Production

ISSN: 0103-6513

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Associação Brasileira de Engenharia de Produção

Brasil

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Production, vol. 25, núm. 2, abril-junio, 2015, pp. 266-277

Associação Brasileira de Engenharia de Produção

São Paulo, Brasil

PRODUCTION
PRODUÇÃO

Production, v. 25, n. 2, p. 266-277, abr./jun. 2015
http://dx.doi.org/10.1590/0103-6513.095212

Understanding the motivational perspectives of sustainability: A case of biogas production

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Abstract

Despite the importance of the expectations and visions of the actors involved in sustainable innovations, only the societal, motivational perspective is usually considered. The fact that local actors may have different multi-motivations is typically overlooked. The aim of this study is to examine and understand the multi-motivational perspectives in a sustainable production project. First, we introduce the concept of the object and analyze the case of a biogas production project as a mediating activity for making swine production more sustainable. We argue that the object of the activity, as manifested in motivational perspectives, shapes the way in which biogas production (BP) systems are implemented. The article concludes by discussing how the concept of object can be used to explore the actual and future possibilities of using artifacts for increasing the sustainability of production.

Keywords

Sustainable innovation. Swine production. Activity theory. Motivation. Object of activity.

1. Introduction

Societal, environmental and ergonomic issues are increasingly penetrating production designs, emphasizing the need for multi-faceted technical and organizational innovations. The point of departure in most innovation studies is the assumption of the existence of a societal problem that needs to be solved. In order to do this, local experiments, interventions and projects must be initiated.

For the success of such projects, collaboration between actors with different perspectives is crucial.

As understanding people's motivation to act is important, many different concepts have been suggested. Brown & Vergragt (2008) suggest the concept of **vision** as an innovative product or service, something that is being socially constructed, something that provides a focus and a shared language for discourse, in turn providing a platform for reframing the clashing interpretive frames in cases of conflict. Raven & Geels (2010), for example, claim that expectation, a notion related to promises of future outcomes, is important in order to attract attention and resources from social networks, and to provide direction for the development of a technology. Van Mierlo et al. (2010), for instance, talk about aspirations, interests, goals and the feeling of interdependence. They acknowledge that people must feel that the achievement of their outcomes relies on collaboration with others.

Although these studies highlight the importance of taking into consideration individuals' interests, goals and visions, they do not explain how they are related to these on a societal or collective level (see Pereira-Querol, 2011). It remains unclear whether people become involved in sustainable-projects for their own benefit and/or for solving a general societal problem. In practice, as pointed by Brown et al. (2003) there is tension between the interests of individuals and institutions, which leads the actors to avoid taking radical steps within their organizations. This may compromise the success of sustainable projects.

Moreover, although these studies on innovations towards sustainable production usually consider expectations and visions as crucial to the emergence

Received: Sept. 17, 2012; Accepted: July 1, 2014

of sustainable technologies, they do not take into consideration the process of how the diverse expectations and visions of different actors merge and change. Usually, only the societal motivational perspective is taken into account, overlooking the fact that local actors may have different multi-motivations

Another issue to be considered relates to the fact that sustainable innovations, as any technical innovation, are the result of a design process (Béguin, 2008). As Bucciarelli (2002, p. 220) states, a design process is essentially social:

> Negotiations and trade-offs are required to bring participants' efforts into coherence. So while members of a collective share a common goal at some level, at another level their interests will conflict and they strive in competition.

The quality of the design process has to be approached through the quality of the design product and its relation to its "context of use". (Kroes, 2002) This is why Béguin (2003, 2008) argues that the success of an innovation process depends on the interaction between users and designers, which allows for mutual learning.

In this study, we aim to examine and understand the motivational perspectives of sustainable production; in particular its developmental dimensions. In order to do this, we first introduce the theoretical concept of the object of an activity, and present the method of data analysis. Second, we introduce the empirical case from a Brazilian biogas production as a mediating activity for making swine production more sustainable. The results of our analysis show that our case had different motivational perspectives of biogas production BP, which are related to the ways how BP is taken as an instrument for making swine production sustainable. Some of these ways are compatible, while others are contradictory. In the end, we discuss, how the multi-perspectiveness of the object relates to triggering actions towards sustainability. The 'success' of a sustainable technology appears not to require every actor to use an artifact in the same way, but that the object incorporates the motivational perspectives of the people involved in the activity.

2. Artifacts, instruments and the object of an activity

Cultural-historical activity theory has its roots in the Russian psychology of the 1920s and 1930s, captured in the work of L.S. Vygostky, written in 1930-31 and first published in 1960, (1978). This approach started with studies on child development and has expanded to studies of everyday working activities, such as banking, health care, legal work and organic farming. Activity theories have a wide range of applications in, for example, information technologies (Kuutti, 1996) and ergonomics (Guérin et al., 2004; Owen et al., 2009); with an emphasis on psychological and organizational developmental interventions (Clot, 2009; Sannino, 2011). The main idea of activity theory is that a historically developing activity is the theoretical unit of analysis.

