning, maintenance and rehabilitation of the water source (pond). Usually, *Jawmu saare* coordinated the regulations that determined rights to use the pond in each pastoral camp.

It was observed that all these regulations were established in pastoral communities by the leadership institutions to build collective action for the purpose of achieving peaceful coexistence between Fulani pastoralists and host farmers as well as to ensure a sustainable environment in rural communities where crop and livestock productions coexist.

Forms of collective action in fostering co-operation for sustainable land use among pastoral communities.

Analysis of indigenous institutions for collective action in land use and natural resource management among settled Fulani agro-pastoralists in Ogun State follows similar patterns and the forms of collective action identified bare some resemblance with ones identified by

Runge (1992), Gebremedhin et al. (2004), German et al. (2006) and Fabusoro and Sodiya (2011). Results revealed the identified forms of collective action used for fostering co-operation which are presented in Table 2.

Table 2. Distribution of respondents to the existence of forms of collective action in land use and natural resources management among settled Fulani agro-pastoralists

Collective action	Yes	
	Frequency	Percentage
Demarcation and negotiation to secure sustainable access to land, water and pasture as well as to promote peaceful coexistence	248	77.5
Investigation teams for land use and natural resource management	315	98.4
Enforcement and monitoring activities	214	66.9
Existence of elders council (FTC)	255	79.7
Financial contribution for payment of dues and royalties	296	92.5
Participation of settled Fulani agro-pastoralists in host communities socio-economic events	301	94.1
Fulani agro-pastoralists' networking with other pastoralists	267	83.4
Fulani pastoralists involvement in collective execution of community projects like schools, road and many others.	277	81.6

Source: Field survey, (2013)

The Table shows that the existence of investigation teams for land use and natural resource management attracts the highest affirmation as a form of collective action for the promotion of sustainable natural resources and peace in pastoral communities A close examination of the various forms of collective action indicates that more than 60% of settled Fulani agro-pastoralists interviewed in the study locations affirmed the existence of each of the eight forms of collective action as coordinated strategies resulting from unified efforts of pastoralists to reduce joint harm or obtain high benefits (Fabusoroo & Sodiya, 2011). Also, other forms of collective action were confirmed by pastoralists as existing in pastoral communities such as financial contribution for payment of dues and royalties to land owners (92.5%), participation of settled Fulani agro-pastoralists in host communities' socio-economic events (94.1%), Fulani pastoralists involvement in collective execution of community projects like schools, roads (81.6%) and Fulani networking with other pastoralists (83.4%). Networking with other pastoral communities as an identified form of collective action was affirmed by 83.4% of pastoralists in the study location. Personal interview indicates that this form of collective action was necessary to seek support for grazing activities during the peak of the dry season. It was observed that this practice was common in the study area in which pastoralists from Iwoye Ketu, Afon, Otapele, Imala, Atokun, Oko-rori and others, usually network with pastoralists in Eggua during the dry season because of the permanent presence of water and pasture in this agro-ecological area.

Process and tools for building collective action by leadership institutions

Among the Settled Fulani agro-pastoralists, there existed traditionally established (accepted and expected) proceedings for building united efforts (collective action). These traditionally established proceedings, for collective action were called processes as indicated in Table 3.

Although there were slight differences among the pastoral communities with respect to the functions of local institutions as shown in Table 4, the study found that Fulani pastoralists usually resorted to negotiation and self-regulation processes through collective action as a way of gaining confidence and access to land, bringing people together and fostering peaceful coexistence as well as ensuring sustainable land use. In organising or building collective action in pastoral communities in the study locations, findings revealed that the hierarchical nature of the structure of the local leadership institution prevalent among the settled Fulani agro-pastoralists influenced the processes of negotiation, consultation, collection of dues and many others. The structure starts from the lowest level of *Jawmu saare* (household), to *Mawdo* (Camp) and *Ardo/Sarkin* Fulani or *Seriki* (pastoral area or community level). The finding indicates that leadership institutions place high emphasis on ensuring that the process of negotiation and consultation for land access is participatory and democratic. Irrespective of the level at which the collective action emerges, the negotiation could end at any level of the local institution depending on the magnitude.

