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Building a Narrative: The Role of Dualisms When Interpreting Food Systems

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Abstract. Against the background of increasingly complex and diverse agri-food systems, calls are made in rural sociology to no longer describe and distinguish food systems based on dualistic oppositions. The aim of this paper is to understand to what extent food system actors use different dualisms to build their ontological narratives. Based on a qualitative analysis, we analyse the narratives of key actors in the Flemish food system on food system challenges, and their relation with specific dualistic concepts and associated meanings, experiences and practices. Two distinct narratives emerge that are embedded in opposing dualisms, what leads us to believe that dualistic oppositions are still a part of the agri-food reality and are something to take into account when different actors have to collaborate.

Introduction

In our global era, European agri-food systems are becoming increasingly complex. A myriad of actors, both public and private, are recurrently confronted with different food system challenges, that each in turn generate various impacts and responses. Despite these and other forms of variety, including those relating to agricultural practices and organizational structures, food systems are often depicted in dualistic terms, such as productivist versus post-productivist, or mainstream versus alternative. While research has shown that dualisms do not reflect the complexity of agri-food practices (e.g. Murdoch, 1997; Morgan et al., 2006; Sonnino and Marsden, 2006), objects of research construct and reproduce these dualisms when acting and reflecting upon the food system.

The aim of this study is to understand the ontological narratives of key actors in the Flemish food system, and how these intersect with various dualisms. Narra-

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tives are accounts or stories of events that occur over time (Bruner, 1991). Yet they are more than a mere reflection of experiences: narratives offer opportunities for capturing actors' perceptions of that experience (Ingram et al., 2014). As such, narratives are a discursive mode of representation. Actors use ontological narratives to make sense of the world. Ontological narratives define the identity of actors and structure their behaviour. Reality is more than a sequence of events and understanding this provides a sense of social being. By embedding the ontological narrative in other narratives, a social identity is constituted (Somers, 1994). This is usually done unconsciously and implicitly, particularly when one's own narrative reflects the dominant world view (Somers, 1994; Freibauer et al., 2011). Using an actor point of view rather than an analytical one, the dualistic concepts under study are considered as metanarratives that comprise both the literal use of dualistic terms as well as underlying meanings, experiences and practices. Metanarratives are broader and more abstract narratives 'in which we are embedded as contemporary actors in history' (Somers, 1994, p. 619). Metanarratives build on concepts and explanatory schemes, and reflect the interaction between individual (i.e. ontological) narratives and institutional dynamics (Somers, 1994; Sheehan and Sweeney, 2009). Where the ontological and metanarratives intersect, world views are made explicit and shed light upon assumptions and discussions about food system challenges. The specific goal of this article is therefore to analyse how ontological narratives are embedded in dualistic metanarratives. This embeddedness can have relevant implications for the debate in rural sociology on overcoming dualisms in food practices, as actors act in accordance with their ontological narrative (Somers, 1994).

In what follows, we first review four dualistic metanarratives that appear repeatedly in literature on food and agricultural systems. Next, we discuss the collection of the interview data and the setting of the research. An examination of the intersection between the two types of narratives reveals two distinct and opposing storylines that are each embedded in specific metanarratives. Finally, we conclude by discussing possibilities for handling opposing narratives in a context where different actors have to work together.

Four Recurring Dualistic Metanarratives

The dualism of productivism and post-productivism revolves around the role of productivity. Productivist agri-food systems aim to boost productivity and efficiency through a focus on intensification, industrialization and specialization, while relying on technological inputs and state support (Wilson, 2001; Walford, 2003; Burch and Lawrence, 2005). Maximizing productivity became a primary policy aim in Western countries after World War II (Wilson, 2001; Bjørkhaug and Richards, 2004, 2008). Apart from meeting a national self-sufficiency objective, the productivist strategy also engendered negative outcomes such as decreasing food prices due to overproduction and the exploitation of natural resources (Bjørkhaug and Richards, 2004, 2008). In response to these and other issues associated with productivism (such as concerns about food quality) the concept of post-productivism emerged as a challenge to the productivist ethos from the 1980s on (Burch and Lawrence, 2005; Almstedt, 2013). Post-productivism downplays the pursuit of productivity relative to other goals, illustrated by values such as the adoption of environmental and health values alongside economic value (Mather et al., 2006). This shift in goals is linked to changes in agricultural practices as well as policy objectives and decision-mak-

ing procedures (Almstedt, 2013). For example, the policy community opens up and evolves from a tight-knit agricultural group to one inclusive of a diversity of actors (Wilson, 2001; Mather et al., 2006). Although the empirical base and definition of post-productivism remain ambiguous, the concept is widely used and is thus relevant for our analysis (Evans et al., 2002).

The second dualism, mainstream versus alternative, is used to refer to different types of food system organization. Mainstream systems of food provisioning supply global markets across long-distance chains (Fonte, 2002; Ilbery and Maye, 2005). As a result, 'mainstream food' has become decoupled from producer and place, rendering it anonymous and placeless (O'Neill, 2014). Mainstream food systems tend to be dominated by large agri-food companies and corporate retailers who are competing with each other to define standards of efficiency and quality (Ilbery et al., 2004; Sonnino and Marsden, 2006). The spatial and structural features of mainstream food systems generally ensure high levels of production, but are also associated with negative environmental, health and social impacts, such as greenhouse gas emissions (Murdoch et al., 2000; Cleveland et al., 2011). Alternative systems of food provisioning aim to counter these unsustainable practices by creating new practices that offer an economic, social or spatial alternative (Watts et al., 2005; Roep and Wiskerke, 2010). Social and spatial distances are shortened by building new alliances between food system actors and with local communities (Jarosz, 2008; Roep and Wiskerke, 2010). Such connections increase the (social and spatial) embeddedness of the food system and help to adapt food provisioning to local values, norms, needs and desires (Roep and Wiskerke, 2010). Furthermore, building new linkages is a way of restructuring food provisioning systems that allows for the pursuit of environmental and social objectives, as well as economic objectives (Cleveland et al., 2014).

Third, the dualism of production and consumption requires focusing on both ends of the food chain in research and policy. Production-oriented approaches to agri-food centre on the supply end of food chains and the exchange relations there. In line with Marxist arguments, power is located in the production sphere, where the resources and extracted surplus value are concentrated (Goodman, 2002; Goodman and DuPuis, 2002). As a result, food becomes a commodity that disguises power struggles between food chain actors. Consumers are considered to be passive actors because their practices can be derived from production (Goodman and DuPuis, 2002; Spaargaren and Van Vliet, 2000). For example, sustainable consumption is to be achieved through product innovations (Martens and Spaargaren, 2005). From a consumption-oriented perspective, however, consumer practices and meanings are more than something derived from production (Spaargaren and Van Vliet, 2000). Despite a variety of approaches used to study consumption, the themes of embeddedness and consumer politics recur in those studies. Consumer practices and meanings are and become embedded through social interactions (e.g. between producers and consumers). Further, valorizing specific consumer practices and meanings enhances the social and spatial embedding of a specific type of food provisioning (Goodman, 2002). When this valorization is part of a reflexive consumer practice a politics of food is created that can empower marginalized or excluded actors (Goodman and DuPuis, 2002).

The fourth and last dualism concentrates on the social and natural aspects inherent to food. This has led to two approaches: a science and technology approach and an eco-social approach. In the first approach, actors in food provisioning try to circumvent any eventual natural constraints by using science and technology (Mur-

doch and Miele, 1999; Murdoch et al., 2000). Two processes are vital here: the food industry appropriates natural and agricultural processes, and producers and products are substituted for others (Fonte, 2002). As a result, industrial actors become more powerful and are able to control food provisioning (Murdoch et al., 2000). Alternatively, eco-social approaches advocate a more symmetrical perspective including both natural and social aspects. These become intertwined in heterogeneous networks that are described by relational concepts such as social-ecological (e.g. Lutz and Schachinger, 2013). Because of their intertwining, the natural and the social become subject to the same processes and can be shaped in accordance with specific types of food systems (Murdoch, 1997).

Collecting Ontological Narratives

The ontological narratives were collected in two series of semi-structured one to two hour interviews. Respondents were asked the open-ended, undirected question, 'What do you perceive to be challenges for the Flemish food systems and why?' The interview script contained a list of challenges that had been identified through a literature review. This list was complemented iteratively with challenges mentioned in the interviews. After the first three interviews, no new challenges emerged. This list was used as a kind of interview script to stimulate respondents. In total 16 in-depth interviews were conducted with 20 respondents (see Table 1). We selected respondents based on their function (or that of the organization they represent) within the Flemish food system (e.g. distribution). The strategy behind this kind of sampling was to purposefully select key respondents who would help us to gain insights into food system challenges and who represent a broad spectrum of perspectives based on their practices and experience (Patton, 2002; Creswell, 2003). All interviews were recorded; after transcription they were presented to the respondent for feedback.

The data were analysed in NVivo using an inductive approach. We began with open coding to reduce and organize the data. We extracted those parts of the data where respondents identified something as problematic or as challenging. Open coding was followed by axial coding. This allowed us to organize the challenges thematically into five categories (Table 2): issues relating to resilience and the environment, economic issues, institutional issues, spatial issues and social issues. The first category (resilience and environment) gathers all of the challenges regarding environmental changes and issues about how to respond to these. The category of economic issues includes matters relating to financial or market aspects of the production, distribution, trade and consumption of food. Third, the category of institutional issues comprises the challenges connected to formal institutions such as laws and policy, and references to the role of institutional actors (e.g. governments) in the food system. Informal institutions are not included here; they are part of the social issues. The fourth category contains spatial issues, which encompasses all challenges relating to the geographic embeddedness and spatial aspects of the food system. The final category of social issues contains all challenges pertaining to the behaviour, attitudes, knowledge, norms, perspectives, etc. of actors within the food system and their relations. Due to the complexity and multidimensionality of many of the issues cited by the respondents, several issues could be classified under more than one category. In addition, not all respondents identified all five of the above-mentioned challenges. We created a synthesis (Table 2) to illustrate that actors identify a range of challenges within the food system. Extensive description of these issues lies out-

Table 1. Interviews.

Interview	Respondent	Function within the food system
1	1	Quality label for fruit and vegetables
2	2	Food industry federation
3	3	Policy actor regional level
4	4	Farmers' distribution initiative
5	5	Conscious consumer
6	6	CSA farmer
7	7	Consumer organization
8	8–9	Monitoring agency
9	10	NGO organic agriculture
10	11	Produce auction
11	12	Farmers' union
12	13	Urban farming entrepreneur
13	14	Policy actor at provincial level
14	15	Retailer
15	16–17	Local food project
16	18–20	Policy actor at provincial level

Table 2. Synthesis of the identified challenges.

Environment and resilience	Economic challenges	Institutional challenges	Spatial challenges	Social challenges
Transition	Export orientation	Labelling	Population density	Number of farmers
Climate change	Viability of businesses	Food safety	Distribution	Awareness consumers
Food system	Innovation	Subsidies	Transport	Consumption behaviour
Food sovereignty	Market dynamics	Complexity of legislation	Globalization vs. localization	Education
Food security	Overproduction	Consistent, strong policy	Space	Image of food
Food waste	Food prices	European policy		Informal institutions
	Income security	Customized policy		Link producers–consumers
				Social support
				Research
				Cooperation
				Different visions / perspectives

side the scope of this article. Instead, we use this categorization as a stepping stone for an exploratory study of the links between narratives and multiple dualisms.

The setting for this research is Flanders (northern part of Belgium), a strongly urbanized region. It is one of the most densely populated areas in Europe with 478

inhabitants per km^2 (compared to the EU average of 166 inhabitants/km^2 in 2012) (Eurostat, 2014) and an average built-up percentage of 26% (compared to the EU average of 4.8%) (Poelmans and Van Rompaey, 2009). The ongoing urbanization of land poses multiple difficulties and obstacles for agriculture (Strategische Adviesraad voor Landbouw en Visserij, 2010). This has caused land to become scarce and thus more expensive. Prices for farmland have doubled in the period 1995–2009 (Bergen, 2011). Agricultural land encompasses nearly 45% of Flanders' territory, but it is very fragmented and interwoven with other land uses. Since land is scarce, land use is increasingly contested or required to be multifunctional (Antrop, 2004; Rogge et al., 2007). As a consequence, agriculture has to share limited open space with other land uses, such as nature, recreational space, environmental buffers, residential dwellings and settlements, etc. (Bomans et al., 2010). This intertwining of functions is characteristic of highly urbanized areas. Because urbanization is an increasingly global phenomenon, its consequences for the food system manifest themselves on a global scale as well (Brunori et al., 2013). Additionally, given that green planning and sustainable development plead for more resilient metropolitan spaces with a mixed land use (Leinfelder et al., 2008), insights into the narratives of Flemish food system actors on food system challenges can serve as a learning opportunity for other urbanizing regions as well.

Intersecting Narratives

The aim of the analysis is to study the intersection of the ontological narratives of key respondents and the four dualistic metanarratives. Specifically, this means that we study whether the respondents' narrative (per theme of challenges) is linked to the four dualistic concepts themselves or the meanings, experiences and practices underlying them. This thematic analysis results in five figures – one for every theme of challenges – where every respondent's ontological narrative is positioned relative to the dualistic metanarratives (Figures 1–5). The positioning of the actors is based on how much their ontological narrative is embedded within a specific metanarrative. For some respondents this was very easy because they clearly stayed within specific metanarratives (e.g. always embedded in the productivist metanarrative), but others sometimes used arguments from opposing metanarratives (e.g. embedded in both the productivist and post-productivist metanarratives). When respondents used more arguments from a specific metanarrative in proportion to its opposite narrative, their ontological narrative was positioned accordingly between the first metanarrative and the centre. When they used a relatively equal amount of arguments of both the opposing metanarratives, they were situated in the middle.

Although research in rural sociology has found that dualistic concepts do not reflect the diversity in practices, our analysis clearly shows that dualistic metanarratives still matter. Figures 1–5 reveal a clear divide between the respondents linked to the embeddedness of their ontological narrative in specific, opposing metanarratives. A first group of respondents we can distinguish embed their ontological narratives within the productivist, conventional, production, and science and technology metanarratives. We will refer to the metanarrative of this group as 'narrative A'. Respondents that belong to this group tend to be representatives of organizations that are active on both national and international markets. Their narratives also show professional distancing, as they are a representatives of large organizations and have experience in this representative role. Based on our respondent sample we find that

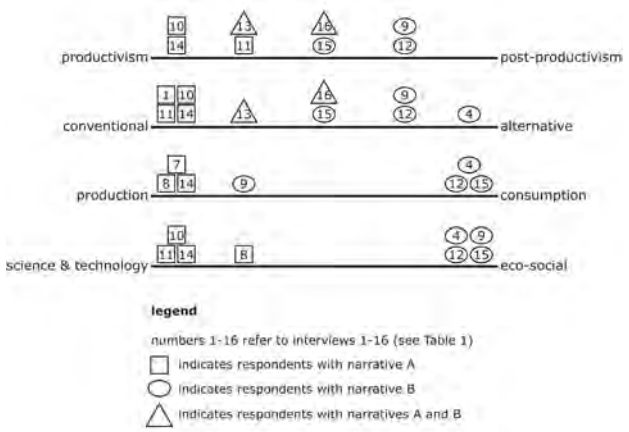

Figure 1. Environment and resilience.

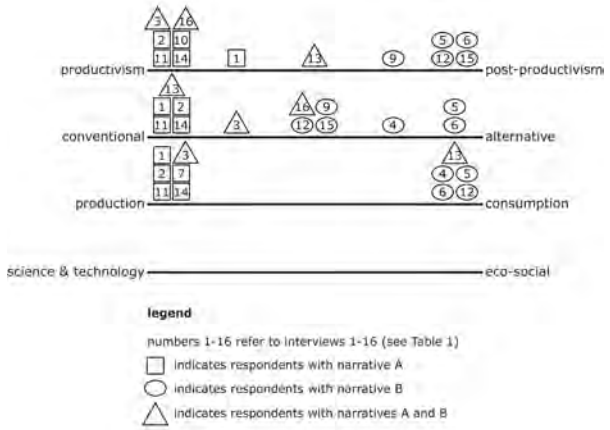

Figure 2. Economic challenges.

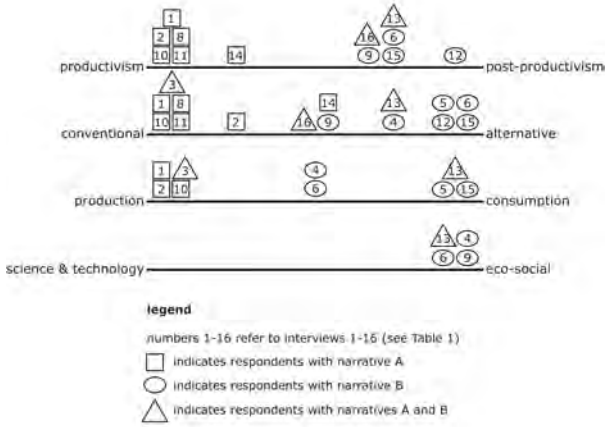

Figure 3. Spatial challenges.

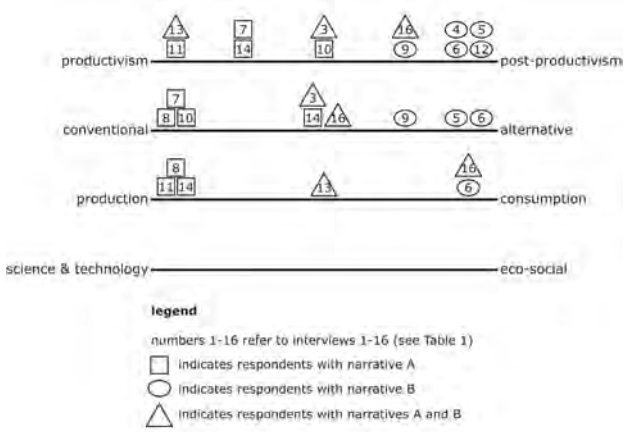

Figure 4. Institutional challenges.