In 1978, L.S. Vygotsky proposed the idea of the cultural mediation of human action, a concept that has become central to activity theory (see Roth, 2007). Cultural mediation means that the relationship between the subject and the object is mediated by cultural means or artifacts used as signs and tools. According to Cole (1996), an artifact is defined as an aspect of the material world that has been modified over the history of its incorporation into goal-directed human action.

Based on the work of Leontiev (1978) and Engeström (1987) expands the unit of analysis from an individual action to a collective activity (see Engeström, 2001). In his interpretation the basic assumption is that an activity is always directed towards an object (Leontiev, 1978; Leontiev, 1981; Stetsenko, 1995; Kaptelinin & Miettinen, 2005; Miettinen, 2005). There is no activity without an object, and the object is what distinguishes one activity from another (Leontiev, 1978, p. 62). In order to understand a certain activity, we first have to identify the object that directs the subject's actions.

The concept of the object of an activity is based on four principles. The first principle is that the object of an activity is its true motive, and the reason for its existence is related to a need that exists in society (Leontiev, 1978, p. 62). In contrast to other motivational theories that see motive as biologically given (for example, Maslow, 1954), the activity theoretical conceptualization of motive is that needs themselves are also socially produced (Miettinen, 2005). Among humans, needs are not purely biological but evolve through human activities, and are mediated by objects that are defined culturally in the course of history (Leontiev, 1978). Human motives emerge through the appropriation, use and development of objects and artifacts in collective human activities.

The second principle points out that the object is twofold, epistemic (ideal) and objective (material). In contract to the traditional notion of object as a thing as such, the concept of object of an activity is true motive of an activity. It is the thing that directs actions. It is at the same time the thing that

is being transformed in a result. For example, using the traditional notion of object we may consider a hammer as an object. But to the object of an activity this hammer should be the thing that is being constructed or transformed – for example a hammer may be the object of the activity of a locksmith that produce hammers. In this case the hammer has a motivation power and is what the person's action is directed to. As Miettinen (1998) explains, the object of an activity includes the "raw material" to be transformed and the vision of an outcome. The transformation is not only mental and discursive, but is also objectified in a hybrid system composed of human and physical, as well as biological elements (Miettinen, 1998, p. 424).

The third principle is that the object is in a constant state of change. The change takes place not only in the object's material aspect but also in its ideal aspect, which includes the conceptualization of something, what includes not only the explicit scientific knowledge of that something and the methods for producing it, but also the tacit practical knowledge which are implicit and not externalized. (Miettinen, 2005).

According to Engeström (1987), objects of activity have inner contradictions because the same object is part of several systems such as the system of its production and the system of its use. Inner contradictions within the object lead to its constant change and evolvement. As pointed by Marx (1992), in the capitalist mode of production, objects are produced as commodities to be exchanged in the market. A commodity can only have exchange value if it has use value in some human activities, that is, satisfies a need. Commodities produced for exchange in the markets do not satisfy the producer's need directly, but provide him or her with the means for obtaining other commodities that may have use value. This duality of commodities constantly generates contradictory objectives and tensions between producers and consumers, and is the main source of the change and development of objects of activities (Engeström, 1987).

The forth principle is that the object can only be achieved collectively in the history of the activity. Objects are, on the one hand, given to individuals in a pre-existing form, and on the other hand, interpreted and reconstructed by the acting individuals. The ideal aspect of the object is understood and defined differently at different times and by different actors in different, contesting ways (Miettinen, 2005).

In this study, we understand the object of an activity as a thing that is being collectively produced to satisfy some needs in society (Pereira-Querol, 2011). Both the environmental and ergonomic aspects of production make objects more complex and multi-voiced. Therefore, more so than previously, some objects require the collaboration of stakeholders from several different activities. The sustainability of an activity depends on how much the object can satisfy the needs of the actors involved over time.

In this article we do not focus in the analysis of game of forces or how tools, technology and instruments are used as tools in a power game. Such analysis would require a different theoretical approach, such as Social Studies of Technology (Bijker et al., 2012) and Critical Theory of Technology (Feenberg, 1991).

In this article we are interested in depicting the actors' motivational perspectives of BP. The general use of an artifact indicates its motivational perspective. *Motivational perspective* is understood here as the benefit or the desirable result produced by the use of the artifact. It is important to point out that artifacts may be understood either as an instrument or as an object, and the transformation that they produce can be either desirable or undesirable. Here we explore the desirable results. The analysis of the function of an artifact, either as an instrument to transform an object or an object in itself, indicates a person's motivational perspective of the artifact. By contrasting motivational perspectives we come to a hypothesis of the basic developmental dimensions of the object of the activity.