Table 3. Collective action, processes, tools and outcomes identified among pastoralists

S/N	Collective actions	Process	Tools	Outcomes
1	Negotiation with host communities and land owners for reception and approval, especially new entrants seeking for land allocation to build pastoral camp.	Negotiation, Consultation, Collection of dues and royalties	Meeting, attendance at host community meeting, attendance at host communities socio-cultural events and financial contributions	Access to and use of natural resources by Fulani pastoralists for grazing and farming. Livelihood security
2	Demarcation of pasture and forest land for the establishment of grazing routes, field and orbits restriction rules.	Making or enactment of rules and regulation	Breaking of kolanut to seal the decision, meetings and monitoring, investigation and enforcement	Reduction in conflict, farm encroachment by cattle, water pollution and farmers' food and cash crop destruction
3	Participation in host communities social and economic activities.	Participation and Coordination	Meetings, information sourcing and sharing, attending host community meeting, market and socio-cultural event and financial contributions	Conflict transformation as market host community meetings and socio-cultural events attendance by Fulani pastoralists, provides potential avenues for developing constructive dialogues, culture and practice of tolerance and re-balancing of interest
4	Payment of required royalties and dues for land allocation.	Collection of dues and royalties	Fulani pastoral meeting, breaking of kolanut and financial contribution	Establishment of community project, for instance bore hole, normadic school and many others, conflict resolution, access to and use of natural resources and hosting of meetings
5	Negotiation with local government authorities on essential amenities such as schools, water supply and road.	Negotiation and Consultation	Financial contribution, appeal, Fulani pastoral meetings, attending host community meeting and socio-cultural events	Establishment of school, grading of roads, construction of culvert or bridges and water supply.
6	Linkage with local extension and veterinary officers.	Linkages	Networking with other Fulani groups and extension and veterinary officers.	Veterinary and extension practices which promotes healthy livestock, good family life and market opportunity.
7	Conflict and natural resources management.	Negotiation, Resolution, self-regulation, constitution of investigation, enforcement and monitoring team	Appeal, payment of bills or court bills, Fulani pastoral meetings, investigation, monitoring and sanctioning, attending of host community meeting, market and socio-cultural event, breaking of kolanut and financial contribution	Peaceful co-existence between host farmers and Fulani pastoralists, sustainable natural resources use and sustainable livelihood.

Table 4. Pastoral areas, local institutions and collective action functions

s/n	Collective action	Pastoral area and local institutions																									
		Eggua FTC				Atokun FTC				Iwoye FTC				Afon FTC				Alabata FTC				Allah Dey Branch FTC			
		SF	M	J	AF	SF	M	J	AF	SF	M	J	AF	SF	M	J	AF	SF	M	J	AF	SF	M	J	AF
1.	Negotiation with host communities for reception and approval especially for new entrants to build pastoral camp.	■	■	■	■	■	■	■		■	■	■		■	■	■		■	■	■		■	■		■
2.	Demarcation of pastoral and forest land for grazing field and orbit restriction rules as well as taking decisions on period for free grazing on agricultural lands.	■	■	■	■	■	■			■	■			■	■			■	■			■	■		■
3.	Participation in host communities, social and economic activities like markets, community development projects and social events.		■	■			■	■		■	■	■			■	■			■	■			■	■	
4.	Negotiation with local government authorities on essential amenities such as schools, water, road as well as security issues.	■			■		■		■		■		■		■		■		■		■		■		■
5.	Payment of required royalties and dues on land.		■	■			■	■			■	■			■	■			■	■			■	■	
6.	Conflict management.	■	■		■		■		■	■	■		■	■		■	■			■	■			■	■
7.	Linkage with local extension and veterinary officers.		■	■			■	■		■	■		■	■		■	■		■	■			■	■	

Legend

SF - *Sarkin Fulani*
M - *Mawdo*
J - *Jamu Saare*
AF - AFCON (Association of Fulani Traditional Chiefs of Nigeria)