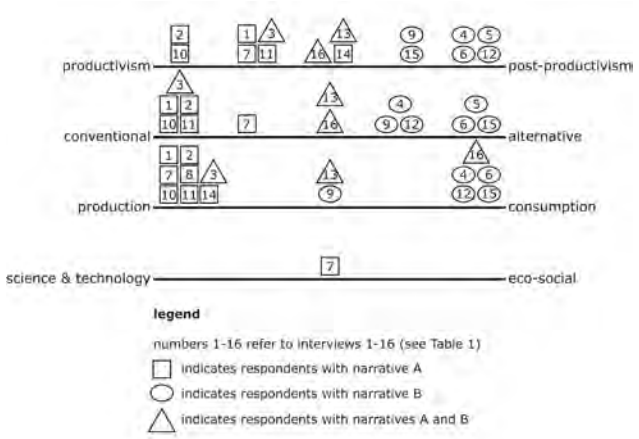

Figure 5. Social challenges.

narrative A can be considered currently as the more dominant narrative, as this is the narrative adhered to by powerful companies and organizations (e.g. retail, produce auction, food industry, etc.). Another group of respondents embed their ontological narratives within the post-productivist, alternative, consumption and eco-social metanarratives. The metanarrative of this group will be referred to as 'narrative B'. Respondents that fall within this group are mainly representative of local and smaller businesses and initiatives. Although they also have experience with representing their organization, the narrative of these respondents often has a more personal touch to it. Especially the narratives of the two entrepreneurs, the farmer and the coordinator of the LETS group are more personal. This can be explained by the fact that the organizations they represent are smaller (SMEs) and these respondents are the initiators and/or (sole) owners of the organizations they represent.

Hence, narrative A and narrative B represent a specific combination of the four dualistic metanarratives that relates to how the respondents' ontological narratives are embedded in the dualistic metanarratives. Because narratives A and B reflect the

embeddedness of respondents' ontological narratives in opposing metanarratives, narratives A and B are opposing themselves. The respondents were often aware of this opposition and used this to distinguish themselves from the other group, thus further deepening the divide. This becomes especially clear when they talk in terms of 'we' and 'them', or criticize the other group for having caused certain problems or for not addressing these problems properly. Ingram et al. (2014) use the notion of alterity to refer to this process of the identification of a real or imagined 'other'. Although both groups are prone to stress this alterity in a negative way, this is especially so for respondents with narrative A. They do not only perceive this alterity to be a threat to their values, but also to their practices. These respondents claim that, for example, localizing food systems or reconnecting producers and consumers is not viable nor realistic, and could only be interesting for educating consumers.

> 'What I'm trying to say about those "alternativo-initiatives" is that they destroy our networks and boycott us. That is a problem. But we try to convince people to "no, do it like this"' (produce auction, manager).

Respondents with narrative B, on the other hand, do not talk about the threats the alterity poses to their own food system organization, but rather stress the environmental, social and economic downsides to society in general.

> 'The globalization of the food system hasn't been a good evaluation and also the free market isn't the right path for food… This is contrary to our [i.e. the Flemish] export mission and the idea of Flanders as a logistic hub for the world. So I think that regarding food, a free market is not a good choice and does not lead to food security in the world. On the contrary. And it also doesn't provide the farmer with a good income either, only the multinationals' (NGO, director).

A third group can be distinguished: respondents from the policy sector. These respondents do not have a 'new' narrative, but instead borrow elements from narratives A and B to constitute their own. Moreover, they do not make a choice between specific concepts, meanings, experiences and practices, but switch between them depending on the challenge being discussed. In the following sections, each narrative is discussed in more detail.

Narrative A

Overall, narrative A intersects with the productivist, conventional, production, and science and technology metanarratives across the five categories of challenges. The extent to which the overarching narrative A and individual ontological narratives are embedded in these metanarratives can vary depending on the specific challenge that is being discussed. For example, the respondents only referred to a science and technology approach in the context of sustainability challenges. With regard to the other challenges, the conventional respondents did not mention this nor did they make another reference to the relationship with nature.

With regard to the environment and resilience, respondents with narrative A focus on conservative strategies that avoid profound systemic changes. The respondents can be divided into two groups: those that think that the environment and resilience are important challenges and those who do not. The first group argues to address such issues within the present organizational frame and infrastructure. They believe

that large-scale, industrialized and intensive processes of food production and processing contribute to food security, food safety and sustainability in general. Issues that arise can be solved through further scientific and technological interventions whose aim is to improve efficiency. Such interventions usually aim to improve economic standards instead of conserving the environment or creating resilience. For this group, economic efficiency is equated to sustainability. Besides efficiency, environmental and resilience issues are attributed to consumer behaviour and awareness. Despite the conviction of consumer responsibility, consumers are not included as active actors and involved in finding a solution. Instead, this group believes that consumers should be nudged or educated so they will change their behaviour.

> 'You bring everything together and tell the buyer, the retailer, that he can find everything in that one place and that he only has to drive one truck from the auction to the store where otherwise you'd have to take 50 or 60 trucks. So can it be more efficient? No. Is it sustainable? Yes' (produce auction, manager).

The group that does not consider environmental and resilience issues to be important argue that 'sustainability is not the core business of our agency' (monitoring agency, manager) or that they already 'meet the legal standards [set by Flandria]' (quality label, manager). Their role within the Flemish food system therefore does not require them to think about these issues proactively.

The focus on productivist values is extended to economic challenges. One example is the critique of the agricultural treadmill farmers, and by extension also food processors, are stuck in. The respondents indicate surplus production, market dynamics, consumer (de)valuation of food products and skewed power relations as causes for the increasing income insecurity that food producers are facing. The respondents hope to solve those economic problems through professionalization, scaling up, intensification and specialization. Although the indicated challenge seems to align more with post-productivism, the solutions suggested by the respondents reflect a productivist, production-centred thinking tailored to a conventional food system organization.

> 'Someone who is big has a cogeneration system for his energy supply and has screens that illuminate his crops so he can harvest his tomatoes sooner; these things make a big difference. The cost is considerably lower' (quality label, manager).

Related to this, the consumer is also blamed with regard to problematically low food prices. The respondents point out two causal processes that contradict each other: the consumer demands cheap food that is available to everyone, and the demand to make food more expensive to ensure fair prices for the producers. Again, the respondents do not see an active role for the consumer as consumers are seen as always buying the cheapest food available. Instead, a solution is found in market dynamics or developing partnerships between producers, processors and/or other food actors.

> 'So paying more for food to provide the farmer a better income? That will not happen. Instead they [consumers] will say: farmer, organize yourself better so you can earn a living' (farmers' union, CEO).

Regarding institutional challenges, a recurring theme is government involvement.

The respondents recognize the need to develop a strong, consistent policy to enforce rules and norms. Also a level playing field is something that should be provided by the government, as a clear set of rules, equally applied to all, eliminates unfair competition. Third, some respondents feel the government should play a more active role in transitioning the food system. Suggestions that are made include monitoring practices to guarantee fair business relations or to prevent monopolies, or the creation of new legal business forms that enhance sustainable development.

> 'When specific legislation imposes those things, then real change will happen. I believe there is a major role for the government here. Everyone can cooperate… but to create a real change, regulation is needed' (consumer organization, researcher).

Despite this call for government involvement, the respondents feel that this should not go beyond the creation of a framework in which the market has free reign. According to the respondents, too much government interference could be inefficient and impede innovation. Another theme is decision-making processes. Here, the respondents only specify roles for traditional chain actors. For instance, consumers are not included in policymaking. One possible reason for this is that the respondents believe that consumers are not enough aware, they do not understand why agriculture needs subsidies, or they have aspirations that are difficult to realize.

> 'But some products, like a pizza for instance, are made from up to 40 different ingredients… That is not so easy. Consumers may feel the need to know whether this comes from Africa or Asia. That is all easily said and done when the product is made out of one ingredient' (monitoring agency, manager).

The spatial challenges within narrative A mainly relate to globalization. Despite Flanders' export orientation and ambitions, the globalized market is perceived as a threat by the respondents as it implies competition with cheaper, foreign products. Moreover, these products originate in another legislative context and are thus subject to other quality and production norms. This is believed to create an imbalanced playing field and can potentially endanger public health. Yet the main issue according to the respondents is the tendency of consumers to buy the cheapest food. This is especially problematized in the case of the Flemish market, because the Flemish consumers have no *terroir* logic when buying food. Again, despite the role attributed to consumers, the respondents do not think consumers should be more involved to create a culture of *terroir*. Although some issues are linked to globalization, this is not a bad thing in itself. A reliance on local production and consumption is certainly not a solution according to the respondents.

> 'If we only did local production and used local networks, we would first lose diversity in our products. It is terrible what we would lose on that front. Second, in terms of efficiency this would also not be good… In one location you cannot be efficient for everything. You are only efficient for some things, which means that your very well-made products ought to be exported. Everyone does that' (food industry, director).

The returning critiques on consumer behaviour in other challenges make this the most pressing social challenge within narrative A. Consumers are perceived as being unaware of and contributing to problems such as farmers' income insecurity,

food waste and low food prices.

> 'Regarding food waste, consumers have a very large responsibility. They should be punished for wasting food, but that is almost impossible' (food industry, director).

Another social challenge that is frequently quoted by the respondents is that of skewed power relations within the food system. Most of the power is perceived to be concentrated at the two ends of the food chain: with the input producers and the distributors. Joining a cooperative could be a solution because a bigger network can be a good mediator between a small producer and a large distributor. Another suggested solution is building relations or increasing cooperation within the food chain (again, the consumer is not included). This can be complicated, however, because of the complexity and fragmentation within the food system and the limits set to cooperation.

> 'Retailers have a lot of power. They use that very well, because they realize that there is a lot of surplus production. Sometimes we have to move heaven and earth to say no to them, because they ask too much. When you are talking to them, you can feel that you are not their equal. That you, as a salesperson, almost have to go down on your knees for them' (quality label, manager).

In conclusion, narrative A underpins a conventional food system organization that is dominated by large-scale businesses, oriented towards specialization and export and led by economic standards. According to the respondents, the challenges they identify are attributed to problems relating to efficiency, power balances or consumer behaviour. The focus remains on the production side of the food system: only actors from within the chain are involved in developing and implementing solutions to these challenges. Consumers remain passive actors because interaction with them is limited to the market sphere. Furthermore, solutions to challenges are approached with scientific and technological interventions, which are usually applied to increase the (economic) efficiency.

Narrative B

In general, narrative B is embedded within the post-productivist, alternative, consumption and eco-social metanarratives. Respondents with narrative B mostly promote an alternative food system organization based on localization and an emphasis on quality. Further, they build on reciprocal relationships between consumers, producers and other actors within the food system and believe that these will stimulate the local and social embeddedness of the food system. This attention to reciprocity is extended to the relationship with nature, which implies that the respondents try to find solutions to challenges that depart from a symmetric approach to nature and society.

According to the respondents with narrative B, the core challenge regarding the environment and resilience is the rebalancing of the food system. This is mainly based on a critique of the productivist paradigm. According to the respondents, a conventional food system organization can have negative environmental impacts. Solving these by improving efficiency or implementing new technologies are 'end-of-pipe solutions and do not look at the food system as a whole' (NGO, director). A

proactive approach based on a long-term perspective, reciprocity and embeddedness is argued to be better suited to resolve challenges related to the environment and resilience.

> 'I think the primary agricultural system, from my position, is sick in terms of impact on the environment… The focus has been placed too strongly on industrialization… which ipso facto has a bigger, more problematic impact on the environment' (urban agriculture, entrepreneur).

Similar to narrative A, narrative B also indicates income insecurity as a major economic challenge. This financial challenge is attributed to another cause, however: the respondents believe that skewed power relations cause income insecurity of farmers and producers. To counter this imbalance, the focus is shifted from producers to consumers. Respondents with narrative B do not consider consumers as passive actors. Instead, the respondents want to involve consumers because they believe this will inform them about underlying processes of food production, will stimulate them to pay a fairer price for quality food, and can inspire a better appreciation of food (producers). Another benefit is that when there is a direct link between producers and consumers, producers can set the prices themselves and receive the money immediately.

> 'When you know that you are not merely buying a product, but you are making sure that the person who worked for it can live off his work. I think that is incredible' (community supported agriculture, farmer).

Although the respondents state that reconnecting producers and consumers can solve some issues, they recognize that it can also cause new problems to arise. One of these is the development of an economically viable business. When developing and maintaining a local food system, both producers and consumers are required to make significant commitments of time and money. This kind of commitment might not suit every producer and consumer. For this reason, local food networks that depend on volunteers sometimes find it difficult to become economically viable or maintain that viability. Also the prioritizing of social or ecological goals over economic profit contributes to this issue.

> 'Consumers are often only looking for an easy way to buy food and do not feel the need to get to know the farmer, organize activities and do something with the team. Some people do not feel this need' (farmers' distribution initiative, manager).

According to the respondents, one solution can be to take a more flexible, pragmatic approach to consumer involvement and to let go of dogmatic beliefs. In this way, the consumers who are willing to invest time and those who are not can both consume local, quality food.

The need for a flexible approach is also mentioned with regard to institutional issues. The respondents advocate an adapted policy that takes business size and local needs into account. According to them, current policy is often aimed at large-scale businesses or is too complex for small producers to manage. Further, policy can and should play an important role in stimulating, facilitating, sensitizing and enforcing in order to make the food system more sustainable.

> 'When you produce organically, you have to be monitored to prove you are not polluting. On the other hand, when you use polluting, conventional

> methods, you don't have to pay and you are not monitored… You get a higher price for organic produce, OK, but if producers would have to pay for the damage they cause to the environment and society, organic food would be 100 times cheaper' (community supported agriculture, farmer).

The respondents with narrative B criticize the lack of long-term thinking in policy and the strong financial state support (e.g. subsidies). According to them, turning both of these around will provide a new perspective on food systems and their impact on the environment.

The main spatial challenges within narrative B are logistics and scale. Regarding logistics, the respondents indicate difficulties in balancing logistical efficiency and environmental impacts in terms of time and money. Investments in logistics and transport costs are expensive in comparison to shorter transport distances, which can make it hard to create an economically efficient logistical system with minimum environmental impacts.

> 'It is our mission to develop sustainable projects that have a significant ecological and social impact, obviously, but that still allow us to make money with a viable business model. That viability can be realized in the long or short term, that doesn't really matter to me. The intention is to finance things and have these investments returned' (urban agriculture, entrepreneur).

Determining the scale on which to operate is not easy according to the respondents. Localizing the food system is a way to limit environmental impacts and to increase consumer involvement, but what local exactly means is hard to determine. As a result, this varies between the respondents from city to provincial and regional levels and even to Western Europe. The respondents recognize that a minimum scale is required to establish a viable business. However, this requires caution and monitoring in order to prevent alternative food systems from becoming absorbed into mainstream systems if this is not their aim.

Finally, equivalent to narrative A, the consumer is the focus of the social issues that were identified in narrative B. Similarly, the respondents believe that consumers are unaware of and contribute to problems such as farmers' income insecurity, food waste and low food prices. However, within narrative B the respondents stress the need to actively involve consumers in order to solve these issues. To the respondents, this implies shortening the food chain and engaging in more direct exchange with a limited number of intermediary actors. As a result, producers can get a fairer price and get to know consumers, who in turn learn about food products and the underlying processes. Another social challenge that has to do with consumers is the need to broaden the interested group of consumers.

> 'For example for CSA… they get a very narrow audience of people that are already motivated to do that. People who want to put on their boots and sink their shovel into the ground… You only reach the conscious, motivated consumer, but not your average consumer… With projects like these, we hope to include the normal consumer in the story of consuming sustainably' (local food project, entrepreneur).

As a solution, one respondent proposes to be less dogmatic about consumer involvement. In the end, participating is what matters and what already causes a change in consumer behaviour.

In sum, narrative B promotes an alternative food system organization based on localization and local and social embeddedness. The main threats to the environment, society and economy are perceived to come from the conventional system. To reduce these perceived negative externalities, the respondents advocate a trade based on a symmetrical approach to nature and society. In practice this means that environmental and social impacts are to be balanced with economic gains. Further, the food community is broadened and consumers are actively involved, both to enhance embeddedness and to get fairer prices.

Narrative of the Policy Respondents

The narrative of the policy respondents does not fit either narrative A nor B. Instead, these respondents borrow arguments and solutions from both narratives to constitute their own. As a result, their narrative constantly finds compromises between two recognizably distinct narratives, which is probably the reason why respondents both within narratives A and B indicate the need to develop a stronger policy and a clearer framework that stimulates innovation and enhances the transition towards a more sustainable food system.

> 'This is a common reproof of the government, especially the Flemish government. They give subsidies to develop GMOs and they give subsidies to organic agriculture, while both are at odds with each other. Policy has to make a choice. Or maybe this is better: not choosing is also a choice… Sometimes decisions have to be made and they will make them. But what is the result? After a few years everything could be revoked' (policy actor, advisor).

This concludes the exploration of the narrative of the policy respondents. Having done the tour, we now proceed to present our conclusions and discussion.