3. Data and method

In this study we further develop Pereira-Querol's analysis of the meaning of biogas production (BP) (2011). The data used in the study is from a BP project implemented by a Brazilian food company. BP was part of the Program for Sustainable Production in a swine production chain, which we will call here the Sustainable Program. The basic idea of the Sustainable Program was to implement bio-digesters among outsourced farms for producing biogas, to earn carbon credits to be sold on the market, to make adjustments to outsourced farms to conform to environmental law, and to improve their socioeconomic conditions (see subsection 4.2). The BP system implemented in the program in 2005/2006 combined the production of carbon credits with the local use of biogas for making swine production in the farms more environmentally sustainable. In this project, a specialized organization, here called the Sustainable Institute (SI), was created for managing the design, implementation and application of the carbon credits, while farmers were responsible for producing and burning the biogas.

The data used in the analysis are composed mainly of informal interviews with key informants (for a further description, see Pereira-Querol, 2011). During the interviews, we asked the actors for their opinion regarding the importance, advantages and usefulness of biogas on the farm; and asked them how they used the BP system. In doing so, we wanted to understand how BP figured in their everyday lives. The interviews are not exhaustive; therefore the interviewees probably left many issues unmentioned, for various reasons. The main usefulness of the interviews was that they constructed a general list of the aspects that were relevant to the sustainability of BP. We rely on the content of the interviews to represent the perspective of the stakeholders. We interviewed nine farmers and ten staff from the company and its Sustainable Institute.

We began the analysis by listening to the interviews and later continued by reading the respective transcripts (The method used in the study is an adaptation of the method of analysis of meaning and sense developed by Pereira-Querol (2011)). We separated the uses of BP into two groups: a) actual use and b) expected use. To depict the motivational perspectives of BP, we continued by exploring how each artifact was used, what was transformed, what benefits resulted, and in which activities.

4. Results

4.1. *Brief project history*

The history of the project may be traced back to the end of the 1990s and the aggravation of the environmental problems caused by swine production in the Southwest region of Santa Catarina, Brazil. Aware of the need to adjust the environmental conditions of the farms of outsourced farmers, the company studied started searching for solutions. In 2004, it discovered carbon credits as a potential financial and technological instrument for adjusting the outsourced farms to conform to environmental legislation. The top administration of the company approved the idea. The design of the Sustainable Program involved hiring a consultant, developing new technologies that adapted to small-scale farms, collecting information about farmers, training technicians, and so forth. Finally, engineers developed and tested an economical version of a bio-digester that could be adapted to small-scale farms, and allowed its installation on all the 3500 outsourced farms. Installation of the bio-digesters began at the beginning of 2006. In December 2006, a new technology for applying for carbon credits was required, which increased the costs of BP for carbon credits, and made it economically unviable for small scale farms to apply for them. This new technology also made it difficult to use the biogas locally within the farms because of the expensive equipment necessary for measuring and burning the gas (for a detailed history, see Pereira-Querol (2011)).

4.2. *Artifacts of the technological system of BP and its products*

The BP technology implemented in the project basically comprised a bio-digester, a combustion system and an open air lagoon in which to store the treated manure. First, the swine manure was collected and conducted to the bio-digester. The bio-digester then transformed the manure's organic particles into methane (CH_4). The gas was collected from the digester and transported to the combustion system, where it was burned and transformed into CO_2. In some cases, the biogas was used to heat chicken houses. The liquid fraction of the manure was stored in an open lagoon and later applied to agricultural fields. The final slurry was an excellent bio-fertilizer, with a composition of nutrients that could be easily absorbed by plants.

The CH_4 produced within the digester was burned and transformed into CO_2. According to studies, CO_2 contributes 21 times less to the greenhouse effect than CH_4. Thus, burning the CH_4 is considered a mitigation of greenhouse gas (GHG) emissions. In a mechanism of the Kyoto Protocol, projects in developing countries that mitigate GHG emissions can apply for certificates of emission reduction, most commonly known as carbon credits. These are certificates awarded by an internationally recognized institution, for example, the United Nations Framework Convention on Climate Change (UNFCCC), which attests that a certain amount of GHG (usually measured as a ton of CO_2) has been mitigated. Once obtained, these certificates can be traded on the market and exchanged for money. The idea is that the organization that buys the carbon credits can use them to adjust levels of GHG emissions. In other words, carbon trade allows GHG reductions to take place in countries with lower costs. This is a brief overview on how biogas is 'transformed' into carbon credits; more complete explanations can be obtained elsewhere (Yapp & Rijk, 2005).

According to the plans, BP would also produce carbon credits. For the food industry and farmers, the carbon credits were a potential tool for paying back the costs of implementing the BP system and an alternative source of income for farmers. However,

applying for the certificates was a rather difficult and expensive process.