Field survey, 2012/2013

Collection action problems and institutional challenges

Collective action is largely based on mutual trust and reciprocity and these two issues are promoted by prevailing social norms, values, laws and belief with which leadership institutions are encapsulated. There exists a range of factors that could render collective action problematic and vulnerable to threats thereby challenging their viability (Ostrom, 2000). These factors affected the strength of the norms of trust and reciprocity held by participants and incapacitated the possibility of unified efforts being produced; when individuals stay unorganised they fail to adopt coordinated strategies to yield higher benefits or reduce joint harm. It is in the light of this discussion that a number of factors that have the capacity to make collective action ineffective were identified. These are listed in Tables 5 and 6. Information in Table 5 indicates that 86.6% of the respondents identified the issue of lack of policy support by government to settled Fulani agro-pastoralists as one of the factors that make collective action vulnerable to threats in their joint pursuit of livelihood activities. Over 60.0% of the Fulani respondents maintained that loose collaboration/contradiction between statutory and indigenous institutions (68.1%), intrusion of migratory pastoralists (*Bororo*) into settled Fulani agro-pastoralists communities (63.5%) and entrance of new herders into settled Fulani agro-pastoralist communities (64.4%) constitute collective action problems.

Table 5. Responses in relation to problems of and institutional challenges towards building collective action

S/N	Problems/Institutional Challenges	Yes
1	Settled Fulani agro-pastoralists refusal to make financial contributions in their various communities	173 (34.1%)
2	Non participation by settled Fulani agro-pastoralists in host communities social ceremonies and market	127 (39.7%)
3	Non Involvement in the execution of community projects	128 (40.1%)
4	Investigation teams failure in the performance of their duties	143 (44.7%)
5	Regulation, monitoring and enforcement teams failure in the performance of their duties	175 (54.7%)
6	Entrance of new herders into settled Fulani agro-pastoralists' communities	206 (64.4%)
7	Intrusion of migratory pastoralists (*Bororo*) into settled Fulani agro-pastoralists' communities	203 (63.5%)
8	Demonstration of unwillingness by host communities to grant permission to settled Fulani agro-pastoralists to use natural resources	257 (76.6%)
9	Lack of policy support by government to settled Fulani agro-pastoralists in the pursuit of their livelihood activities.	277 (86.6%)
10	Loose collaboration/contradiction between statutory and indigenous institutions	191 (68.1%)
11	Refusal to abide by rules and regulations	237 (74.1%)
12	Deviations from customs/non-observance of religious beliefs by settled Fulani	232 (72.5%)

Source: Field survey, (2013)

The collective action problems relating to loose collaboration/contradiction between statutory and indigenous institutions was observed at Opeji in which the investigation, monitoring and enforcement team put in place by the community was accused by the police of taking over its (police) statutory responsibility and threatened to arrest any vigilante member that refused to stop investigating cases whether civil or criminal in nature in the area.

This position of the pastoralists was corroborated by our observations of the cases in which most of their places of settlement were not officially recognised as either towns or villages; they lacked access roads and permanent supply of water. Table 6 shows that this collective action problem is very challenging in Yewa North Local Government Area (Eggua and Atokun).

Table 6. Responses in relation to problems of and institutional challenges towards building collective action

S/N	Institutional Challenges	Abeokuta Rounda	Yewa North Eggua	Atokun	Imeko Afon Iwoye ketu	Afon	Odeda Alabata
1	Settled Fulani agro-pastoralists refusal to make financial contributions in their various communities	13(16.5)	23(31.0)	18(42.4)	17(25.3)	19(29.8)	36(67.9)
2	Non participation by settled Fulani agro-pastoralists in host communities social ceremonies and market	2(2.5)	20(27.0)	13(17.6)	7(10.4)	9(13.4)	29(54.7)
3	Non Involvement in the execution of community projects	9(11.5)	26(35.1)	20(27.4)	10(14.9)	14(20.8)	4(7.5)
4	Investigation teams' failure in the performance of their duties	11(13.5)	36(48.6)	10(4.0)	9(13.4)	15(8.9)	26(49.1)
5	Regulation, monitoring and enforcement teams' failure in the performance of their duties	12(15.2)	33(44.6)	9(12.1)	20(29.8)	24(35.8)	25(47.2)
6	Entrance of new herders into settled Fulani agro-pastoralists communities	1(1.3)	35(47.2)	6(8.1)	44(65.6)	20(29.8)	47(88.7)
7	Intrusion of migratory pastoralists (*Bororo*) into settled Fulani agro-pastoralists communities	2(2.5)	44(59.4)	44(65.6)	30(44.7)	27(40.3)	30(56.6)
8	Demonstration of unwillingness by host communities in granting permission to settled Fulani agro-pastoralists to use natural resources	59(74.7)	46(62.1)	30(44.7)	20(29.8)	38(56.7)	27(50.9)
9	Lack or policy support by government to settled Fulani agro-pastoralists in the pursuit of their livelihood activities	69(87.3)	56(75.6)	10(13.5)	41(77.3)	20(13.7)	24(45.3)
10	Loose collaboration/contradiction between statutory and indigenous institutions	14(17.7)	53(71.5)	12(16.2)	26(38.8)	20(29.8)	31(58.5)
11	Refusal to abide by rules and regulations	58(73.4)	38(51.3)	11(14.8)	25(37.3)	21(31.3)	33(602.3)
12	Deviations from customs/non-observance of religious beliefs by settled Fulani	39(49.4)	32(43.2)	10(13.5)	12(17.9)	30(44.7)	51(96.2)