Conclusion and Discussion

In this article we discussed the embeddedness of the ontological narratives of key actors in the Flemish food system on food system challenges in four dualistic metanarratives: productivism versus post-productivism, mainstream versus alternative, production versus consumption, and science and technology versus eco-social. Based on qualitative analysis, we found two overarching narratives (narrative A and B) that are embedded in opposing metanarratives. Narrative A supports productivist values such as intensification, industrialization and specialization (Wilson, 2001; Bjørkhaug and Richards, 2004). A conventional food system organization with large-scale, export-oriented business (Ilbery et al., 2004) is promoted in order to attain maximum productivity. The strong focus on productivity is also reflected in the embeddedness of narrative A in the production metanarrative, as respondents turn to food chain actors for solving food system challenges (Goodman and DuPuis, 2002). These challenges are mainly attributed to flaws in the (economic) efficiency of food processes, and can be addressed with scientific and technological interventions (Murdoch and Miele, 1999). In contrast, respondents in narrative B downplay the importance of maximizing productivity and adopt instead social and ecological values alongside economic viability (Mather et al., 2006; Jarosz, 2008). Food system

challenges are addressed by stimulating the local and social embeddedness of food systems and through integrative mechanisms that include previously marginalized actors (Goodman, 2002; Roep and Wiskerke, 2010). The narrative of the policy respondents does not fall entirely within either of these two narratives, but instead borrows from both.

Our findings clearly show that, regarding food system challenges in Flanders, dualistic oppositions still prevail in actors' ontological narratives. The respondents identify an alterity, which they perceive to be a threat to their (shared) set of values and practices (Ingram et al., 2014). Respondents with narrative A saw a threat for their organization of the food system; respondents with narrative B indicated a threat for society as a whole. Within these two narratives the identified alterity works as a cohesive force, uniting actors to resist a collectively identified threat (Ingram et al., 2014). Yet it is this unity that is both cause and effect of the persistence of the polarization between the narratives. Furthermore, since actors behave in accordance with their narratives, the dualisms can be translated to their practices as well. Hence, despite evidence of hybrid manifestations in actual practices, our data illustrate that this hybridity is lacking or at the least less prevalent in the narratives of our respondents.

Further research is required to fully understand the link between ontological narratives and dualistic metanarratives and how this translates to practices and networks, but we can make some recommendations for dealing with the existence of dualistic narratives in a context where different actors have to work together. Dualistic polarizations hamper cooperation between actors that are embedded in opposing metanarratives and can even paralyse decision-making. In addition, this also impacts individual performance when actors dismiss potential solutions that do not fit well within their narrative. In this regard, creating a new narrative that embraces contradictions without slighting any actors, can stabilize assumptions for decision-making (Hampton, 2009). The narrative of the policy respondents uses elements from both narratives A and B, and could thus potentially be a bridging narrative. However, we find this narrative to be empty as it combines these narratives because of a lack of choice and not with the aim to bridge the gap. As a result, the narrative of the policy respondents tends to confirm existing polarization. This leads to inconsistencies and hampers decision-making and collaboration as much as the opposition between the other two groups.

Several routes can be taken towards the establishment of a bridging narrative. A first one is linked to the notion of alterity. Although the majority of our respondents identified the alterity as a threat or even as an enemy, one respondent pleaded for a different approach. He argued for a less moralizing and a less dogmatic approach to alterity.

> 'People are thinking very dogmatic, which prevents real results from happening: they say it should be 100% like this, for example organic, or they won't accept it. Thinking like that is not good enough… You have to make certain compromises' (urban agriculture, entrepreneur).

Indeed, there is a difference between identifying alterity as a threat or as an opponent with whom you need to reach a compromise. By avoiding polarization and drawing lines between 'us' and 'them', this approach leaves more room for collaboration. A similar option is using consensus topics. An example from our case is using the consensus between respondents to change consumer behaviour as a lever for co-

operation, participation and change. Consensus topics are general enough that each actor can stay within her or his narrative, and at the same time have the capacity to stimulate exchange between different narratives (Brunori et al., 2013). However, the possibility of different interpretations also implies the possibility of different pathways of action (Brunori et al., 2013). Allowing for too much interpretative flexibility can lead to inconsistent policy or a perpetuation of the polarization that one hopes to overcome. In our case, for example, narratives A and B are polarized with regard to both problem framing and problem-solving, which means that there are different interpretations on at least two levels. Combined with the wide variety of actors that are involved in the food system and the complex nature of food system challenges, the likelihood increases that simply defining a common goal is not going to be enough to move beyond the existing polarizations (Loorbach, 2007). This is further complicated by the continuous reaffirmation of the polarization by the respondents, who use the contradictory narratives to distinguish themselves. A third possibility is acknowledging the reality of opposing and conflicting narratives and using this as a catalyst for change. By confronting the narratives, the relevance of both perspectives can be assessed and questions can be raised that stimulate further debate. Furthermore, this could also encourage cooperation and participation within the food system (Aylett, 2010; Silver et al., 2010). In addition, confronting the narratives can be used to counterbalance skewed power relations. By allowing conflicting perspectives, excluded or marginalized groups are given a voice and engage in social learning. At the same time, more powerful actors are held accountable for their ideas and actions and are required to comply with regulations and agreements (Aylett, 2010; Silver et al., 2010).

Establishing bridging narratives, however, is not easily done and requires complementary insights besides narratives. Sutton (1999) for example points out that narratives serve the interests of certain groups, and help to transfer ownership of processes to members of the group that sustains a specific narrative. Furthermore, Sutton (1999) claims that every narrative needs a counter-narrative in which the decisions and actions made by its representatives are called into question. The concept of the narrative network, can then help to understand (power) dynamics between different groups and the democratic, innovative and inclusive potential of networks (Lejano et al., 2013; Ingram et al., 2014). Although examples can be found in literature of networks that succeed to be flexible and inclusive regarding narratives (Ingram et al., 2014), we find that in Flanders the persistence and internalization of the dualistic metanarratives in actors' ontological narratives leaves little room for this inclusiveness. In this light it is important to study possible routes for bridging narratives from a network perspective. Effective networks have the potential to bridge polarizations, to integrate different perspectives and to forge collective aims (Lejano et al., 2013). Studying the potential links between narratives and networks could provide fruitful insights.

Besides understanding the link between narratives and networks, an investigation of the evolution of different narratives over time could also provide fruitful insights. For example, will repeated confrontation and contact lead to a homogenization of contradicting narratives or will it deepen the divide? In addition, the question which narrative will emerge as dominant over time is relevant. Currently narrative A seems to be more dominant, as we have found that this is the narrative of more dominant actors in the Flemish food system (e.g. retail and food industry). However, there are indications that this could be changing. Powerful actors are feel-

ing threatened by alternative narratives such as narrative B and respond to this in different ways. Some actors try to negate this threat by adapting their own narrative to include elements from the opposing one. Others only adapt their public narrative as a marketing strategy but do not change their own ontological narratives accordingly. To understand and follow this evolution, longitudinal research might be promising to document changes in narratives over time.

Finally, analysing the intersection of ontological narratives and dualistic narratives can also be relevant in other contexts besides that of food system challenges or transitioning the food system. Especially in the context of creating and maintaining alliances or networks, research has shown that getting actors with different expertise and backgrounds to cooperate can be difficult due to their unique perspectives (Cross et al., 2002). Being able to assess the position of relevant actors based on how their ontological narrative is embedded within specific metanarratives can be very interesting then. This is not only true for actors in the field, but can also be relevant to policymakers wanting to stimulate or facilitate certain networks. The assessment can then be used as a tool to anticipate and moderate frictions between stakeholders. At least knowing every actor's position might help to find common ground or stimulate discussion in a context where cooperation is required.

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Performing an Invisibility Spell: Global Models, Food Regimes and Smallholders

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Abstract. The present construction of global representations of food and farming is problematic. For example, how can we 'know' the world needs to double food production even though we cannot foresee a food crisis? How can we estimate investment opportunities while failing to quantify their impacts on smallholders? Global models constrain the manner in which we perceive the food regime while producing such representations. We need to identify the causal relations embedded inside models' equations and why they are arrayed in this fashion. This article combines actor-network theory and structuration theory to analyse a sample of 70 global models. It locates the modules and equations of these black boxes in the sociotechnical and political context of their production. Finally, a bibliometric analysis sketches the overall epistemic community that drove models into success or extinction. Dominant global models recycle equations, modules and databases to effectuate narrow worlds. They make smallholder farming invisible in spite of its prevalence around the world. They do not address food needs and construct pixellated representations of underutilized land. They systematically favour large-scale agricultural trade and investments in production and productivity. This reflects the structure of signification modellers adhere to as well as the structure of domination they are embedded in. Securing clients ensures the success of global models independently from their validation. The article demonstrates the manner in which modelling is a social practice embedded in power relations. Considering simultaneously the structure of domination formalized inside models and surrounding modelling is crucial. Future research should investigate how various actors resort to global models to champion their goals. It should question the policy recommendations drawn from such models and their relevance as decision support tools.

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Introduction

A food regime is defined as a structure of production and consumption of food on a world scale, including the explicit and implicit rules that govern it (Friedmann, 1993). As such, a food regime is a structure of domination, according to the idiom of structuration theory (Jabri, 1996). Global models aim to represent food production and consumption around the world. They play a pivotal role in the construction of specific patterns of production and consumption, a role which goes far beyond representing these patterns. Which actors want these models, for which purposes, and how they use them needs to be examined at the same time as we study the manner these models attempt to represent the world. The 'co-production' of scientific knowledge designates the process whereby the latter both embeds and is embedded in social identities, institutions, representations and discourses (Jasanoff, 2004). This article investigates the co-production of global models and the food regimes as well as some of the consequences of this co-production.

Science is a social practice. The multiplicity of knowledge productions concerning the environment or agriculture makes the practice of environmental science and the study of food production and consumption even more complex than that of classic laboratory fields. Scientists are unavoidably influenced by the perceived needs of those who try to 'apply' environmental knowledge. They are also influenced by the widely circulating knowledge claims made by scientists and others within and outside their fields. As a result, scientific practice cannot be understood in isolation from the processes of knowledge circulation and application (Turner, 2011).

Actor-network theory (ANT) has argued against defining a priori the context within which actors interact. It has distinguished entities and actors on the basis of their connections with other entities and other actors (Latour, 2007). This has proved immensely useful to study the role of agency, whether human or non-human. Its unfortunate side effect, however, is to neglect power interactions among various actors. If interactions are not examined within their wider context, the power imbalances within which actors evolve can go unnoticed. We risk ascribing an agency to people acting under duress, for example. Structuration theory reconciles the consideration of human agency with the consideration of structures of domination within society (Jabri, 1996, 2013). Both agency and structure need to be examined when we turn to human interactions with the environment such as occurs in agriculture (Trottier, 2007). Harnessing this approach allows us to shed new light on the manner in which global models contribute to the global food regime.

The term 'black box' designates a scientific claim once it has been turned into an unquestionable scientific fact, or a machine after it has been made to work (Latour, 1987). This article opens 70 'black boxes' as it analyses a sample of global models and examines the causal relations that are put into equations inside them. It locates these causal relations in the context within which the models were produced. It questions the silences within these models. It shows the specific worlds that such models produce as well as the policy recommendations they can or cannot lead to. It questions the types of government embedded in such models. The article then examines the links among the numerous models that often borrow modules or equations from one another. This sheds light on the struggles or extinction of alternative models. Finally, the article turns to the epistemic communities that have championed various models. The article argues that the co-production of global models and the food regime means that models effectuate the world far more than they represent it.

Understanding the causal relations embedded within global models of food pro-

duction and consumption allows us to identify which agency can actually be exerted according to these models. It also allows us to identify which actors are effectively silenced because their agency cannot be represented by these models. Our study demonstrates that the models who became dominant were the ones who enrolled most allies, exactly as ANT expects. It also demonstrates that those models that succeeded in enrolling most actors were embedding specific power interactions within their equations. They contributed to constructing a structure of signification that suited a specific structure of domination, exactly as structuration theory expects. Successful global models thus posited, the only possible development of the food regime occurs through international trade and through targeted investments, for example on the basis of potential yields.

Beyond shedding light on the manner in which models contribute to the food regime, this article shows the usefulness of combining ANT and structuration theory. These two approaches have tended to shun each other when tackling such complexity.

Global Models: Opening the Black Box

What Is Inside a Model?

For the purposes of this article, a model is understood strictly as a set of computerized, mathematical relations that link variables within functions purporting to explain, describe, judge or predict. The article examines models that deal with food consumption and production at the global scale. Each model puts forward a number of causal relations linking variables such as economic demand, agronomic practices, climatic conditions, and population growth, to represent the global picture. The manner in which these causal relations are formulated and arrayed is shaped by the structure of signification the modellers favour. Structuration theory defines a structure of signification as the overall production of meaning achieved by the creation and repeated use of interpretive schemes to describe the world and our actions within it (Jabri, 1996). A structure of signification emphasizing interactions among states produces a world-scale depiction of the food regime. A structure of signification emphasizing interactions, such as climate change, among a much greater variety of actors around the world produces a global-scale depiction of the food regime. Which variables modellers choose to integrate and how they arrange them into causal relations allows us to distinguish four main categories of models: economic models, biophysical models, integrated models and hybrid models, as illustrated in Table 1.

Our sample of 70 global models was built through a literature review of large-scale modelling of food and farming, including grey literature on the different modelling enterprises. We applied a broad sampling method taking into account both academic models and those developed by think tanks, international institutions and ministries. The purpose of this sample is to characterize the practice of global modelling rather than to identify the 'representative' models (Becker, 1997). Out of an initial set of 90 models, 20 were discarded because of lack of information, limited focus on food and farming issues, or limited spatial scale. Early warning systems of food and farming and monitoring of food insecurity were also excluded because they do not offer a formalization of food and farming systems but rather a collection of indicators. Such representations were not considered as global models for the purpose of our exercise.

Global economic models focus on the exchanges of agricultural products. They relied initially on a set of national modules, usually those of main exporting or importing states such as the United States, Canada or Australia, and an additional module describing the 'rest of the world'. Such modules are connected through international market functions where demand and supply meet and thus determine physical and economic equilibrium prices. Economic models thus rely on pre-existing national-scale models and databases. By the 1970s, time series-oriented models had started harnessing the latter to extrapolate past trends in order to predict future trends. Later, models based on a general equilibrium theory, relying on price to balance demand and supply supplanted them.

Global biophysical models focus on the production potential of the planet from an agronomic point of view. Their equations link physical variables such as rainfall, temperature, and surface properties to calculate the quantity of biomass that can be

Table 1. Typology of global models.

Type of Model	Representation embedded in model	Subcategory	Representation of food and farming	Heyday	Users
Economic	Agricultural sector –> supply	Time series	Statistics of past trends –> future trends	1970s	FAO, World Bank, USDA
	Food –> demand	Equilibrium	Prices balance demand and supply	late 1970s	World Bank, USDA, OECD, IFPRI
Biophysical	Potential agricultural production of planet and impact of environmental or technical alternatives	Theory based	Yield according to agronomic theory	late 1970s	Wageningen University, IIASA, INRA, CIRAD
		Data driven	Yield as a function of statistical production data	1990s	Stanford University, Goddard Institute for Space Studies (Columbia University)
Integrated	Interactions of human activities and the environment, incl. agricultural production and consumption	Homogeneous systems dynamics	Interactions and retroactions between variables	1970s	MIT, Club of Rome, Bariloche Foundation
		Heterogeneous models	Yield according to agronomic theory, prices according to equilibrium theory	1990s	PBL Netherlands Environmental Assessment Agency, Centre for Global Modelling (Japan), United Nations Trade and Development
Hybrid	Link global datasets of production and socioeconomic data at a pixel scale		Cross data layers such as economic indicators, food consumption, agricultural production and distances to roads	2000s	Center for Sustainability and the Global Environment (University of Wisconsin-Madison), Institute on the Environment (University of Minnesota)

produced. They can be theory based and determine the yield strictly on the basis of agronomic theory, or data driven. In this case, they rely on the statistical analysis of datasets to identify the main contributions to the crop yields. Databases the Food and Agricultural Organization of the United Nations (FAO) collected across countries served to elaborate the first biophysical models. Later, the ecophysiological measurements carried out in experimental stations around the planet and remote-sensing data fed them further.

Global integrated models focus on the interactions between human activities, as economic models do, and the environment, as biophysical models do. Two main sorts of integrated models have emerged. Homogeneous models have been developed, each by a single team, often using system dynamics modeling. These have tended not to include prices, favouring kilocalories instead, for example. They have also tended to extinction. Heterogeneous models have been developed by several teams, each contributing its own module to the overall model. They link modules from each of the economic and biophysical models, gathering variables that are measured in different units, such as kilocalories, dollars or cubic meters. These have tended to include prices. And they have fared much better than homogeneous models.

Global hybrid models overlap broad sets of factors, whether economic, physical or social, as layers of pixels. Most land-use datasets integrated in global models have a 5-arc minute resolution, in other words the pixels represent around 100 km^2 or 10 000 ha. Hybrid models use the pixel as the basic unit of analysis instead of the state. Yet the state often remains the central unit of data gathering even within global datasets. The representations that emerge from these models thus sometimes express divisions along national borders even when this was not intended.

Locating the Causal Relations Embedded in the Models

Locating the causal relations embedded in each category of models in the political and economic context within which the models emerged is important. It sheds much light on why these causal relations were put forward. Once it is enshrined inside an equation within a model, a causal relation becomes essentialized, i.e. the fact that it is a socially constructed depiction of reality no longer appears. Instead, this causal relation appears as a 'law of nature'. Locating the construction of the models, together with the specific causal relations they embed, allows a more critical understanding of the role models play in the co-production of the food regime.

National research institutions and national planning agencies were at the forefront of the development of economic models. The Ministry of Agriculture Forestry and Fisheries in Japan produced the World Basic Food Model in 1974 and later IFPSIM.[1] The United States Department of Agriculture (USDA) developed the World Grain-Oilseed-Livestock Economy model (GOL) and SWOPSIM in the 1970s. The Institut national de la recherche agronomique (INRA), in France, developed MISS. Such models emerged then because datasets and adequate computing facilities became available. Researchers and planners turned to datasets produced by national accounting systems, concerning exports, imports, inputs and outputs, as well as to datasets concerning elasticities (Josling et al., 2010). Most industrialized, capitalist states set up such datasets in the 1950s to inform national policy. This was a state-driven process where economists and civil servants defined categories to analyse and manage the economy. Keynesianism dominated at that time, and both econo-

mists and civil servants usually considered the state was in charge of regulating economic markets (Desrosières, 2003).