The next section delves more deeply into the actors' subjective perspective of the relationship between BP and the activity they are involved in on the farms; swine production.

4.3. *The motivational perspectives of BP for the food company and the Sustainable Institute*

To depict the motivational perspective of BP for the food company and Sustainable Institute, we analyzed ten interviews with key informants. Table 1 summarizes the actual and expected uses of BP, and motivational perspectives for the food company's and the Sustainable Institute's staff. While listening and reading the data, we found two lines of discourse regarding the importance of BP for the food company. One line, expressed mostly by the staff, greatly emphasized environmental benefits such as the reduction of pollution and GHG emission. In contrast, the food company staff working in the industrial department tended to emphasize the benefits and advantages of the swine production business itself. The Sustainable Institute staff highlighted the increase in the food company's social and environmental sustainability, while the food processing company staff stressed cost reduction and the adjustment of the farms to environmental legislation, which guaranteed the supply of raw material. Such differences in response may be attributed to the different objectives of these two groups, and their specialization in different aspects of the object.

Another way of using the artifacts was to use the whole project as a way in which to show consumers and investors that the company takes the environment into consideration. In this way, the motivational perspectives regarding the environmental impact reflected societal needs (expressed by the needs of consumers and investors) rather than the needs of the company itself.

As pointed out by the coordinator, making adjustments to the farms in order to comply with environmental legislation allows a supply of raw material to the food industry and expands the market. This second motivation was much more strategic for the company, and represented the opinions of the top administration. This may explain why more space was devoted in the food company's annual reports to sustainability.

According to the operational manager of the Sustainable Institute, who was also the environmental manager of the company, BP and the 3S Program were ways in which to make swine production more sustainable, and guarantee a long-term supply of pork. As the engineer explained, the current environmental and economic situation of farmers was leading to a reduction in their number and threatening the long-term supply of raw material to the food industry. The same opinion was shared by the other engineer of the institute.

According to the food company's production manager, the main importance of BP was to reduce the environmental impacts of swine production and to improve environmental issues on the farms. Swine manure management and environmental legislation were two of the main barriers to the further expansion of swine production in the region, and BP was a partial solution to assure an economically viable supply of swine to the food industry. However, the area of land on which the end slurry could be distributed was limited. Thus, other solutions were needed; reducing the volume of the slurry and allowing it to be distributed more widely; increasing the area of distribution of the slurry; or even a completely different technology that eliminated the slurry.

The main expectation was that BP would provide extra income for the farmers, and help them reduce production costs by using the biogas

Table 1. Food industry's artifacts, uses and motivational perspective of BP.

Artifact	Actual uses and expectations	Motivational perspective
Bio-digester	For improving working conditions of farmers and keeping farmers producing swine, and storage capacity	Maintaining the supply of pork meat to the industry in order to produce food products, and allowing further expansion of production
Biogas	As energy for reducing production costs in swine production, and to sell as a commodity	Maintaining the supply of pork meat to the industry in order to produce food products
Carbon credits	For providing financial resources for improving environmental conditions of farms, and increasing the income of farmers;	Reducing the pressure on the price of swine and making swine producers more competitive
Sustainability indexes	For using the indexes (indicators, such as GHG emissions) in Annual reports in order to show sustainability to consumers and investors.	Evaluating market shares, maintaining and/or expanding markets

in farming activities, and/or selling it as electricity or another commodity; in addition, carbon credits could produce money. The farmers expected the use of biogas to reduce their costs, and the use of carbon credits to increase their income. The resulting increase in their economic sustainability would reduce the pressure to raise the price of swine (though indirectly).

The use of the artifacts by the food industry and the Sustainable Institute was indirect. For example, the company did not expect to directly use the biogas but expected to benefit if farmers used it by generating extra income that would be an indirect payment for the swine supplied to the industry. Although the same artifact may have the same meaning, the motivational perspective – the way in which they enter into the activity – is different. In other words, the food industry use the results produced by the direct use of BP to obtain results in their own activities.

The relation between farmers and the industry was mediated by contracts that established prices and the production conditions such as minimal infrastructure, technology and practices that would have to be taken by farmers and the industry. Both the price and the conditions of production were determined by the industry and hardly were challenged by farmers. This is probably because of the huge difference of power of negotiation between them. In theory, farmers were free to chose the company that they wanted to supply but in practice there were limited choices and farmers had simply to accept the production conditions established by the industry, which did not differ much between among the companies. There have been several studies disclosing this process of domination from industry towards agriculture (see for example Goodman et al., 1985).

4.4. *Farming activity's motivational perspectives of biogas production*

To depict the motivational perspective of BP, we analyzed the nine farmers' interviews. We discuss the uses and expectations in relation to specific artifacts or sub-products of BP, but the use is not necessarily limited to the specific artifact or sub-product discussed. Table 2 summarizes the results.