Source: Field survey, (2013)

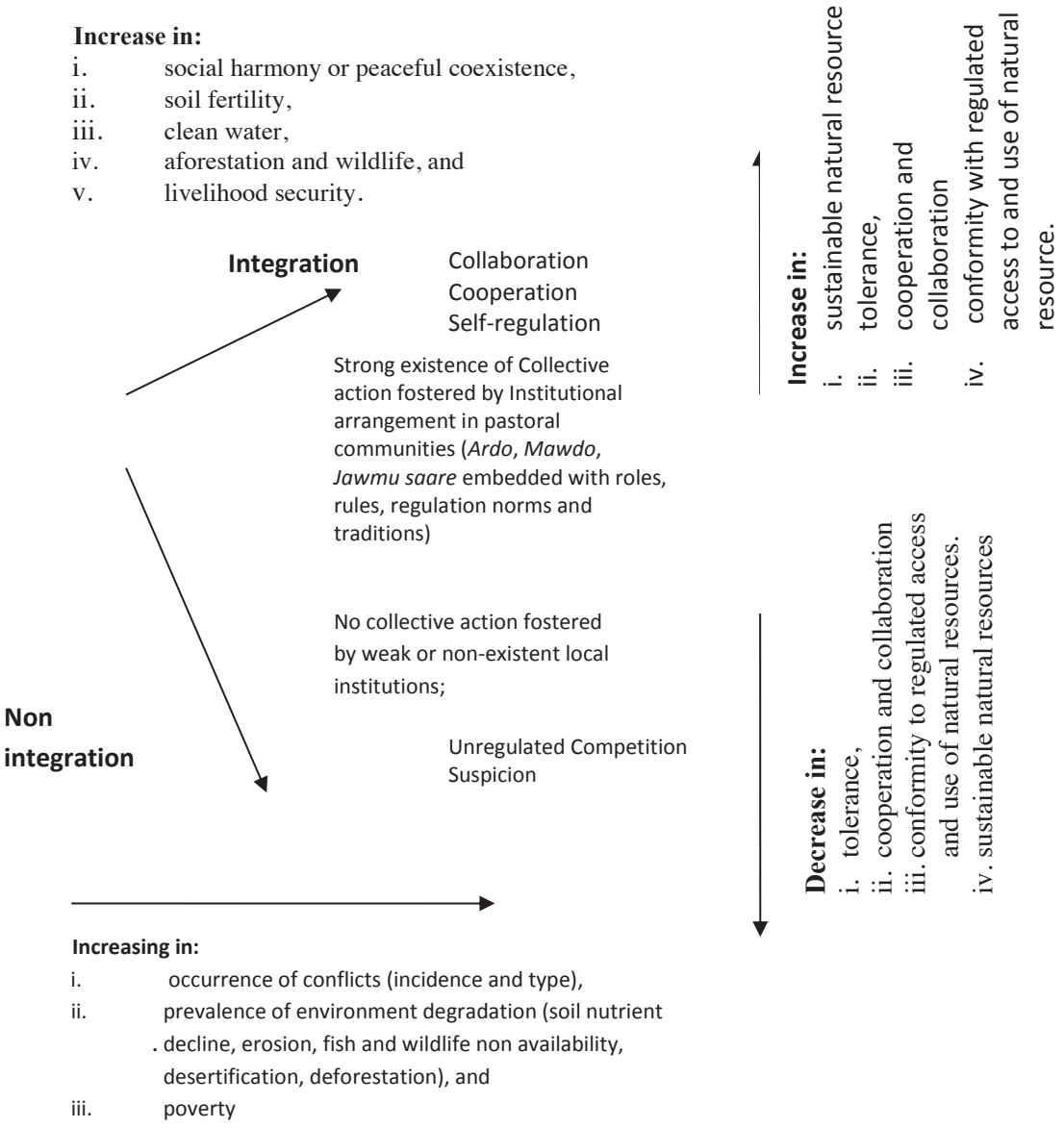

Figure 2. A conceptual model of factors influencing Fulani pastoralists' integration or differentiation and changes in peaceful coexistence with host communities and sustainability of environment.

Figure 2 further explains the role played by leadership institutions in building collective action for co-operation and sustainable land use among settled Fulani agro-pastoral groups. The figure also explains what will be the outcome of integration (in the event of existence of strong collective action fostered by institutional arrangements which promote cooperation, collaboration and self-regulated access and use of natural resources) or non-integration (in the events of unregulated access and use of natural resources, competition and suspicion) with the host community members (Yoruba farmers) in some cases.

Conclusion

Drawing from the findings of the study, the nature and intensity of co-operation and land use vary from one study location to other. Fulani pastoralists and host farmers have variously responded by evolving leadership institutions for fostering collective action to address the interlinked challenges of co-operation, collaboration, sustainable land use and welfare. Evidence from the study, shows that local institutions for building collective action in the management of sustainable land use - *Sarkin Fulani, Mawdo and Jawmu saare* embedded with tradition (*aldu*), laws (*doka*) and justice (*sharia*) - are important for the maintenance of peace and sustainable land resources among the Fulani pastoralists. It was discovered that local leadership institutions used processes and tools to achieve collective action functions. Some of these tools were: payment of bails or court bills, appeals, meetings, investigation, enforcement, monitoring, financial contributions, breaking of Kolanut, networking with other Fulani groups and governments.

Recommendations

The achievement of peace and sustainable land resources management is dependent on viable collective action processes and efforts by natural resource user groups to deal with the threats of collective action problems and challenges. These can be achieved through the following:

i. Capacity building and advisory services on leadership and institutional building;
ii. Development of designated areas for Fulani agro-pastoralists to settle with provision of infrastructure and demarcation of grazing routes as well as formulation of land use policy for pastoral areas in the four LGAs in Ogun State;
iii. Fulani pastoralists should be supported by government to develop mini-earth dams into which water would be collected during the raining season and made available to pastoralists for their herds during the dry season;
iv. Government should provide portable water in all pastoral areas to prevent both Fulani pastoralists and host Yoruba farmers drinking polluted water which has been alleged to be the cause of reported cholera outbreaks especially during the dry season.

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On-farm energy generation: enabling innovation?

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(Abstract only included at author's request)

Abstract: This presentation examines the role of renewable energy generation in enabling innovation in the agricultural sector by comparing and contrasting policy incentives in two territories: Nova Scotia, Canada, and the United Kingdom. The Nova Scotia Community Feed-In Tariff (COMFIT) is the world's first example of a scheme which provides financial incentive for the local generation of electricity from renewable resources (such as wind, solar and hydro) and it has resulted in the transformation of the agricultural landscape of this region of Atlantic Canada and a rapid transition of the electricity generation mix there. This scheme was closed in 2015 and the full extent of the impacts of its closure are poorly understood. The system of feed-in tariffs operational in the United Kingdom was placed under review soon after the General Election in 2015 and reduced financial incentives have been announced recently; it is widely predicted that the scheme is likely to close altogether in the near future. A comparison between these two regions, therefore, might be advantageous in order to make predictions about future impacts upon farmers in the United Kingdom. This presentation discusses a research project currently in the planning phase.

Keywords: Renewable energy; on-farm energy; innovation