The development of global economic models occurred at a time when controversy raged concerning national agricultural subsidies and the liberalization of international agricultural trade. Several Western countries were producing more than they could consume and favoured liberalization of international exchanges. American economists perceived models as a pragmatic tool to guide policies (De Benedictis et al. 1991; Armatte, 2010). As the development of the categories and of the datasets was only carried out in Northern states, it fitted their economic structure, where agriculture is industrialized and food commercialized. This left the rest of the world in a void, both from the point of view of data and the development of appropriate categories to describe widespread activities, such as smallholder agriculture. However, the dominant ideology, soon after the Second World War, promoted a technological solution to the food problem, one where agricultural technology and increased production should end hunger (Cornilleau and Joly, 2014). Information concerning smallhoder agriculture seemed unimportant because, as a relic of the past, it would soon be transformed into more efficient, scientifically driven systems.

As opposed to economic models, which were state driven, global biophysical models were driven by international initiatives. Spurred by the 1972 *Limits to Growth* report, international organizations sought to establish the carrying capacity of the planet. They urged scientists to turn away from national food self-sufficiency and to think globally. Wageningen University developed MOIRA in 1972 and the International Institute of Applied Systems Analysis (IIASA) produced the most detailed biophysical model, the Global Agro Ecological Zones project. FAO collected worldwide datasets, establishing the first satellite databases to map cultivated areas around the world. In the 1970s, the carrying capacity was believed to be determined strictly by physical and technical constraints. Environmental research later demonstrated that the carrying capacity of any ecosystem is also a function of human practices. Biophysical models predated that understanding and the causal relations they embed reflect this.

The rise of system dynamics and the cold war both fostered the rise of global integrated models. Protecting the global environment could rally both East and West around a common goal, thereby appeasing tensions. Global modeling was appealing because this representation of the world dis-embeds production and consumption data from their local political context and thus appears apolitical. The causal relations it embeds in its equations are deeply political, but the overall tool appears to be neutral and technical (Taylor and Buttel, 1992). The IIASA was thus located in Vienna, aiming to gather scientists from communist and capitalist states, seeking to respond to the *Limits to Growth* report with the development of new models.

Global hybrid models proliferated especially after 2000. This was a time when satellite-produced datasets became easily available for all, as well as Geographic Information Systems (GIS). Financial deregulation and new doctrines promoting intervention inside state affairs withered away the Westphalian structure of the international community. The state ceased to appear as the basic building block and the only legitimate actor. Hybrid models such as the food density map of the FAO (Matuschke, 2009) reflected this change as they replaced a world composed of a collection of states with a world composed of a collection of pixels.

In recent years, all four types of models underwent a 'spatial turn', i.e. they integrated GIS and undertook to project their results on grids of pixels. This approach

was championed by the World Bank Development Report in 2009, which insisted on economic geography. This systematic spatialization has several consequences. It projects homogeneity on any area represented by one pixel, thereby erasing anything that exists only at a smaller scale. The grid size becomes extremely important in making small-scale farming systems invisible or not (Trottier, 2006; Chouquer, 2012).

As we located the production of models within their political and economic contexts, it is worth also locating the extinction of some models. Economic models based on statistical series fell into disuse because they could not model prices and simulate market dynamics. World Bank economists judged them inferior because they considered the market was central to the world food system and food security. Models, for example LAWM, which included radical changes such as land redistribution scenarios, were deemed unrealistic and later fell into oblivion (Bernardini, 1974). Actually, any model that could not target and secure the loyalty of clients was doomed. Siegmann noted that finding clients for a model was very problematic unless it catered specifically to their practical concerns, such as economic forecasts (Siegmann, 1985).

Which Silences within These Models?

Any scientific discourse is based on the silence of its object (Foucault, 1972). Ignorance is part of the construction of science, either as a driver or as a product (Proctor, 2008). Scientific practice, by selecting information, highlighting pathways or stabilizing methods, can produce numerous silences, inadvertently or deliberately. All four categories of models embed important silences. We will mention only three, which have far reaching consequences: silence on the context of the data, silence on non-monetary exchanges, and silences on food needs.

All data used in these models are necessarily dis-embedded from its context. Agricultural systems appear as starting points and evolve only under the pressure of variables such as prices, technological features and trade policies. As a consequence all previous subsidies and state support that shaped these production systems are essentialized, i.e. they are made to appear as a part of nature. In these models, a Californian agribusiness heir to decades of free water channelled thanks to infrastructure funded by the American taxpayer is indistinguishable from a Malian farm practicing subsistence agriculture. The essentialization of socially constructed phenomena prevents models from integrating their evolution.

These models use databases structured according to categories that were defined to address agricultural marketing in the 1950s or 1970s. Thus, food production and consumption that is not based on monetary exchanges does not exist within the representation produced by these models. The term *family farming* designates a form of organization of agricultural production 'characterised by organic links between the family and the production unit and by the mobilisation of family labour, excluding permanent employees' (Bélières et al., 2015, p. 20). Quantifying family farming and on-farm consumption is notoriously difficult. However, statistics from 81 countries, gathering 84% of the world population, show that 85% of agricultural holdings, i.e. 373 million holdings, are family farms under 2 ha (Bélières et al., 2015; Sourisseau, 2015). This is far smaller than the usual grid size used by global models, around 10 000 ha. Undeniably, the bulk of basic food production in these countries originates from family farms, with important on-farm consumption and contribution to the

livelihoods of extended families. Models are particularly ill equipped to represent the contribution of family farming.

Finally, the manner in which the modellers pictured the food regime shaped the equations within the models. These usually rely on food prices as a proxy to food access. Drawing on the datasets produced by national accounting systems, they calculate the point at which demand meets supply. Food demand is a function representing the amount of food an individual wishes to buy at a given price. The demand expressed by someone who has no money at all is necessarily satisfied, even when he is starving to death. The demand expressed by an individual matches his needs only if the market prices for satisfying them are affordable for that person. Food needs include both a quantitative dimension, as individuals require a minimum number of calories, and a qualitative dimension. Indeed, individuals require a variety of foods to avoid malnutrition and to maintain the cultural processes in which food is embedded. Dominant models make needs invisible because they only focus on demand. Obesity is also made invisible, because the causal relations framed within the models do not allow to represent it either. Yet, obesity is a major problem within the food regime. Models most widely used are therefore structurally incapable of addressing food needs.

In short, the silences within these models are important and are part of their structure. They contribute to representing a specific food regime. Many other silences could be identified. For example, cattle raising is often under-represented, especially extensive pastoralism, because the land used for this activity is difficult to represent. Access to infrastructure necessary for distribution and exchange capacity is rarely represented within these models.

Which Worlds Do These Models Produce?

All four categories of global models construct a very specific paradigm to understand a food regime, thereby portraying very few options for its development. They contribute to the co-production of narrow worlds.

Global economic and integrated models rely on a world structured into states, which they reproduce within the representations they generate. Hybrid and biophysical models rely on sets of pixels that do not show state borders. Thus, hybrid and biophysical models represent Europe as a global wheat basket whereas economic models represent it as a collection of states or economic regions producing and trading wheat. None of them represent the trade of crops within states from one region able to produce it to another unable to produce it, such as the trade of olives between the south and the north of France, for example.

Global economic models and modules place states and exchanges among states at the centre of the world they produce. For example, the Basic Linked System (BLS) model, links national markets to a world market (Fischer and Frohberg, 1982). Through iterations, they balance national demands and supplies showing different elasticities. Unavoidably, this iteration process concludes that countries with a lower marginal cost of production will specialize in this production. Development can only mean a greater international food trade. Yet, currently, international food trade represents only a small fraction of food production. Less than 15% of cereals produced in the world are currently exchanged on world food markets, for example (FAO, 2015). These models thus *effectuate* a world where international food trade is the dominant development path in spite of the fact that it remains marginal.

Biophysical and hybrid models produce sets of pixels, each of which is independent from the other. They co-produce a world where intervention is possible over various spaces without any need for these spaces to match the boundaries of a state. For example, global datasets allow identifying 'climate risk hot spots' where climate change is most likely to impact agricultural yields negatively (Deryng et al., 2011). Adaptation strategies, such as planting new crops, for example, can then target specific zones that might straddle a national border or be a small subset of a larger national space (Lobell et al., 2008). These models thus *effectuate* a world where state sovereignty does not matter much.

The spatial turn, which most models underwent after the 2000s, has had an especially far-reaching consequence. Projecting datasets on grids of pixels has produced underutilized lands and vacant lands. Dominant models do not include land uses such as pastoralism or non-monetarized agriculture in their inputs or their outputs. The homogeneity projected on each pixel, usually representing 10 000 ha, masks a great diversity of resource access and property regimes. Fine-grain representations can show clusters of farms smaller than 10 ha, but, for several reasons, such representations are not integrated in global models. First of all, high resolution datasets exist concerning some regions of the world, such as Europe, but not the entire world. As a result, their integration in a global model is problematic. Moreover, they require prohibitive processing capacities. Mixed pixels allow considering several land uses within an area smaller than that represented by the pixel. However, neither agronomy, economic or ecological theory is yet capable of integrating this category of 'mixed pixel' within the calculations carried out by the models. As a result, those smallholders who are active over a scalar level smaller than that represented by a pixel are made invisible. Vacant land is thus constructed within a representation that shows intervention on any portion of space as possible or even desirable.

Finally, these models have very poor representation of transport infrastructure, which is crucial for the exchange of agricultural products. The world they construct is one where transport is not problematic, where the trade-offs between transport infrastructure and other land uses, whether agricultural or environmental, are negligible.

In summary, all four categories of models produce simplified worlds where few interventions are possible and only partially assessed. In global economic models and integrated models centred on equilibrium theory, the only possible development of the food regime involves monetarized agricultural production and international trade. In global biophysical models and hybrid models, vacant yet potentially productive land replaces large stretches of smallholder agriculture and pastoralism. They produce worlds where intervention can be elaborated on portions of space anywhere on the planet. Therefore, the policy recommendations they can lead to are worth examining to understand the role they play in the construction of the food regime.

How Global Models Constrain the Scope of Potential Policy Recommendations

The mechanisms whereby models function restrict greatly the sort of policy recommendations they can lead to. They are unable, structurally, to inform policy that would include smallholder agriculture because the categories they rely on underrepresent it. However, since the 2000s their pixelated design allows them to promote investments in any area on the basis of its biophysical and economic potential, re-

gardless of its political or social context. The contract 'Lessons for the Large-scale Acquisition of Land from a Global Analysis of Agricultural Land Use' between the IIASA and the World Bank illustrates this. It produced tables of results expressed as potentially available good quality land rated according to its accessibility, defined as reachable within six hours of road travel, and its population density (Fischer and Shah, 2010). This report assessed, in dollars, the profitability of investments by calculating the ratio of potential production over present production.

The causal relations embedded in models lead them to recommend policies that sometimes satisfy demand but never address food needs. Economic models seek to balance demand and supply. They do not seek to end hunger. They cannot recommend policy targeting the poor, whose demand is automatically satisfied because they don't have money to spend on food. Hybrid models produce policy recommendations where the aim of food policies is transformed from an effectivity principle, such as ending hunger, to an efficiency strategy, such as maximizing profitability of investment. These models are useful to produce policy recommendations to support investors. They cannot possibly contribute to policy recommendations to support livelihoods they make invisible.

The manner in which malnutrition has been embedded in models' equations locks them into productivist policy recommendations, whereby the quantity of food produced should be increased in order to decrease malnutrition. Yet, malnutrition and famine systematically result from access problems, often in situations where production is unproblematic (Sen, 1981). The International Food Policy Research Institute (IFPRI) developed a partial equilibrium model, IMPACT, in 1995, to promote investment in agricultural research. IMPACT calculates the production of a foodstuff so as to equilibrate food demand, a curve determined by consumer prices, per capita income and elasticities, instead of by the population's needs. The model thus mechanically produces greater food demand where revenues grow and undernutrition where they are weak. This partial equilibrium model uses two indicators to represent hunger: food availability and child malnutrition. Food availability is expressed in terms of quantity of food per person as kg or calories per day. Child malnutrition is expressed in terms of the percentage of children between zero and five years of age whose weight was under two standard deviations in comparison with the standards of the World Health Organization. This is illustrated by the following formula (Rosegrant and IMPACT Development Team, 2012, p. 28).

$$\Delta_{t,2000}\mathrm{MAL} = -25.24 \times \ln\left[\frac{\mathrm{KCAL}_t}{\mathrm{KCAL}_{2000}}\right] - 71.76 \times \Delta_{t,2000}\mathrm{LFEXPRAT}$$
$$- 0.22 \times \Delta_{t,2000}\mathrm{SCH} - 0.08 \times \Delta_{t,2000}\mathrm{WATER}$$

where MAL = percentage of malnourished children; KCAL = per capita kilocaloric availability; LFEXPRAT= ration of female to male life expectancy at birth; SCH = total female enrolment in secondary education (any age group) as a percentage of the female age group (corresponding to national regulations for secondary education); WATER = percentage of population with access to safe water; $\Delta_{t,2000}$ = the difference between the variable values at time t and the base year 2000.

Based on this percentage, the number of malnourished children may be calculated by multiplying MAL by the number of children between 0 and 5 years old in the population. All variables are exogenous, except KCAL. 80% of KCAL is based on the variable 'Total Supply' (Production + Imports – Exports – Other Uses) calculated by the model. The other 20% (corresponding to the contribution of sugar, vegetable, fish and fruits) is based on FAO studies.

The structure of the model links child malnutrition to a single endogenous variable: food availability. The other variables in the equation are exogenous, in other words, these values are fed as entry data into the model. As a result, hunger cannot be reduced in the model unless food availability, understood here as meaning production, is increased. Therefore IMPACT automatically leads to a policy recommendation of increasing food production.

Simultaneously, IMPACT produces vacant lands. Its representation of food production is based on national and subnational agricultural statistics merged with remote sensed cropland data. (Robinson et al., 2015) Both are inadequate to grasp small scale farming. IMPACT also fails to take into account on-farm consumption and the livelihoods of the rural population. Therefore, the model inevitably leads to the representation of underproductive land. It simultaneously promotes policy recommendations according to which investments should be made in agriculture to satisfy an ever increasing food demand. Therefore it promotes land uses competing with the ones actually in place, all in the name of ending hunger, which it doesn't address. The second part of this article will return to IMPACT, showing that this equation to represent malnutrition was carried over into several subsequent models.

Which Types of Government Do These Models Embed?

Global models play a crucial role in the government of the food regime. The term *governmentality* was coined to describe a type of political rationality whereby technology and knowledge are deployed to organize human populations in order to steer them into a certain type of behaviour (Foucault, 2007). Global models participate in a governmentality that has global ramifications, whether intended or not.

The first economic models were produced at a time when the United States sought to reroute the surplus it produced towards developing countries through food aid. America thus sought to ward off communism and promote national models of agro-industrialization as a path to development in poor countries (McMichael, 2009). Global models that found clients in the 1970s shared this vision of the food regime. They focused on international markets, technologies, free trade and national growth. They embedded the mechanisms their clients wanted to put in place.

Are global models now embedding a new food regime? As they have switched from state to pixel as their basic unit since the spatial turn, they are compatible with the corporate food regime McMichael (2009) argues has now arisen. The latter is based on free trade rules, the persistence of subsidies in Northern countries and decreased agricultural regulations in Southern countries. It operates through the corporatization of agriculture, the appropriation of land for agro-exporting, and the displacement of smallholders to a pool of impoverished labour. Global representations identifying fertile spaces to invest and urban populations to feed effectuate this food regime.

So, what is inside a model? After opening the black box and locating the causal relations embedded in their equations as well as their silences, we conclude that they are both products of science and producers of the food regime. A food regime is a political structure, a political project. This political project lies inside the models, structuring the causal relations they embed in their equations. In the co-productionist idiom this is typical of scientific discourses, which systematically embody both what the world is and what it ought to be (Jasanoff, 2005). The important point here is that the models that fared well, those that didn't drift into extinction, embody a food

regime that relies on international exchanges of foodstuff, where subsistence agriculture doesn't exist, where only demand matters, instead of needs, and where the only path forward lies in investments in agricultural production and productivity. Such models construct a world that welcomes what is often described as land grabs.

Do Models Breed?

Anyone wishing to represent world food production and consumption can pick among a vast number of global models. However, this does not mean a similarly high number of independent assessments.

Proliferation and Reproduction

Models are rarely constructed independently from other models. They are based on similar equations and thus rely on similar hypotheses. Dominant global economic models are based on equilibrium theory. They incorporate little real-time data and simulate poorly the vulnerability of households to price shocks. As a result, none of them can either analyse or predict a food crisis, such as occurred in 2008 (Headey, 2011). Global biophysical models are based on independent pixels, each of which is supposed to be optimized. They all tend to promote crops according to the biophysical potentiality of the land within each of these pixels, without consideration for the knowledge and experience local farmers might or might not have. Conversely, these models do not include retro-actions of large scale monocropping, such as vulnerability to pests or the dependency on the price of the crop.

Global models share the same datasets. The Global Trade Analysis Project (GTAP) database, which contains bilateral trade information, transport and protection linkages, is used by thousands of economic modelers around the world. Most models also use FAO datasets for food production and consumption. This restricts the possibility of assessing the quality of the datasets and other parameters as they outnumber greatly the independent observations that are available. The hegemonic position of a few institutions and databases thus leads global models and their results to be used in spite of the impossibility to validate them.