The most acknowledged benefit of BP was the improvement in swine manure management (10 of the 11 interviewed farmers), what we call **BSMM** (bio-digester for improving swine manure management). In addition to the facilitated handling of the slurry, BP also improved working conditions by reducing flies and odor. The technology that was used before the bio-digesters produced the smell of putrefied egg, which was considered undesirable; a problem that was aggravated in the summer when high temperatures increased the emission of methane and other gases.

Another benefit of BP was the improvement of the quality of the end slurry as a bio-fertilizer. The nutrients that composed the manure were transformed into forms that could be easily absorbed by the plants, producing an excellent source of fertilizer. This had at least two uses. For farmers who did not have agricultural fields (7 of 11 farmers), the improvement in the chemical properties of the slurry meant an increase in the demand for the slurry, and a reduction in its disposal costs, a benefit we call **FertCoR** (fertilizer for cost reduction). With the improvement in the quality of the slurry, some neighbors came to the farm to pick up the slurry free of charge to use in their agricultural fields as fertilizer, reducing operational costs in swine production. Among the farmers who had other agricultural activities (e.g. maize or grazing), the

Table 2. Farmers' artifacts, uses and motivational perspective of BP.

	Artifact	Actual use or expected use	Motivational perspective
BTec	Bio-digester	As a tool for social relations	Improving the relationship with technicians
BStor	Bio-digester	As a storage tank	Obtaining or keeping an environmental license
BCor	Bio-digester	For cost reduction	Better economy by reducing investment costs in treatment system
BSMM	Bio-digester	For manure management	Better working environment by reducing odor and flies in the slurry
FertCoR	Fertilizer	For cost reduction in uploading and distributing the slurry	Better economy by reducing time for slurry upload and distribution
FertAgr	Fertilizer	For reducing costs in other agricultural activities on the farm	Improved economy by replacing chemicals by organic fertilizer
GasMark	biogas	For selling in the market as extra income	Extra source of income for the farm
GasErg	biogas	For energy to be used in other activities on the farm	Reducing costs by using the heat and electricity on the farm
CC	carbon credits	As money from carbon credits as extra income	Extra source of income

slurry had the direct motivation of a fertilizer, which we refer to as **FertAgr** (fertilizer for reducing costs in other agricultural activities on the farm), as they were used to replacing chemical fertilizer. The use of the fertilizer indicates that, depending on the activities on the farm, the same sub-product – the slurry – can have a different motivation. For farmers without agricultural activities, it simply meant cost reduction in swine production, while to farmers with agricultural fields, a bio-fertilizer meant a cost reduction in another agricultural activity on the farm.

Another advantage of BP was the reduction of investment costs in a new open tank (6 of 11 farmers). The bio-digester tank was financed through the Sustainable Institute and was to be paid with carbon credits. Thus, the bio-digester was constructed at almost no cost to farmers, reducing investment costs in a new storage tank and increasing the capacity of storing swine manure; **BCor** (bio-digester for reducing investment costs in larger open tanks).

Five of the eleven farmers acknowledged the importance of the bio-digester in increasing their capacity for storing slurry (**BStor**), and allowing a further increase in the volume of swine production. The bio-digester enabled one farm to obtain an environmental license. Without the bio-digester, the farmer would not have obtained this, because of his already large number of animals. For him the bio-digester was also a way in which to increase the volume of production.

Farmers were further motivated to be involved in BP because the process satisfied technicians (3 of 11 farmers), referred to here as **BTec** (bio-digester for satisfying the technician). When asked about the importance of BP, some farmers answered that they had joined the Sustainable Program because the technicians had asked them to.

Eight of eleven farmers were interested in using biogas energy either on their own farms or by selling it on the market. However, only one farmer was already using biogas. Five farmers were planning to use the gas as a source of energy on their farms (**GasErg**, biogas for energy to be used in other activities on the farm). The only farmer interviewed who was already using biogas was using it to heat his chicken warehouse during the winter. Two farmers were interested in using the gas for heating their chicken warehouses, but they were not yet using it. In general, farmers who produced chickens had a strong desire to use biogas because of the significant costs of fuel during the winter.

Another expected use of biogas (3 of 11 farmers) was its sale outside the farm as a source of energy; **GasMark** (biogas for market as an extra source of income). In 2008, a farmer installed an electrical generator to supply electricity to the local electrical company. One farmer was planning to sell the gas to a company that was interested in producing electricity for sale. Only one farmer expressed interest in obtaining money from carbon credits as a motive for joining the Sustainable Program: **CC** (biogas for carbon credits).

5. Developmental dimensions and restrictions

The analysis shows that all the farmers interviewed were producing and using biogas in some way in their activities. Most of them acknowledged the benefits of BP as a way in which to manage manure, though in different ways. Several farmers planned to use biogas. Most of them were planning to use it on the farm to reduce costs, while others expected to sell it in the market (for example, as electricity) and earn extra income. Based on these findings, we can say that farmers acknowledged the relationship between BP and their environmental challenges, as well as the reduction of costs in swine production, and the opportunity for extra income that it offered.

Interestingly, the findings of farmers' motivational perspectives contradict the explanations given by the engineers for the inappropriate operation of the BP system. The explanations given by engineers are related to farmers' lack of motivation regarding BP or lack of instruction. However, as we have seen above, farmers were mostly motivated. How can we explain this mismatch?

Here we will not explore the explanations given by farmers and engineers to the disturbances that were taking place in the biogas production. Such analysis has been done in previous studies (see Pereira-Querol, 2011; Pereira-Querol & Seppänen, 2012). To explain the mismatch between engineers' explanations and the findings regarding the actual uses and expectations of farmers, our analysis proceeds towards analyzing the object of the activity: what is crystallized in the artifacts used in the project and how these artifacts enter into the everyday activities of farmers. This may or may not match the object proposed in the project. In order to do this, we further analyze the developmental dimensions attributed to the motivational perspectives.

We classified the motivational perspectives according to: a) the societal and environmental benefits generated by the use of the artifacts, b) the spatial location or activity in which the artifact was used and c) the economic benefit generated by its use. Figure 1 summarizes the results.

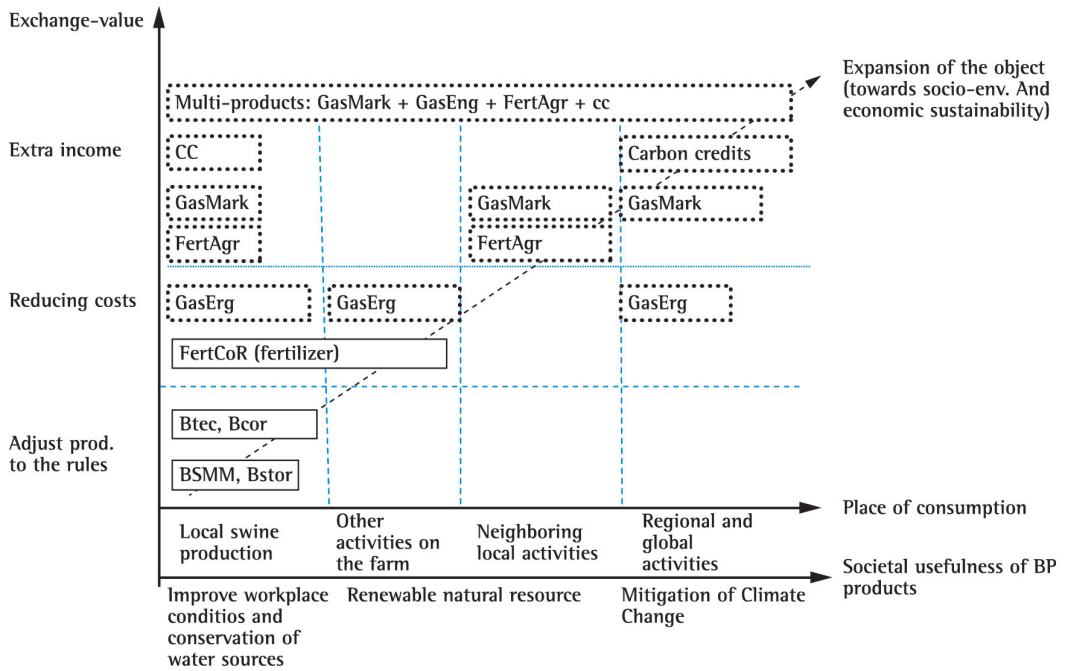

Figure 1. Dimension classification of motivational perspectives of BP.

Regarding the place of consumption, we identified four basic activities or sets of activities: 1) consumption in local swine production in which the products were used mainly to keep or improve working conditions in swine production, 2) consumption within other activities on the farm, 3) consumption within other neighboring activities, and 4) consumption by global activities. The lined boxes represent artifacts that were already being used, whereas the dashed boxes represent those that the farmers expected to use.

Regarding the value that the use of the artifacts generated, two dimensions were identified: the economic dimension and societal value. The economic dimension varied from use for adjusting or maintaining a certain swine production activity, to reducing costs and generating extra income. The societal usefulness generated by BP varied according to the artifact used (bio-fertilizer, biogas, energy and carbon credits). Some artifacts produced societal advantages at different levels (local, regional and global), while others, for example the bio-digester, generated only more local benefits.

In the next section we discuss how the perspectives of farmers and the food industry were related, the societal meaning of BP, and their strategic implications.