More crucially, the modules of one global model are often recycled from one model to another. It seems models can breed and produce several generations of offspring, each new model carrying the same equations as the previous generation in the manner in which living organisms carry DNA. Some modellers like to refer to the need to 'have models marry other models' (Cornilleau, forthcoming). The IMPACT model's family tree illustrates this quite well. Produced by the think tank IFPRI in the 1990s, it was reused in 2002 as the IMPACT-WATER model, after being linked ('married') to a water module (Water Simulation Model). In 2009, it was once again coupled: IMPACT married the DSSAT cropping system model to assess some impacts of climate change. Its equations, such as the equation used to calculate child malnutrition examined earlier, were thus transmitted to its descendants (Figure 1).

Global models may converge in their results, but their consanguinity means their convergence does not indicate their validity as two models cannot be used to achieve a triangulation concerning a given result.

Alternative Models?

The deficiencies of dominant global models, such as their inability to consider needs

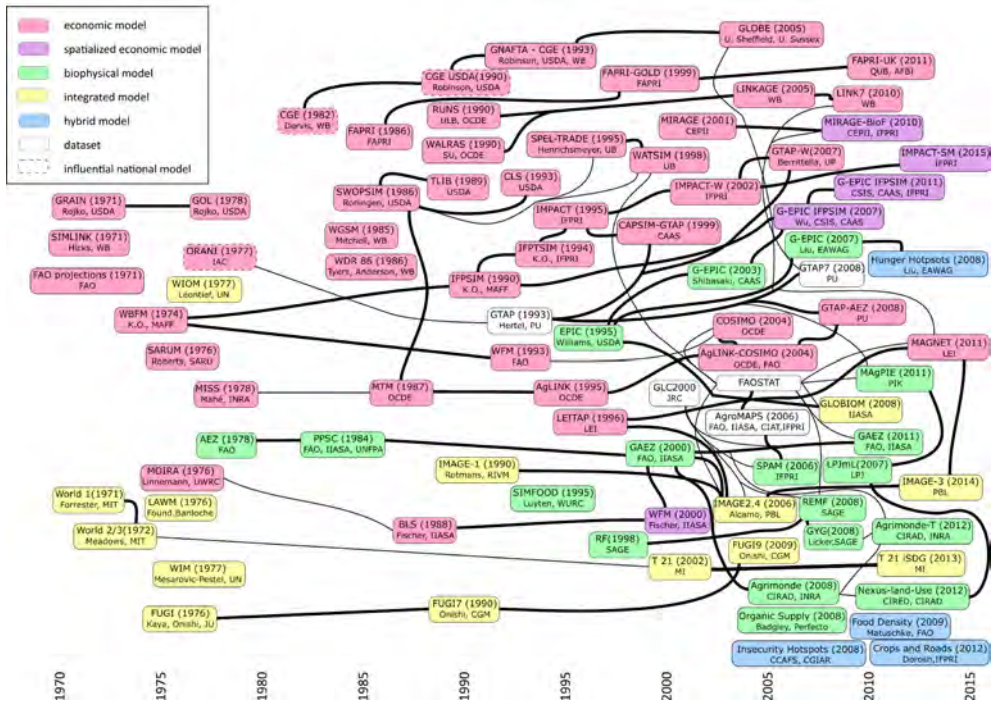

Figure 1. Proliferation and reproduction of global models of food and farming.

instead of demand and their structural inability to perceive or predict a food crisis should spur the development of alternative models, embedding other hypotheses and causal relations within their equations. So we should expect alternative models to emerge and challenge the dominant ones. Much scientific effort has been actively devoted to this goal. Yet, no 'new guard' of models is presently emerging to challenge successfully the 'old guard'.

Part of the explanation for the absence of alternative models lies in the economics of modeling. It is a very costly activity in terms of time, datasets and infrastructure.

> 'Building an applied trade model is a costly exercise, which tends to require several man-years of dedicated work on database construction, theory formulation, parameter estimation and computer implementation. In addition, the size of the investment implies that the basic design choices are to a large extent irreversible. Once a particular route has been chosen, the switching cost may become prohibitive' (Tongeren et al., 2001, pp. 167–168).

Once datasets exist for a certain type of models, most probably, future models will converge to that standard type.

Can we find examples of alternative models in spite of this path dependency? Yes, and studying their destiny sheds light on the reasons why a model rises to dominance or becomes extinct. The example of Agrimonde is worth pausing over. A foresight study launched by the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) and INRA in 2006, Agrimonde is based on a biophysical model, Agribiom, that estimates production and needs along

a variety of scenarios (Dorin et al., 2011). As opposed to most models, it is not based on equilibrium theory. It relies on a direct match between the kilocalories that are produced and those that are needed. Several scenarios radically different from those of other models were produced. They include normative considerations such as sustainable food production and the reduction of inequalities in food and health. Most importantly, this model proposed to follow the flow of calories instead of prices.

Although Agrimonde did contribute to the global debate on the food regime, its international impact was quite limited. The scenarios based on the 'sufficiency narratives' were especially difficult to integrate in the broader debates (Labbouz, 2014). Instead of maximizing production, such scenarios set as an aim the limitation of production once repletion has been achieved, i.e. once the food needs of the population have been satisfied. This was not an appealing aim for many members of the modelling community. Moreover, entering modelling platforms proved very difficult for this model because it had very different structural properties. Regrettably, a model that is 'too original' cannot be integrated while one that recycles modules, equations and datasets used in previous models is easily welcomed.

We conclude that, yes, models do breed. They have proliferated within a very small genetic pool. But they have not done this on their own. Their interactions with modellers and users were crucial in this process. Models may marry, but these are arranged marriages where modellers are the matchmakers. The reasons a model may become dominant or extinct are largely found in the interactions within the epistemic community producing and using models.

Epistemic Communities and Their Models

The term 'epistemic community' designates the networks of professionals with a recognized competence and expertise in a specific field, who appear legitimate to produce relevant knowledge necessary to support public policies in that field (Haas, 1992). The economists, engineers, computer programmers and systems analysts who elaborate global models make up such an epistemic community. The interactions among them, between them and their clients as well as between them and their models have largely contributed to shaping both what these models are and their fates in the larger construction of the food regime.

The Fate of Models in Clients' Hands When Clients Are Modellers

The rise of modelling relying on system dynamics, economic theory and large datasets took place initially in a variety of fields in the United States. It led to a hegemony of rational choice theory and of models as an inevitable tool to manage large systems. This process occurred in the United States in the 1970s in the field of water management, for example (Espeland, 1998). The rise to hegemony of the modelling approach was possible because its promoters managed to convince clients of the usefulness of their models. And this was possible because their clients shared the world view expressed by the modellers.

When asked why a model becomes dominant or extinct, a modeller often answers that models that become extinct did so because they were bad models. This begs the question of what is a bad model. As opposed to hydrological models, global food models cannot be calibrated. Indeed, no independent dataset exists that can allow us

to confront the results generated by a global food model. When the model IMAGE-2 was run to simulate the period from 1900 onwards, it reflected very accurately the situation. But its authors became aware the datasets they used to validate their model had been reconstructed by models structurally similar to IMAGE-2 (Costanza et al., 2007). Their exercise was thus futile. Global climate models face similar problems of data availability, yet they undergo numerous validation processes (Edwards, 1999; Guillemot, 2010). The rich network of weather stations around the world allows climate modellers to attempt a validation process that is only partially undertaken by global food modellers. Thus, a model is not 'bad' because it cannot be calibrated or because it has been invalidated. A model is 'bad' because the epistemic community has not found it to be useful.

How does an epistemic community sift through existing questions and methods to produce the ones it deems useful? This social process involves interactions between modellers, their peers and their clients. For example, when six American agricultural economists, among whom Tim Josling and Alex McCalla, created the International Agricultural Trade Research Consortium (IATRC) in 1978, they were spearheading macroeconomic modelling. With funding from the Ford Foundation, this think tank tackled a fundamental problem: their partial equilibrium models relied on world-market prices as inputs. But the United States and Canada's contribution was so overwhelming that their domestic policies determined the prices of world cereal markets. The outputs thus contradicted the inputs. The IATRC needed to develop a new method (Josling and McCalla, 2010). It organized comparisons between several international models produced by the FAPRI, the USDA, the University of Michigan and the IIASA and the INRA. The IATRC economists shared the conviction that free trade was necessarily good and a completely liberalized agricultural sector would necessarily function best. They borrowed from other models only what was compatible with this premise.

A number of these American modellers pursued their work within international institutions. Tim Josling, for example, went on to the FAO to set up databases of two indicators: Producer and Consumer Subsidy Equivalent (PSE and CSE). PSE estimates the transfers from domestic consumers and taxpayers to farmers under a set of agricultural policies. These indicators introduced a distinction between subsidies deemed to impact market prices and subsidies that didn't impact market prices. This method was then carried over to the OECD in 1982 and led to the MTM model, a macroeconomic model that quantifies the impact of state support in terms of trade distortion. This process led to two important transformations. First, the concepts of 'decoupling' and of 'trade distortion' became hegemonic (Fouilleux, 2000). They are based on the premise that agricultural markets exist as autonomous entities, quite independently of the social and political contexts in which agriculture is carried out. Second, international equilibrium models were effectively black-boxed as the necessary tools to represent world markets and assess the effects of PSE and CSE in terms of price distortions. Modellers in effect penetrated their future clients when they joined institutions in the late 1970s dedicated to policymaking. There, they shaped datasets and approaches that informed later models that these institutions were to call upon.

Modellers joined international institutions at a time when the latter developed macroeconomic models. This allowed these institutions to remain visible as producers of knowledge and to acquire credibility within the new paradigm of world food security. In the 1970s, FAO defined food security in terms of adequate availability

in spite of crop failures or price fluctuations. The models estimated such availability strictly in terms of revenues and food prices. Though such an estimation shrinks the broader understanding of food security as defined by international institutions, it allowed them to take part in the new paradigm. For example, in 1993 the FAO developed the WFM, a partial equilibrium model based on the IFPSIM model. By the end of the 1990s, an international network of macroeconomic modelling was sharing its datasets located in the FAO, the World Bank, the USDA, the OECD, and the GTAP. This network also shared its paradigmatic formulation whereby individual utilities aggregate into the global well-being, a process made possible by the equilibrium of national and international markets.

More recently, institutions such as the FAO have changed their policy and now want to act as critical purchasers of strategically chosen pieces of research, instead of producers of research. As modellers have been migrating to international institutions early on, the clients of modellers have themselves often been modellers for a long time.

Epistemic Communities from Bibliometric Analysis

The overall epistemic community working on food and agriculture at the global scale is so vast and its academic production is so large that a bibliometric analysis can be useful to provide an overview of its structure. We used the free access software CorTexT to identify networks of authors, and cited authors. We analysed two corpuses of scientific papers, one dealing with global food security, the other with international agricultural trade. We composed each corpus from the ISI Web of Knowledge over the period 1974–2011. We used the keyword search 'world food security OR global food security' and identified 1,763 papers. We used the keyword search 'international food trade OR international trade agricult*' and identified 1,814 papers. We used CorTexT to analyse the metadata of these publications. The CorTexT platform reveals and maps the links between authors, concepts, references and institutions. This allowed us to locate modellers and global models in the overall epistemic community focused on food and agriculture at the global scale.

Figure 2 shows the map produced by CorTexT using the international trade corpus. The authors and institutions cited appear in red circles. The blue circles indicate the authors who publish. The size of the circles is proportional to the number of citations or publications. The large circles thus indicate influential sources of legitimate knowledge. Institutions such as the FAO, the World Bank, the WTO, the USDA, the OECD, the WTO and the WHO as well as the European Commission therefore appear prominently as sources of knowledge. Anthropological fieldwork in the World Bank highlights this strategy (Goldman, 1997). Modelers such as Kym Anderson, Arjen Hoekstra, Tim Josling, Mark Rosegrant, Will Martin, and Jikun Huang appear as important sources of knowledge who both publish a lot and are cited a lot.

Although this corpus was not constructed using a keyword containing 'model' or 'modeling', by far the most prominent scientists contributing legitimate knowledge are modellers. Institutions that produce the datasets used in their models also figure prominently as sources of legitimate knowledge. This is testimony to the weight of global models in the scientific discourse concerning food and agricultural international trade. Of course, such a bibliometric analysis cannot show users of global models, such as private corporations, who do not publish. It also shows disproportionately authors who publish in English language journals. Additionally, it reflects

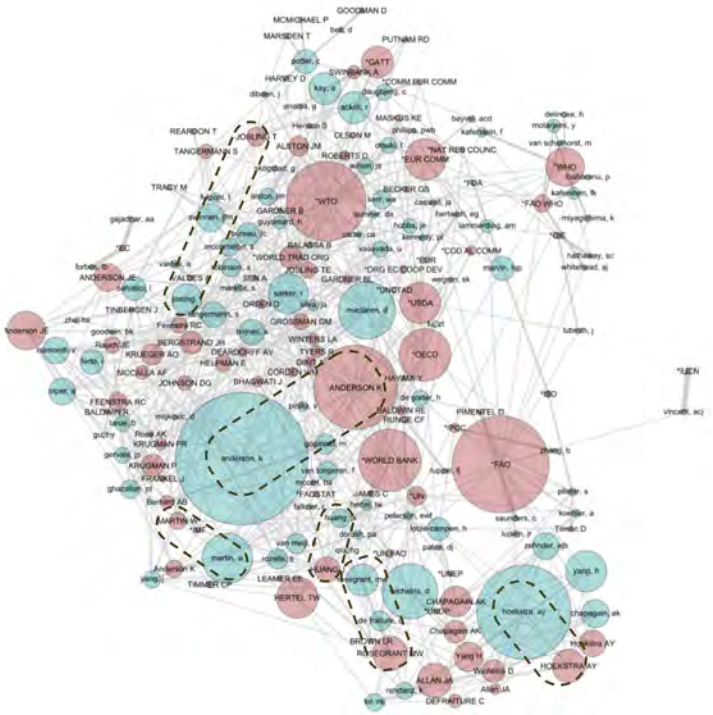

Figure 2. Network of authors and cited authors and institutions, based on the analysis of the international food and agricultural trade corpus with the CorTexT digital platform.

Note: Red circles correspond to cited authors and institutions (legitimate sources of knowledge). Blue circles correspond to authors (producers of knowledge). The thickness of lines as well as the size of the discs is proportional to their weight. Dashed ovals indicate authors that both publish a lot and are cited a lot. Some authors appear several times. This is an anomaly caused by different spelling of their names leading CorTexT to distinguish them.

metadata rather than content and modellers may also publish articles unrelated to modelling. In spite of these limitations, this bibliometric analysis demonstrates the numerous interactions between modellers, data providers, institutions using global models. Such thick networks are indicative of a thriving epistemic community.

Conclusion

Global models of food production and consumption appear to be neutral and apolitical. Yet, when we open them and examine the causal relations their equations express, their political nature becomes apparent. Such power relations were essentialized, i.e. made to appear natural, because they match the world view of the modellers and of the model users. Models that became dominant use prices as a proxy for needs, thereby representing only demand instead of needs. They use elasticities to calculate the development food production should follow. This means that states, or regions, with the lowest marginal production cost for a given foodstuff are inevitably invited to specialize in that production and international trade is inevitably

supposed to grow. Dominant models use a representation of malnutrition that links it to food production, thereby leading mechanically to recommend a greater production to solve this problem. Recent dominant models represent the world as a series of pixels. The grid size within pixel-based representations erases all production units smaller than a pixel from the map. These are all important constructions of power relations. The representations that successful models generate suit several features that match a very specific structure of domination.

Clearly, models that rose to prominence did so because they circulated in dense networks of modelers and users. Alternative models that attempted to track the flow of calories, for example, were unable to integrate such thick networks. Their contribution to the debate concerning the global food regime thus remained marginal. Successful models embedded and thus promoted a structure of domination that suited their users' conception of a legitimate government of food production: one that led to ever increasing international trade and showed investments in agriculture and agricultural productivity as solving hunger.

Smallholders seem erased from the representation of global food production within dominant global models. Yet, the overwhelming importance of smallholder farming is undeniable both in terms of food production and in terms of its role within commercial farming. Indeed, the individuals involved in commercial farming as labourers, for example, are often engaged simultaneously in subsistence farming. The structural difficulty for dominant global models to include smallholder farming raises the question of their usefulness.

Global models that rose to dominance proved very successful at constructing a representation of the world that legitimizes the activities of certain actors, such as foreign investors who claim to develop potential yields in places suffering from inefficient or inexistent agriculture. They also legitimize productivist policies and the promotion of a deregulated international market of agricultural products. Yet, the same models show grave deficiencies. They are structurally unable to predict a food crisis such as arose in 2008. So, the success of global models stems from their capacity to effectuate a world that matches both the structure of signification modellers adhere to and the structure of domination their clients champion.

Global food production models that rose to dominance did so because the epistemic community that generated them enrolled enough users into a dense network. An approach rooted in actor-network theory allowed us to demonstrate this. These models embedded very specific power relations within the causal relations expressed by their equations. This led them to promote a very specific food regime that matches a global structure of domination the users of these models sought to establish. An approach rooted in structuration theory allowed us to demonstrate this. Combining both of these approaches was necessary to understand the contribution of global models to the food regimes. They effectuate the food regimes their champions wish to establish far more than they describe the existing world in a 'neutral' fashion.