The differences of perspectives within the company and between farmers may be seen as expression of the division of labour in the production chain, and express the contradictory aspect of the object. The strategies for keeping rates of profit (concentration of production in area, reduced prices) was leading to negative undesirable effects in swine production, such pollution and reduction of income of farmers. The 3S Program was an attempt to attenuate these negative effects not by transforming the swine production (e.g. fair prices and changing technology) but by generating an extra external income (e.g. carbon credits and biogas) and adding new technologies for resolving the undesirable polluting effects. Biogas had many use-values such as treating the manure and energy, but the production of had a exchange value that restricted its use. Some individuals (e.g. Institute for Sustainable Production) emphasized more the use value, while the industrial and financial department emphasized the exchange value.

6. Discussion

6.1. *Societal meaning at different levels*

The analysis so far has shown the existence of multi-perspectives towards what was being produced and why. Farmers' uses and expectations varied from the technicians' simple satisfaction to the expectation to sell the gas for producing electricity and obtaining

carbon credits, to increasing the economic viability of the farm. The economic return or benefits gained through the production and use of biogas also varied, from the simple adjustments made to the farm in order to conform to environmental legislation so that swine production could be maintained or expanded, to cost reduction and even extra income generation.

Actors had different perspectives of BP, depending on the space or location in which the product was consumed. At the very local level its meaning was to treat the manure to reduce the environmental impact; at the national and global level to be a source of renewable fuel and to reduce the impact of the activity on climate change.

From the societal perspective, the most expansive and desirable solution would be to combine the production of biogas for carbon credits and the use of biogas for energy. By combining these two artifacts, BP would contribute not only to the treatment of the manure and to the reduction of the local impact on water resources, but also to the use of the biogas as a renewable natural resource and to maximizing the transformation of the methane in carbon dioxide, a green house effect that is 21 times less harmful to climate change.

From the production perspective, the different products (biogas, energy, bio-fertilizer, carbon credits) may not be mutually exclusive. One artifact may be produced simultaneously with another, and the maximization of one may lead to the maximization of the other. For example, maximization of the production of biogas for energy consumption on the market may lead to maximizing the reduction of GHG emissions and the treatment of manure.

6.2. *Differences and similarities in farmers' and food industry perspectives*

Regarding the use of BP for reducing production costs in swine production and as an extra source of income, the motivation of farmers and the food company's industrial department are both complementary and interdependent. Such interdependency is understandable as these two activities were tightly linked. Farmers supplied the material used by the food processing company. Thus, the farmers' challenges were indirectly also challenges for the industry and vice versa. In general, the food company recognized the need to improve farmers' economic and environmental conditions in order maintain a long-term supply. BP was used in both farming and the food processing company as an instrument for quantitatively expanding production. On the farms, BP increased storage capacity, facilitated adjustments to conform to environmental law, and in some cases increased storage capacity beyond that required by the law, in turn allowing the future expansion of production. The food company also used BP as an instrument to expand markets.

The overlapping of motivations regarding the use of BP within swine production can be explained by the historical development of swine production, which saw an increasing interdependence between the food industry and outsourced suppliers. The tightening of this relationship gives them common motivations. BP was an aspect of the increasing interdependence and tightening relationships between the outsourced farmers and food production.

However, the motivation for reducing GHG emissions was contradictory. The food industry's main motivation was that it wanted to be seen as an environmentally sustainable company. However, GHG emission reduction did not serve as motivation for farmers at all. The reduction of emissions could be used by the food company for evaluating the value of its market shares by participating in Indexes of Sustainability. Moreover, it could also be used as an indicator of sustainability for consumers.

Holland & Reeves (1994) relate the differences in perspectives to ongoing tensions and contradictions both within and outside an organization. They explain the differences in perspective as an outcome of historical contradictions. In line with this, the differences in the BP of the company's food production chain seemed to be an expression of the contradiction between the social and environmental aspects of swine production and the economic aspects.

The sustainability of BP required collaboration between outsourced suppliers (farmers), the staff of the company and the Sustainable Institute. On the one hand, in order to obtain carbon credits, pay back loans, reduce GHG emissions, and improve its image as a sustainable company, the company needed farmers to maximize biogas production. On the other hand, farmers depended on the company for installing and maintaining the bio-digesters so that they could use BP for making adjustments on the farms to conform to the environmental legislation, reducing costs in swine production and/or even obtaining some extra income. The commercialization of carbon credits and biogas products was a shared object that could facilitate this collaboration.

6.3. *Strategic implications*

Although, technically speaking, many products can be produced in complementary ways their actual use can require that the elements used in production follow a completely different logic. Engineers know

very well, for example, that the technology required for using biogas locally in farms differs greatly from the technology using biogas for electricity to be sold in the market. Moreover, the characteristics of the elements of the activity (type of division of labor, instruments and so on) also vary, depending not only on what is produced (e.g. biogas) but also on where and for what purpose it is consumed (to produce electricity, to be sold and consumed on the market). What is less considered is how the object may shape a general logic or principle to make the production of a certain product viable.

The strategy should be chosen to suit the object purpose of the activity. Production for local consumption requires attending to the local needs of farmers. The scale of production does not necessarily have to be large, and the technologies have to be adapted to the local conditions and needs of the farm. The organizational structure needed to produce and consume such a product may be the same as that of the organizational structure of the activity in which the product is consumed. However, the production of biogas for carbon credits may require a much more sophisticated technology recognized by certifying institutions. This standardization enables the scale of production and the specialization of tasks, which lead to a hierarchical and autocratic form of organizing work. Thus, the strategy used for making one product viable may not be the same for another product.

The application for carbon credits and the use of gas as bio-energy were potential instruments for expanding the object of swine production so that GHG emissions could be taken into consideration. Whether using gas either as bio-energy or for obtaining carbon credits, methane is burnt, and the effect on the emitted gases is considerably mitigated. However, carbon credits were not a strong motivation for farmers. A stronger motivating factor for them was the use of biogas to either reduce costs on the farm or to increase income. Carbon credits may, however, become a strong object if farmers were to get a share of the value. However, at the time of the last data collection, the application for carbon credits was not yet approved.

As previous studies have shown, other aspects also affect farmers' decisions to act (Pereira-Querol, 2011). Even though they were interested in using the biogas products in their activities, they could not do so because of the other aspects of the activity: a) lack of technology, b) financial resources, c) market, d) rules and so on. As Pereira-Querol (2011) points out, the adaptation of the BP project for obtaining carbon credits seems to require a technological structure that restricts the possibilities of the local use of the gas. The local use of biogas as bio-energy and the trade of carbon credits seems to require a different logic. The diversity of uses entails a way of developing the technology and a different organizational structure to coordinate these actions that is different to that currently being used by engineers to develop the BP project. To make biogas use possible, the technology would have to be developed and financed, and the product marketed. These actions require collaboration between the food industry, technology manufacturers, the biogas producers (farmers) and the potential consumers (electricity companies or even farmers themselves).

We mostly focus in the ideal aspect of objects because most of the objects (carbon credits, biogas) kept ideal and were not materialized. The non materialization of the object was actually the very problem that did make the object a motive able to direct the operational actions. In other words, objects such as carbon credits and the use of biogas as energy did not have the motivational power to trigger the required operational actions by farmers. We argue that to become a real motive with the power to direct actions, first the system for using it would have to be developed. For example for making biogas to become a "real" motivational object, some technologies for using the gas would have to be developed. At the time of last data collection the use of the biogas was very limited to replace natural gas for heating the chicken warehouse during the winter.

7. Final considerations

The fact that an object purpose is multi-voiced and composed of several products or sub-products leads us to the question of which products or perspectives to include in the object. The study suggests the existence of multi-perspectives of what is being collectively constructed; a collective object that incorporates the motivational perspectives of the actors. The 'success' of a sustainable technology appears not to require every actor to use an artifact in the same way, but that the object incorporates the motivational perspectives of the people involved in the activity. A particular perspective of the object leads an actor to take and use the artifacts in a particular way. The diversity of perspectives may be understood as the outcome of the division of labor within and between activities (the societal division of labor).

The analysis of this article suggests that the existence of a shared object is not enough to trigger actors to act if the object does not incorporate their needs. In this case, both the local use of biogas products and the commercialization of carbon

credits require further development of the means of production (technologies and organization). This suggests that the analysis of people's motivation to act cannot be limited to the object but should also include the mediators, such as artifacts, used to produce this object. This includes not only the technology but also the organization, rules and division of labor.

The case suggests that sustainable production requires not only the expansion of societal value, as sometimes is argued: "Farmers have to become conscious of the problem", but also the generation of local benefits to the activities that are producing them. The farmers knew, though in a different way, that their activity was causing environmental damage to the globe. The results suggest that the expansion of the societal and environmental benefits of BP should entail the expansion of economic benefits. This suggests that people's individual motivations are dialectically related to societal or collective ones. The societal meaning of a sustainable activity depends on the satisfaction of individuals' motivations, as individuals' motivation can only be achieved because the actions that they take produce artifacts that somehow produce societal benefits.

Rather than seeing different perspectives as fixed to individuals or actors, the study proposes that they should be attributed or linked to the tasks and activities in which people take part. Different actors are part of different activities, and therefore have different motivations regarding sustainable technologies.

Such issues could be anticipated if farmers were involved in the design process. As we argued in our introduction, a design process based on mutual learning between users and designers would give designers an insight into the context of use and its constraints, and allow for object definition in a collaborative process. From this perspective, we can say that technical innovation depends fundamentally on the design of the innovative social context of its design process.

We conclude that in order to Biogas Production to contribute to the sustainability of farmers, it has to contribute to the productive activity of swine production by generating extra income, or reducing costs; something that was not yet taking place in the analyzed case.

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