Note

1. Acronyms of the global models cited in the article: DSSAT: Decision Support System for Agrotechnology Transfer ; GAEZ: Global Agro Ecological Zones ; GOL: Grain-Oilseed-Livestock Economy Model; IFPSIM: International Food Policy Simulation Model; IMAGE-2: Integrated Model to Assess the Global Environment ; IMPACT: International Model for Policy Analysis of agricultural Commodities and Trade; LAWM: Latin America World Model ; MISS: Modèle International Simplifié de Simulation ;

MOIRA: Model of International Relations in Agriculture ; MTM: Ministerial Trade Mandate model ; SWOPSIM: Static World Policy Simulation Model ; WFM: World Food Model.

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Cooperation Models, Motivation and Objectives behind Farm–School Collaboration: Case Insights from Denmark

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Abstract. Children lack an understanding of and connectedness to food and agriculture, while policies are calling for more emphasis on food and nutrition at school. As a result, foodscapes at school are increasingly the focus of public policy. More initiatives are targeting food literacy of young people and their ability to understand the food system. Thus, efforts are made to promote food literacy through strengthening of farm–school links. The case-study research from Denmark investigates existing cooperation arrangements in farm–school collaboration and the underlying motivation of the farmers and teachers. Findings show distinct differences in motivation. Farmers want to create transparency in their production, ensure support for the agricultural profession or promote food and agricultural literacy. The idealistic motivation of teaching children about food and agriculture weighs higher than economic incentives. Teachers display academic motives for engaging in farm visits, but also a broader focus on shaping children's world views, connectedness to food and nature and fostering life skills. The farm can be an important setting for promoting food, agricultural and ecological literacy. We propose more generic collaboration models of farm–school collaboration to characterize the field: from short-term, informal cooperation involving just a farmer and a teacher to longer-term and closer collaboration involving several teachers, farms, schools or other stakeholders from a foodscapes approach. These characterizations of farm–school collaboration can contribute towards future research of farm–school programmes. The study applies a foodscapes approach and in doing so uncovers learning opportunities in the foodscapes in and outside the school, which goes beyond eating. This adds to a broader understanding of school foodscapes.

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Introduction

> 'Send them to regain in the open fields the strength lost in the foul air of our crowded cities' (Rousseau, 1979).

Already in 1782, Jean-Jacques Rousseau emphasized the need for connecting urban children to agriculture in his book on education, entitled Émile. Today, the disconnection from rural and natural environments is even greater with a massive gap between food producers and consumers. Children lack a connection to nature, food production and an understanding of the impact of their food choices due to urbanization and an increasingly complex and globalized food system (Harmon and Maretzki, 2006; Hess and Trexler, 2011). UNEP draws attention to the environmental impact of food and agriculture, being 'one of the most important drivers of environmental pressures, especially habitat change, climate change, fish depletion, water use and toxic emissions' (UNEP, 2010). The World Watch Institute estimates that up to 51% of all annual greenhouse gas emissions are from livestock production alone (Goodland and Anhang, 2009). Thus, food and agriculture in primary school curricula deserve special attention to promote sustainable consumption practices amongst the future generations. Academics and practitioners across Europe and the USA highlight the importance of reconnecting children with food production and the environment. The aim is for children to understand agricultural production, that their food choices affect the food system and nature, and to enable them to make informed and sustainable food choices (Berry, 1990; Pollan, 2006; Mayer-Smith et al., 2009; Smith, 2009).

Food and agricultural education constitute something tangible to which children can relate. It includes daily experiences with food (psychological, social and cultural) that can be tied to more intangible societal and environmental dimensions. Food education, including farm–school collaboration, can ideally bridge this gap between people, nature and food production. According to Illeris (2006), the interaction between sensory impulses and feelings filters subjectively relevant 'traces' archived in the long-term memory. This can be activated on a farm by doing hands-on activities. Skills-related memories from planting, smelling and walking around a farm, doing experiments and using language are harder to forget. Cognitive memories from the classroom are more likely to be forgotten. Thus, the farm setting is ideal for fostering motivation, interest and a deeper learning. The school reform undertaken in Denmark in 2014 supports such efforts to enhance hands-on and experimental learning. It includes more hours in school combined with goals of supporting outdoor education and collaboration with local organizations and enterprises, e.g. farms.

Schools have long been viewed as an important arena for promoting a sustainable development agenda in the food system, in health and in environmental protection. Experiences from the USA and Italy show that collaboration between farms and schools is an important driver for reconnecting the economic and social relations between producers and consumers. These relations, which include education, can ideally push for health, ecological, social and economic benefits in the food system, shifting towards a local food supply and multifunctional farms (Morgan and Sonnino, 2008; Canavari et al., 2011; Hess and Trexler, 2011; Feenstra and Ohmart, 2012; Mikkelsen, 2013). Such collaboration creates a new understanding of the school as a place of social practice related to food and hands-on learning. Opportunities to go to farms, engage in school garden activities, and in other ways experiment with food are important components of these hands-on food activities.

Farmers across Europe have opened their farms to visitors for decades. City farms or school gardens were widespread in the Nordic countries, including Denmark, already in the early 1900s. Today there is a wealth of programmes like farm-to-school, farm-based education, farmer visits to the classroom, school and community garden programmes in countries such as the USA, Canada, Australia, Brazil, United Kingdom, Ireland, Germany, Netherlands, Norway, Italy and Denmark (Canavari et al., 2011; Ratcliffe, 2012; Roche et al., 2012; Moss et al., 2013). This cooperation varies from a focus on school food supply, school gardens on farms or at schools, to collaboration related to food and farm education.

Farm–school collaboration covers two distinct types: farm-to-school programmes and farm-based education. Farm-to-school (F2S) is a broad definition for bidirectional school-based programmes common in the USA connecting schools and local farms with the objectives of serving local and healthy meals in cafeterias or classrooms, improving student nutrition, providing health and nutrition education opportunities and supporting small and medium-sized local and regional farmers (Joshi et al., 2008). It includes eating and educational components. In the US, 31% of schools (2,401) participating in the US Department of Agriculture's Farm-to-School programme conduct student field trips to farms or orchards (USDA, 2015), which fall under the educational part of farm-to-school programmes. Farm-based education (FBE) is a unidirectional programme. The farm is a setting for learning and the farmer is an authentic expert for students to learn from. FBE is the most common approach to farm-school cooperation in Denmark and most European countries. Another type of collaboration is to have a farmer come to the classroom, and programmes such as Future Farmers of America. The latter is a national programme with local chapters aiming to provide agricultural education to young people, preparing them for careers, and making informed choices related to global agriculture, food and natural resources systems.

No research to date has documented cooperation between farms and schools in Denmark, and many other European countries. In Denmark, the collaboration is mainly unidirectional, focusing almost entirely on educational aspects of farm-based education and integrating this in the classroom in various ways. Nevertheless, whole-school approaches are emerging, involving food supply, food service, school food policy and learning (Food for Life Partnership, 2013; Ruge and Mikkelsen, 2013)

Against this background, the aim of this article is to identify models of cooperation between farms and schools in Denmark with reference to international practice as well as to identify the motivation and objectives of the two key actors: teachers and farmers. Their motivation and objectives (intended learning) are essential to investigate, as they determine the content and actual learning opportunities for children, ultimately impacting on the benefits of these programmes for children. The different cooperation models, stakeholder motivations and trajectories in farm–school collaboration have implications for policy and practice: Thus this article also aims to inform research and policy for the development of future strategies. The research questions are:

- How can farm-school programmes in Denmark be characterized and linked to the concept of foodscapes?
- What are the objectives and motivation of farmers and teachers in Danish farm-school programmes?

State of the Art of Farm-to-School and Farm-based Education

Studies on farm-to-school programmes from the USA focus on the economic aspects, actors, food supply, provision of schools meal, and less on educational aspects. A study from Vermont, USA, looked at the actor network including the flow of financial resources, food and information (Conner et al., 2011). Allen and Guthman (2006) looked at the political philosophy, economic rationale and discourses. Other studies focus on the supply of locally produced foods in schools combined with nutrition and food education and its impact on children's fruit and vegetable consumption. A review of 15 studies of programmes in the USA documented increases in daily fruits and vegetable intake (Joshi et al., 2008). A study surveying 632 elementary students in Vermont also looked at dietary benefits (Roche et al., 2012). Similarly, Ratcliffe (2012) pointed out in a qualitative study and research review that the programmes on school food look promising in relation to addressing childhood obesity. In fact, several F2S programmes and related evaluation research are framed within either an obesity prevention discourse or an economic discourse related to farmers. Other studies show that F2S programmes have further benefits, such as promoting life skills and better eating habits (Graham et al., 2004; Joshi et al., 2008), when incorporating healthy foods with classroom and farm- and garden-based educational activities. The review by Joshi et al. (2008) showed that educational activities can increase knowledge about growing cycles, sustainable agriculture and gardening. Other impacts such as development of social skills, self-esteem, responsible behaviour and increased physical activity were also noted (Joshi et al., 2008). Only a few studies focus on teachers and their experiences.

Limited peer-reviewed research on FBE is available. Jolly and Krogh (2011) document farm-based education in Norway, highlighting how the farm is used as a setting for place-based learning and the farmer being a role model for students to learn about farming and other practical trades. Joining farmers and teachers together in workshops has been a way of creating a pedagogical arena for developing collaboration and curricula for children to work with and care for nature, the local area and facilitating experiences and connections on which to build an understanding about sustainability (Jolly and Krogh, 2011). In Italy, Canavari et al. (2011) document how 'educational farms' aim to develop schoolchildren's knowledge of the countryside, biological cycles, agricultural production, processing and related products. The overall focus is on consumer education: the link between production, consumption and the environment with sustainable development as the underlying perspective (Canavari et al., 2011). Similar FBEs are found in countries such as Germany, Finland, Poland, Austria, and Netherlands.

Conceptual Framework

The school has developed increasingly into a recognized setting for promoting food literacy and a broader ethical, social and ecological understanding of agricultural and food systems. At the same time, school food service and eating practices are slowly changing and schools are increasingly becoming the target of ambitious healthier eating strategies. Farm–school cooperation is part of this complex food, nutrition and health reality students encounter in school. From traditionally having the simple service provision task, the school food reality is in a state of transition (Morgan and Sonnino, 2008). It has become a target for food strategies dealing not only

with foodservice but also increasingly considering food as an object for learning. As such the foodscape concept is in line with the whole school approach (Langford et al., 2014) used with success in school interventions. The whole school approach to health and food involves capturing the learning potentials related to hands-on-food activities of, for instance, school gardening, farm–school links, taste education, etc. The approach is about the school setting and student involvement to improve health and to implement activities including the social, physical, educational, and policy levels at the school. It involves multiple stakeholders and resources and gives attention to the school ethos and its ability and potential to put issues of food, nutrition, life skills and health on the agenda (Henderson and Tilbury, 2004). We use 'foodscapes' to refer to the mesh of food, place and people that comprise the real and imagined food environments that constitute sources of energy and nutrients and opportunities for learning. In line with the whole school approach, the foodscape concept is increasingly accepted as a useful way to look at the broad range of determinants that shapes food and nutrition literacy of young people.

The foodscape mindset takes inspiration from the settings approach to health promotion by WHO in 1986 and later conceptualized by Dooris (2009). The 'scape' concept was originally suggested by Appadurai to capture the interconnectedness of things through place and time (Appadurai, 1996). It has been further developed by different scholars into the idea of 'foodscapes' (Mikkelsen, 2011; Torralba and Guidalli, 2013) A foodscape is a way of referring to and understanding the complex socio-physical environment at school in relation to food, eating and learning. The school foodscape stretches from food provision to curricular activities aimed at increasing the food literacy of young people. We argue that farm–school links can be considered an important part of the curricular activities that, together with the broad spectrum of food activities, make up the school foodscape. By fitting the earliest stages of the stable-to-table chain into a foodscape context, we invite a holistic approach to understanding the complex social interactions taking place in relation to eating and learning at school.

A foodscape is made up of cultural, historical, economic, personal and political elements as well as social landscapes that are related through food, including the farm. Adema (2006) refers to the notion of foodscapes through its ability to capture complex relationships between people, food and surroundings. The idea of foodscapes is inspired by Gibson's (1986) notion of affordances, which are the action possibilities that the environment offers that come into play through the perception of individuals. It opens up for a discovery of new potentials in the environment: that a foodscape offers possibilities for promoting healthy eating, environmental awareness and food and agricultural literacy. Food growing in is an obvious example. These opportunities exist in relation to the school food-service environment and in relation to the learning potentials embedded in the environment of the school and farm. These possibilities are discovered by the agents (teachers, farmers and others) and are dependent on their ability to explore these. In the case of farm–school links, action possibilities connect to the ability to discover and explore learning potentials in the food and agri-environment of the farm and link them to the food reality of the school and home. The foodscape concept will be used to understand the farm–school links and programmes and their relevance for the school setting.

Research Context and Methods

The Danish Agriculture and Food Council (DAFC) registered that over 12 000 school-

children visited farms in each school year from 2010 until 2014. This is a relatively small number out of the approximately 550 000 students in Danish public schools (Bager, 2013). Yet an unknown percentage of farm visits are unregistered. DAFC has over 350 participating farms across Denmark. Organic Denmark (OD) and the Producers' Association for Organic Schoolyards initiated an educational programme with 35 'organic schoolyards' on farms in 2013. Organic schoolyards are farms that take in classes for visits and provide educational materials before and after the visit (Dyg, 2014).

The article presents findings from a PhD thesis (Dyg, 2014) involving case studies conducted in Denmark from September 2011 until April 2013. Four maximum variation cases of exemplary farm–school collaboration were selected reflecting different types of farms and farm–school collaboration, including one with a whole school approach. The following selection criteria were applied:

1. variation among farms: part-time farms, full-time farms, farms with integrated production and specialized production, cooperative farms, conventional and organic farms.
2. variation among schools: a. schools integrating farm visits into a longer educational programme related to food production, consumption, sustainability, health and environment, science, etc. in one or more subjects or as interdisciplinary projects; b. schools with an established long-term collaboration with farmers and/or integrating farm visits with other activities at the school (e.g. food service, school policy, hands-on-food-activities); and c. teachers from rural and urban, public and private schools.

The case selection included both uni- and bidirectional farm-to-school collaboration types.

Multiple sources of evidence were gathered, including a research review, analysis of teaching materials and learning plans, semi-structured qualitative interviews with farmers (6), teachers (9) and experts on didactics and food education from agricultural organizations (5). Teachers of third to ninth grades were interviewed to obtain different perspectives on how farm visits and food and agricultural themes are integrated in the teaching. All qualitative interviews were carried out by phone or in person; they were combined with farm visit observations. The interview topics are presented in Table 1.

The empirical phase included initial and follow-up interviews with key inform-

Table 1. Topics covered by the interview questions.

Teachers	Farmers
1. Motivation and objectives of the collaboration with farmers	1. Motivation and objectives of the collaboration with schools/teachers
2. Learning goals, content and teaching methods	2. Content covered during visit and teaching methods
3. Integration of the farm collaboration into subjects	3. The farmer's role and cooperation with teachers
4. Students' learning from the collaboration	4. Learning objectives for children's learning
5. Own values related to nature, food and sustainability	5. Own values related to nature, food and sustainability
6. Barriers and opportunities in farm–school collaboration	6. Barriers and opportunities in farm–school collaboration

ants in interest organizations to get an overview of farm–school collaboration and their organization's motivation and objectives. It served as external validation of findings from interviews with farmers and teachers. Farms were selected with assistance from the Organic Schoolyard programme and DAFC. Through contact with farmers and during farm visits, teachers were approached for interviews and additional observations on-farm or later in the classroom. A review and analysis of educational materials on agriculture and food in Denmark was also conducted.

Nvivo 10 was used for data analysis, through which interview transcripts, case-study reports and other empirical data were categorized.

Findings

Farm–School Cooperation Cases and Typologies

In the following section, a description of the four cooperation models is presented based on the case studies. Their characteristics are summarized in Table 2 according to relation type, mode of curricular integration, cooking and eating modality, farm and production type. The table provides an overview of the four cases, which will be used to suggest more generic typologies.

Cooperation through Single Farm Visits

The single farm visit is the most common model of collaboration. In case study 1, a conventional dairy farmer near Copenhagen takes in schools on single farm visits. This is a part-time, family-run farm located around an hour and a half from Copenhagen by public transport. Due to relatively easy access, the farmer takes in on average 50–60 visits per year, and sometimes up to 80. The farm is a conventional dairy farm. The farmer makes explicit that she will not take in classes who are just there for a tour and a day off without any educational content (Interview with farmer). The farm visit is conducted in a traditional way: a tour around the farm including the stables, looking at calves and young cows as well as dairy cows. During the visit, pupils see the different stages of the cow's life and the different processes and conditions under which the cows live. The pupils are eager to ask questions and the farmer also asks questions of the children. The farm visit was part of a longer interdisciplinary theme about animals, which the fourth grade teacher integrated in science and mathematics.

Students from eighth and ninth grades of a private rural school also visited the farm. They organized their own visit and interview with the farmer as part of a group project on agriculture. The purpose was to learn about project work and to gather information through farm visits, interviews with farmers and information searches on the Internet. The groups present their results during an agricultural fair for younger students at the school (Interviews with teacher).

The collaboration is informal and with weak ties between farmers, teachers and, in the latter case, students. The visits focus on place-based learning, where pupils learn about the farm, farm-life and specific production methods on-farm. The farmer does this through a farm tour. Sometimes the farmer also sets up workstations on-farm, where pupils do hands-on activities, e.g. measuring the stable, tasting silage, mucking out the stable or interviewing the farmer (Dyg, 2014). This approach is also seen in farm–school cooperation in other countries, e.g. Germany and Norway.

Table 2. Overview of farm–school cooperation cases.

Type	Relation type	Curricula integration	Cooking and eating	Farm type	Production type	Products (main)	Distance and logistics
1. Single farm visit with pre- and post-classroom integration	Loose, informal and weak ties between a farmer and a teacher	Integration in science by single 3rd grade teacher (urban school). Student-driven projects and agricultural fair (rural school) 8–9th grades	Limited focus on cooking and eating, except some taste of different organic/non-organic products	Part-time Family	Conven-tional *The rural schoolchildren go independently to nearby farms both conventional and organic	Dairy	Accessible by train (approximately 1.5 hours one-way) by urban school and within bike and bus distance of a rural school
2. Multiple visits and organic farmer collaboration	Closer collaboration between several farms and schools, multiple stakeholder involvement	Integration by one or several teachers in Danish, science and math, thematic weeks during a school year or several months. 3–4th and 6–7th grades	Farm-to-table focus involving cooking either on-farm or back at the school. Linked to themes on e.g. healthy eating	Part-time Family and cooperative farm	Organic	Integrated production and Beef	Within walking and biking distance of several schools
3. Science network and closer collaboration between several schools and stakeholders (municipal level)	Close collaboration integrated in school curriculum in participating schools. Multi-stakeholder involvement, integrated in school policy and involvement at the municipal level	Integrated in all 4th, 5th, 6th grade science teaching. Included in the formalized curriculum at the schools. Professional networking across schools.	Farm-to-table focus, incl. taste workshops on different breads, cooking with own crops and collection and cooking of wild foods.	Full-time family	Conven-tional	Pork	School garden on farm in semi-urban area where the farm is brought in. School garden within walking distance of two schools, third school by bus/train.
4. Whole-school approach integrating food and agricultural education with cooking	Connections between annual farm visits, teachers and subjects (science, home economics), school foodservice/canteen, nature guide and part of school profile and policy.	Farm visit integrated in science teaching and home economics in e.g. 3rd grade, with teacher drawing on lessons in school canteen, where pupils cook.	Focus on development of cooking skills and healthy eating in the school canteen. The canteen is 90% organic.	Full time socio-economic enterprise and part-time family farms	Organic	Integrated production and Dairy	Accessible by bus/train (approximately 1.5 hours one way).

There is a formal collaboration with DAFC, providing farmers with compensation for their time. DAFC also provides them with support and advice, including teaching materials before and after the visit. The relation between the farmer and teacher is brief, primarily to prepare and conduct the visit. In some cases, the same teacher or group of teachers return to the farm year after year (Dyg, 2014). The collaboration is described and illustrated as a generic model in Figure 1. In some cases, farmers are invited to schools to give presentations or observe students' presentations of their farm projects.

The opportunities of this cooperation model are that it takes time out of the teachers' tight schedule only once, and that the visit can be integrated in the teaching before and after the visit. Agricultural interest organizations assist with funding to cover the farmer's time, requiring the school to pay only for transport. The challenge for children's learning is that they only get a glimpse of farm life from the brief visit and see only one type of production. Additional visits or use of video to learn about other production types in the classroom is crucial for reaching the full learning potential. To enable children to connect farm visits to academic learning, food system understanding, and hands-on food activities in school, it is important to organize activities before and after the visit. Teachers integrated various food and eating components into their teaching following the farm visit to link the visit to a farm-to-table understanding. Thus, one-off farm visits can be linked to the school foodscape, e.g. through tasting different types of milk or breads in the classroom and talking about where the lunch comes from. However, the foodscape approach is more pronounced in the other collaboration models.

Multiple Visits and Farmer Collaboration

The second model builds on case 2: a network of organic farmers cooperating across

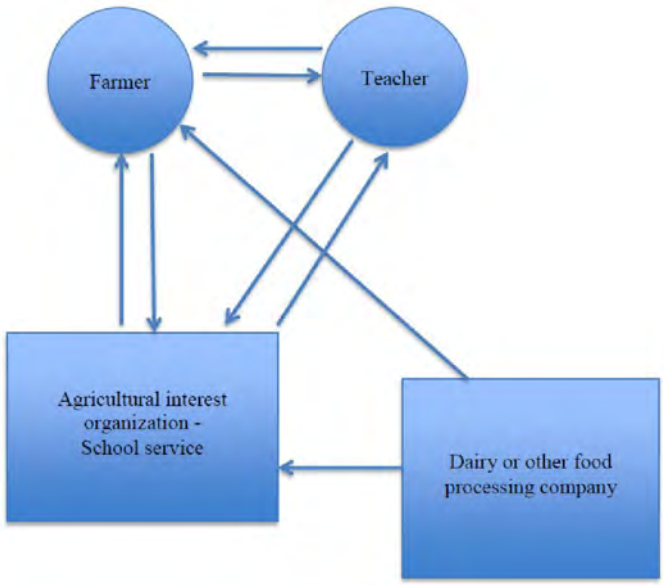

Figure 1. Farm–school collaboration model 1.

the country to promote organic schoolyards, exchange information and seek funding. The case study looks at collaboration between a family-run organic meat farm and a cooperative with an integrated plant and livestock production in a peri-urban community outside a major city in Denmark. The collaboration enables schools to go on several visits to the cooperative and the organic meat farm. The meat farm has cows, calves, horses and fields around the farm with a small pond, birdlife, insects and frogs. The family farm offers half-day tours around the farm including information about ecology, organic farming, cattle, the fields, nature and the pond. The cooperative is a living community, where housing, agriculture, energy production, social development, consumption, waste handling and financial aspects are based on sustainability principles. The cooperative has land available and prioritizes longer educational collaboration, which involve a school garden, where classes can come and participate in farm activities over an entire growing season. The schoolchildren are engaged in activities such as sprouting, planting, weeding, watering, and harvesting the plants as well as cooking activities either outdoors or back at the school, while learning about organic agriculture and ecology (Dyg, 2014). From a more generic perspective, the multiple visits can involve visits to other productions, such as family farms, urban farms and manors.

Model 2 includes a greater number of stakeholders and stronger connections than in case study 1. It is based on a long-term but non-formalized collaboration, between: 1. farmers on educational activities, knowledge exchange and funding; 2. farmers and their organization on funding, development and dissemination of educational materials; 3. schools and the different farms on visits to one or more farms. This model could also involve a local food production company through visits and educational activities to understand production aspects in other parts of the food

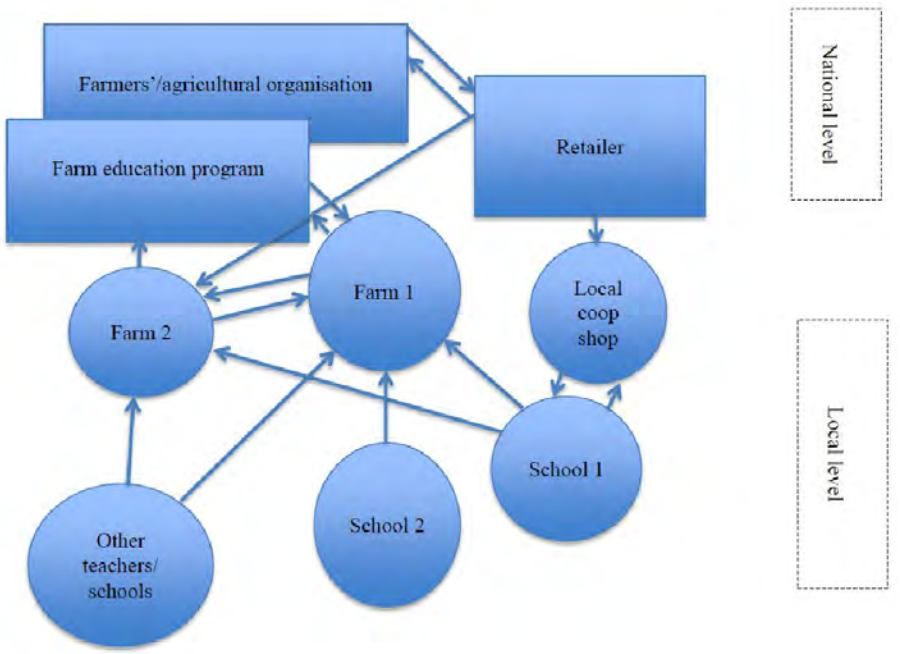

Figure 2. Farm–school cooperation model 2.

chain. In the case study, a retailer at national level and its local branch supported schools with food for their cooking activities.

The opportunities in this model are that it provides more time for hands-on food activities at school (sprouting, cooking, taste workshops) enabling in-depth learning throughout a growing season. Farmers can join forces to ensure that children visit different farms. This model encompasses a stronger school foodscape approach in that the school garden and other on-farm activities are linked to the school food environment: the visits are followed up with making healthy breakfast and lunch at school. This collaboration model can enhance teachers' familiarity with agriculture and improve farmers' teaching skills. One of the challenges is that it requires more time and funds to pay the farmers.

Municipal Science Network and Closer Cooperation between Several Schools and Stakeholders

The third case is a science network between three schools in and around a rural midsized town in collaboration with local farmers and a science centre. DAFC supports the project with consultancy advice and education materials and a large supplier of agricultural inputs provides grain for teaching. There is close cooperation between the science teachers in the three schools, who receive expert advice from a farmer, nature guide, science staff and a plant consultant when organizing educational activities relevant for pupils in fourth, fifth and sixth grades. Activities include workshops for the fourth graders, experimenting with planting potatoes, wheat and corn on a field near the science centre, with assistance from the farmer, his tractor and a plant production consultant. The children learn about different varieties of grain, food quality and health, do sensory experiments and take-home experiments on growing potatoes from potato peel and applying different amounts of water on wheat, which they can follow up on in the classroom. In fifth grade, students water, weed and harvest their crops, pick wild foods with guidance from a nature guide, cook their own corn and potatoes and include wild plants and berries in the cooking. They learn how people ground flour in the old days and how to make butter from cream. The sixth graders do experiments with soil, estimating the content of nitrate, lime and pH value, and do experiments on the effect of over-fertilizing and under-fertilizing the soil vs. applying adequate amounts (Dyg, 2014).

Cooking and food tasting are important components alongside agricultural activities, thus being part of a foodscapes approach. However, this case also does not entail actual provision of school food from the farms, like many farm-to-school programmes in e.g. the USA.

The cooperation involves several stakeholders and multiple interactions between the stakeholders. The core of the collaboration is the coordinator, who acts as a link between the different stakeholders in organizing events. The network enables teachers to exchange information and materials with each other and to receive advice from experts. The science centre is a key stakeholder offering expertise and a physical setting for educational activities. The municipality initiated the network activities, which fit into the municipality's educational strategy of science and business promotion. The strategy could also have been linked up to health promotion, food education or sustainable development, which is the case in other municipalities in Denmark. This multi-stakeholder cooperation is illustrated in Figure 3.

There are a number of opportunities in this model: for teachers to get assistance

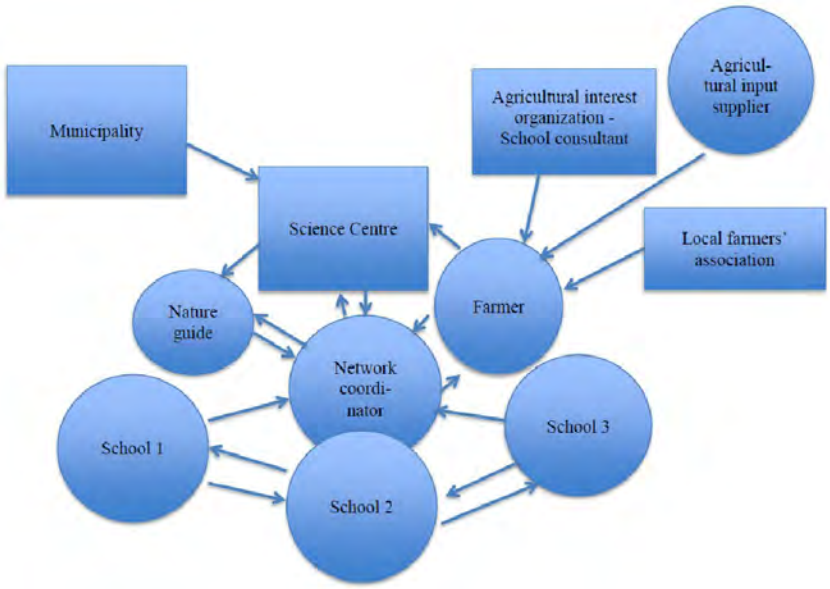

Figure 3. Farm–school cooperation model 3.

from experts when developing and teaching science, agriculture and food to exchanging ideas and equipment with other teachers and experts. The longer-term programme builds up students' knowledge about food, cooking, science and agriculture over three school years ensuring a progression in the children's learning. A similar cooperation model is seen with school garden programmes in Denmark. Yet, cooperation between schools is not yet common. The challenge with this model is the initial top-down approach from the municipality.

Whole-school Approach to Food and Agricultural Education

This case is whole-school approach at a public school located near Copenhagen. During 2004–2005, the school was going through a crisis, which led to the decision to restructure the school. The school now applies a whole-school approach involving experiential teaching, cooking in the school kitchen, school gardening and excursions outside of the classroom, combined with an organic food strategy and food service. The school has 'professional skills days', where teaching is integrated with, for example, professional cooking. The whole-school approach to food involves an organic and healthy school food policy, food education and meals prepared and sold at the school by students. The school's educational strategy aims at integrating theory and practice, free time and play with academic and professional skills. Teachers take the pupils on farm visits to learn about organic farming and to understand the underlying reasons for the school's organic meals policy. The connection with a farm is similar to model 1, a single visit to a farm with integration into the teaching before and after. The school is exemplary of how a school can work with a foodscapes approach, combining provision of school food, food preparation in the school kitchen and educational activities related to food and agriculture.

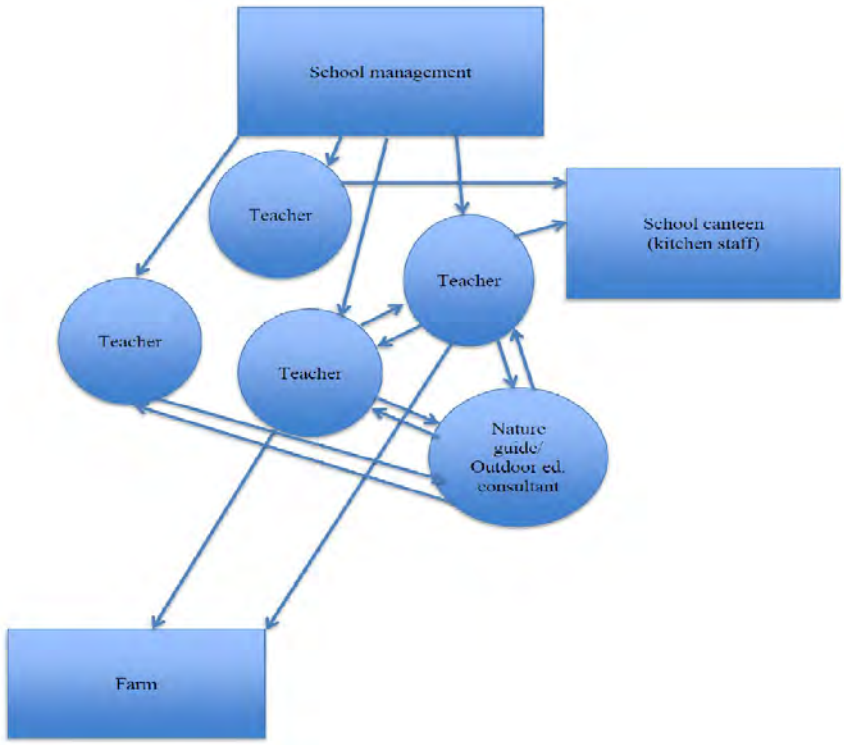

Figure 4. Farm–school collaboration model 4.

This bidirectional cooperation model (illustrated in Figure 4) is almost entirely based within the school. It comprises: 1. the school management initiating the approach, 2. teachers implementing it, and collaborating with staff in the school canteen, 3. a nature guide supporting teachers in developing skills and methods in outdoor pedagogy, and 4. the farm (an organic farm run as a social enterprise in a peri-urban area). This model could have had a stronger connection to other stakeholders in the community than is the case. Although there is no close collaboration with a particular farmer or farm, the teachers prioritize taking students to a farm once a year. This is a good example of a farm-to-school programme with multiple components. The school does not procure food from local farmers, as is the case in the programmes in the USA or Brazil and in recent initiatives starting up in a few municipalities in Denmark (Ruge and Mikkelsen, 2013). School food provision is rare in Denmark, for which reason this model is still in its infancy.

The key opportunities are that students get a broader understanding of food and agriculture and are better able to connect what they learn on the farm, with their school garden and the organic food at school. This means that they are more likely to understand e.g. the seasonality of food when cooking meals and the reasons for the schools' organic meal policy (Dyg, 2014). A key challenge to this foodscapes approach is that it requires support and commitment from school management and teachers and coordination between school management, teachers, kitchen staff and other stakeholders.

The analysis showed that the cases can be categorized into broader models. These

suggested collaboration models can probably also be applied to farm–school cooperation elsewhere. The results from interviews and data from DAFC show that the most common collaboration model in Denmark is the one-day or half-day farm visit with varying degrees of integration into subjects in the classroom before and after (model 1). Some of these visits are characterized as social events with no or limited educational content. The models 2 and 3 are longer and more demanding to establish focusing on experiential education to enable students to follow the production cycle, do experiments or other practical work on the farm or school garden. Cooking activities are often combined with other hands-on activities. In the second type, individual teachers or a group of teachers organize visits to a farm (or several farms) over a growing season. In the third type, schools, even municipalities, have a long-term collaboration with a farmer or school garden project, integrating it into the school policy or science curriculum over a season or several school years. In both models, it is common for students to be actively involved in the field or stable using the farm setting for experiments. It is often combined with cooking activities. Findings shows that farm visits, cooking and other food related activities are linked to objectives of fostering food literacy, agricultural literacy or ecological literacy (Dyg, 2014). The fourth type can be characterized as a whole-school, bidirectional foodscape approach, where provision of food in the school canteen is part of the school's food policy and teaching food and agriculture topics. The educational components involve farm visits, school gardening, cooking and classroom activities. The four typologies derived from the case studies are summarized in Figure 5 (models 1–4).

Figure 5 summarizes this into a model classifying farm–school cooperation. There is a fifth model included here, which was included in the case studies. This model is where a class or individual students go on a farm stay to work for several days or a week to learn about the farming profession and farm life. The reason for not including it is that it is typically not integrated into the subjects in schools but has

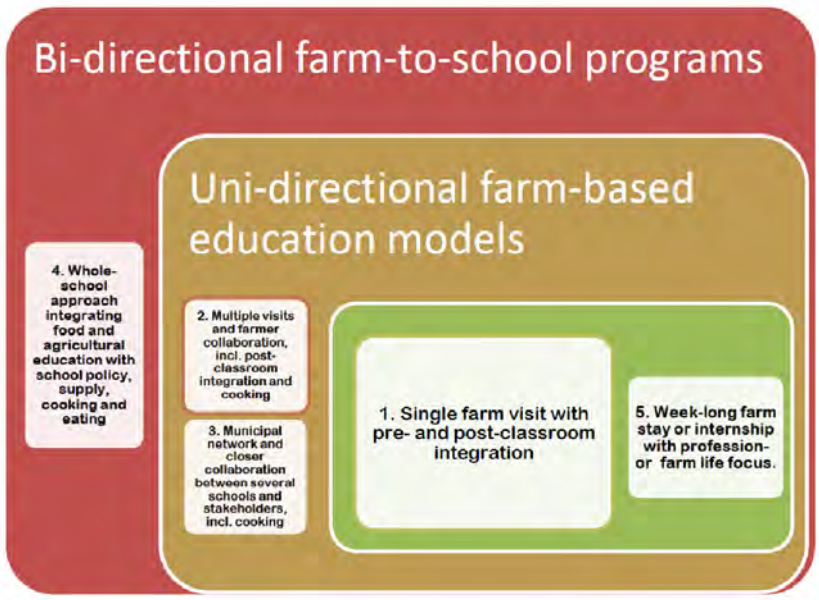

Figure 5. Models of farm–school cooperation.

a stronger profession target for older students. In addition, it has a unidirectional scope with similarities to model 1, except for the fact that the visit to the farm is longer and more in depth than the one day field trip described in Figure 1, and requires a closer collaboration with the farmer. The emphasis was to explore more of the bidirectional types of cooperation.

Teacher commitment can be relatively low in model 1 depending on the level of classroom integration before and after the farm visit. Model 2 requires higher commitment of the teacher in terms of taking students to the farm several times and integrating this with classroom follow-up, although this is not always the case. Some teachers leave most of the teaching up to the farmers, whereas others follow up and work with experiments and reflections in the classroom. Both types of teachers were found in case 2. In models 3 and 4, teacher commitment is high for the programmes to succeed: it requires a close collaboration with the farmer and other stakeholders as well as planning and coordination with colleagues and linking subjects and other activities at the schools. Farmers' commitment is similar to the teachers: the higher commitment and time is required, the closer the collaboration. In model 1, farmers' commitment and teaching competence can be relatively low in terms of only doing a tour and/or providing an excursion place. Commitment in terms of time, motivation and pedagogical goals is stronger, the closer the collaboration, i.e. in models 2–4. Although students' learning outcomes were not studied in this research, closer and longer collaboration will inevitably have a stronger impact on children's learning. This is supported by international research stressing the importance of longer-term and multicomponent food interventions. Short-term programmes are less effective than year-long programmes (Poston et al., 2005; O'Brien and Shoemaker, 2006; Evans et al., 2012).

Objectives and Motivation

The Farmers

For the majority of farmers, it is not economic incentives that motivate them to open up their farms to students. Presumably due to procurement regulations in the EU, low prevalence of school lunch programmes in Denmark and limited focus on schools as a potential market, the farmers did not highlight the economic incentive. An exception was the farmer located close to Copenhagen with easy access to public transportation, which enabled her to take in schoolchildren several times per week to supplement her income. According to DAFC, many farmers do not bother with the registration required to claim reimbursement for their time, especially in sparsely populated areas with only few visits. Farmers regarded opening up their farm to the public as a matter of principle, wanting children to experience the reality of farming and rural living, and to increase the transparency of agricultural production. As a dairy farmer puts it:

> 'I would like to help turn around the negative image that used to be that farmers are grey and boring, that they pollute and destroy the environment, and that they are tough on the animals' (Interview with Hanne).

They highlight the importance of people knowing where their food is coming from and of providing a good impression of agriculture to ensure its continued support in the community and society at large.

The organic farmers also had an overall goal of informing future consumers about organic agriculture, implicitly perhaps with some underlying long-term economic incentives to ensure a future market for organic products. An organic meat farmer in case 2 explains:

> 'I think they [the children] come and would like to learn a lot and they also leave here having gained a lot of knowledge. Some of all that theory they hear about in school is actually understood out here when they see it in real life… It is not right that we have so many people in Denmark who grow up without having knowledge of where food comes from, and I want to also tell them about ecology. About what is involved in operating an organic farm. So about what conditions the cows and the horses live under, and how we treat the soil' (Interview with Anne).

All the farmers revealed a passion for teaching children and opening their eyes to understanding agriculture. They highlighted that they want children to learn and not just have a fun day. The farmers involved in closer collaboration with schools in cases 2 and 3 see their role in an even broader perspective: of offering children a practical experience to learn complex theory in the real world as a key motivating factor (Dyg, 2014).

DAFC's motivation for engaging in educational activities is naturally linked to the motivation of farmers: to foster public support for agriculture, create awareness and increase transparency of agricultural production. The motivation of the organic producers' association has a slightly different emphasis, as organic agriculture has a more positive image in the media and to the public compared to conventional agriculture. Thus, the focus here is on explaining the principles of organic farming and promoting awareness to ensure support from future consumers, and less on defending their production (Dyg, 2014).

The Teachers

Teachers' motivations for engaging in cooperation with farmers vary. However, there are also similarities: one of the biggest being that teachers see the importance of fostering children's food literacy, including an understanding of where their food is coming from. The collaboration offers an alternative, real-life classroom with a number of benefits for children's learning, which the regular classroom cannot. Some teachers mentioned going to a farm helps shape their worldview and life skills. Several believed it is something children will remember later in life. As this teacher explains:

> 'It is more their deep understanding of things. That they remember it for the rest of their lives…, because much can otherwise be learned and then quickly forgotten. But you will not forget such a visit… They become wiser. They get a larger worldview, because they have been out and experienced different things' (Interview with Sanne).

Several teachers highlighted this point, which is supported e.g. by Illeris (2006).

Learning goals of fostering food literacy, agricultural literacy, ecological literacy or a combination were documented to varying degrees (Dyg, 2014). The common focus was on teaching children where and how their food is produced. A broader ethical, social and ecological understanding of agricultural and food systems was

the aim for some teachers and organizations, especially those working with organic agriculture (case studies 2 and 4).

Apart from the uniqueness and effectiveness of learning on a farm and other outdoor environments, teachers' motivation is also related to the importance of learning about agricultural production. This is similar to the motivation of the farmers. One teacher explains:

> 'The children get an insight into what is it about the soil and… into what makes up a farmer, and what it is he needs to do before he can even put something in the soil. And I think there is an incredible amount of professionalism in it, also because they've become much criticized: "but they fertilize too much" and "it flows into our creeks"… And then we have some tests at home that actually show if you apply too much fertilizer then nothing will come up. The plants must get only just as much as they can handle. If they get too much, the plants die' (Interview with Stine).

In other words a strong motivation factor is to foster a more nuanced understanding of agriculture.

Another teacher stresses this point:

> 'We live in the countryside, but there are very few children who know anything about agriculture. It is disappearing more and more… it is changing to large-scale production and small farms are becoming fewer and fewer. So fewer children know anything about it. If you only say "crops", "what is a crop?" They do not know it [laughs]' (Interview with Bente).

The lost and perhaps romantic connection to farming and the countryside is highlighted here. Most teachers are likely to have limited agricultural understanding. A study by Trexler et al. (2000) from the USA found that teachers in general did not feel comfortable teaching agriculture, requesting more support in the form of educational materials and training. This is not the case with the science teachers interviewed in the Danish study. Yet a few other teachers did not feel comfortable teaching agricultural topics putting emphasis on health or organic food more broadly, others used the collaboration with farmers to fill their own knowledge gap. Teachers were also motivated by the academic benefits of farm visits and closer collaboration, working in an outdoor and different learning environment, and by the opportunity to combine academic and theoretical objectives with experiential teaching (Dyg, 2014).

There could be some tension between teachers' academic interests and the interests of farmers, such as in case study 1 focusing on transparency of the production. However, only one teacher mentioned this. Nonetheless, it is likely to affect children's understanding of agriculture in terms of the academic relevance and bias that can be derived from difference in objectives. There is a risk of misconceptions of agriculture, if teachers do not encourage a deeper and critical reflection of the farm experience afterwards.

Even though food literacy is a common motivational factor for farmers and teachers, farmers do not necessarily focus on food, but on their production. Although food is clearly the overarching focus of teachers, the interviews revealed that farmers focus on production details.

Some teachers were hesitant to be interviewed because they were not very familiar with agriculture and science-related issues, for which reason they only had a limited focus on and interest in agriculture in their teaching. When the motivation

of farmers and teachers is limited to only giving the children a fun day at the farm, or driven by the wish to change the image of farmers, there is a risk of children uncritically accepting what they see, hear and read without deeper, critical reflection. The risk of misconceptions of agriculture, when the children meet a friendly farmer and read educational materials from agricultural interest organizations, which do not mention environmental issues and broader sustainability perspectives, is cause for concern.

On a personal level, teachers in case 3 are motivated by the professional network, where they get inspiration and exchange ideas with other science teachers and agricultural experts. One teacher explains:

> 'It's quite amazing that we have such a professional science network, where we can get experts in and can tell them about it, because although we know quite a lot as science teachers, but certainly not one tenth of… yes, one hundredth of what they know. Because they know it and can explain to the kids what it is all about' (Interview with Bente).

Farmers and other agricultural experts are keen on sharing their expertise with teachers and students. The opportunity to work with farmers, local companies and other stakeholders is an important motivating factor for teachers in case study 3. Apart from sensory experiences of a farm visit or longer collaboration, farmers and other experts play a unique role in providing important expert information. Teachers mentioned the importance of farmers being authentic experts able to provide students with clear opinions. The fascination by students of meeting an authentic farmer was evident in all observations.

The findings show that farmers and teachers with a longer-term collaboration also had a strong motivation to make education more experiential, linking theory to practice and giving children new realizations and action competence. Other research shows that longer and multicomponent food interventions (field trips to farms combined with farmers' visits to schools and school gardens) are important for attaining desired impacts on food and agricultural knowledge and behaviour (Poston et al., 2005; O'Brien and Shoemaker, 2006; Evans et al., 2012). For this reason, cases 2, 3, and 4 and to some extent also a student-driven problem-based project in case 1 are of particular relevance, because they are tied to either on-going on-farm activities or combine food and agriculture-related activities, experiments, investigations and classroom teaching, all of which are more conducive to children's learning.

Discussion

The school-garden and urban-agriculture boom spreading in Denmark opens up new and longer-term opportunities for children to connect to their food, not only on rural farms. These new forms of agriculture can enable a stronger connection between children and food in areas closer to their schools, as seen in models 2 and 4, involving respectively a school garden on a peri-urban organic farm and a farm visit to a peri-urban farm run as a social enterprise. Case study 4 documents a broader school foodscape approach and how it can be developed to realize the full change potential of food at school. Foodscape thinking challenges traditional thinking about food, being limited to simple provision of lunch, and takes a more active and learning-based approach.

The study discovered various action possibilities and affordances of the proximal

'food landscape' to be used as a learning scape. It gives attention to the school ethos whereby agriculture, nutrition, life skills, and health are put on the agenda through their common denominator, food. A school foodscapes approach, as in model 4, involves political and cultural elements, i.e. an organic school food policy and values related to cooking and organic food, affecting the school food environment and hence eating at school. The attention of teachers to the learning opportunities in working with food and agriculture in various subjects, further contributes to realizing the potentials of fostering food literacy action competence and academic skills among students (Dyg, 2014). Studies also show that learning opportunities in school gardens offer additional benefits, by providing a foodscape that promotes connectedness to nature, science understanding, as well as social and personal development in children, e.g. interpersonal skills, self-understanding, self-esteem and the ability to work in groups (Murphy, 2003; Desmond et al., 2004; Green, 2004; Wistoft et al., 2011).

Framing farm–school programmes within a foodscapes approach opens up a discovery of new learning potentials in the environment. Whether this is within the school setting or growing food on a farm or in a school garden, it offers possibilities for promoting healthy eating, environmental awareness and food and agricultural literacy. These and academic learning possibilities are discovered by teachers, school managers, farmers and others, when establishing closer external networks and collaboration, combining these with classroom integration and initiatives targeting the school food environment. Studies show that multicomponent interventions are most effective, as they combine the learning potentials in the food- and agri-environment of the farm or school garden with the food reality of the school. (Poston et al., 2005; O'Brien and Shoemaker, 2006; Evans et al., 2012) We also argue here that these learning potentials affect classroom and subject integration and not only the school food environment.

The application of the foodscapes approach to farm–school programmes contributes to a better understanding and analysis of the farm–school programmes, the extent to which these embrace the full learning potentials offered within the food environment at school and the food and agri-environment of the farm. The four suggested farm–school collaboration models realize to varying degrees the potential of the foodscapes approach. The first three models realize to different degrees the learning potentials of the food and agri-environment of the farm, integrating it with subjects such as science, mathematics and languages. Models 2 and 3 work more thoroughly with hands-on food activities on-farm and back in the classroom. Only model 4 integrates the full potentials of a school foodscape: it combines the promotion of healthy eating through cooking and school meals with environmental awareness and food and agricultural literacy from experiential learning on a farm and from classroom teaching.

With the recent school reform in Denmark, many key factors are in place for promoting farm–school programmes, including more teaching hours, flexibility in schedules, alternative teaching methods and cooperation with stakeholders outside the school. Structures to establish canteens, school kitchens and supply locally sourced food is not yet part of the reform and policy. In the USA, federal and state governments/policymakers view the USDA Farm-to-School Program as worth supporting. Policy has been a primary vehicle for developing these programmes at national, state and local level, with a health and nutrition promotion rationale while supporting markets for US farm products. In Denmark, the emphasis on meals, mar-

kets for farmers and school health policy combined with educational objectives is not yet part of a national policy. However, this could be a way forward for stronger integration and provision of school meals to support longer school days and more hands-on teaching under the school reform. School foodscapes approaches are still only the reality in a few schools and municipalities in Denmark. Promoting model 4 more widely across Denmark requires programme and policy support similar to the one in the USA.

Current discussions and research on food at school should take advantage of a broader understanding of food realities at school. We suggest this broader approach to be informed by a foodscapes approach. The Danish school reform refers to the idea of an 'open school' as the creation of stronger links with local community actors, which could include farmers and others. It emphasizes supportive learning strategies in which hands-on learning about food might well be an option. Farm-to-school programmes are a good example that could be used to tap into this potential.

There is a need for more research on broader school foodscapes perspectives documenting learning, health and sustainability outcomes. So far, most research and conceptual papers on foodscapes focus on the organizational and sociocultural aspects of the food environment and related eating practices, although some recognize the curricular and other learning opportunities in school foodscapes (Henderson and Tilbury, 2004; Adema, 2006; Mikkelsen, 2011, 2014; Torralba and Guidalli, 2013). However, the main focus is on eating as a form of learning: learning to participate in collective practice, to become a member of a group and to eat in a context (Mikkelsen, 2011, 2014; Torralba and Guidalli, 2013). Curricular integration and learning about food and agriculture is lacking.

The contribution to uncover these other learning opportunities in foodscapes in and outside the school and beyond eating adds a broader understanding of school foodscapes. Furthermore, the systematization of different farm–school collaboration models can help inform future research on foodscapes, linking school food and farm–school programmes, for example, to investigate whether or not there are particular models that are more common in particular contexts (e.g. social background, countries, institutional contexts, countries with stronger or weaker agricultural traditions, types of schools) or the historical trajectories and evolution of these models.

Conclusion

Farm–school cooperation in Denmark ranges from short-term, informal, unidirectional programmes to longer close collaboration with a bidirectional scope involving a foodscapes approach to food and agriculture education and school food. This approach and related farm–school programmes opens up new potential developments in the environment for promoting healthy eating, environmental awareness, academic learning and food and agricultural literacy among children. The learning potentials embedded in the farm and school food environment depend on farmers' and teachers' motivations and learning goals, and are linked to the nature of their collaboration (shorter or longer-term collaboration). It is also connected to the ability of school managers and municipalities to explore and support the learning potentials of the environments. Thus, farm–school action possibilities are connected to the learning potentials in the food and agri-environment of the farm and the ability to link this to the food reality and teaching at the school. For closer cooperation models and foodscapes approaches to become more widespread, a school reform such as the

one implemented in Denmark combined with policies supporting school foodscapes and procurement of food from local farmers are of key importance.

Longer-term collaboration models are linked to farmers' and teachers' objectives of making teaching more experiential, giving children new realizations and action competence, thus leaving a stronger impact on children's learning about food and agriculture. Longer-term and broader foodscape interventions are likely to have a stronger impact on children's food and agricultural literacy. The study has uncovered learning opportunities in foodscapes in and outside the school beyond eating, which adds a broader understanding of school foodscapes. More research is needed related to this aspect of foodscapes, but also on the relevance of the suggested collaboration models' systematization in other contexts.

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