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Sub-theme 51: Valuation and Evaluation within and across Organizations.

SHORT PAPER

Analyzing valuation practices through contracts: the case of animal breeding under the genomic revolution.

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SHORT PAPER

Introduction

The relation between societies and animals is of increasing topicality in social sciences and more specifically organization studies (Haraway, 2008; Pina e Cunha *et al.* 2008; Hamilton and Taylor, 2012; Labatut *et al.* 2014; Drake, 2015). Industrial farming is highly criticized and animal biodiversity losses are recognized as a major threat for future generations. Moral and ethical values implied in our relations to animals are also under scrutiny. However, societies are far from stopping the “animal industry. Since the second half of the 13th Century, agriculture has been one of the most important fields of activity concerned by the development of counting, measuring and "probabilistic reasoning" (Power, 2004; Giraudeau, 2010). Animal genetics, linking since the 1950's genetic sciences and bioinformatics to economy, offers a great opportunity to address research questions to valuation processes (Dewey, 1944; Joas, 2000; Bidet *et al.*, 2011). Indeed, animals and plant genetics, alongside agricultural chemicals and fertilizers, were the two pillars of agriculture industrialization in the past century. Transforming the Holstein cow in a “milk machine” relied on the development of tremendous amount of numbers and calculative devices to evaluate and govern previously incommensurable living entities. This paper seeks to analyze the most recent changes in how societies value animals. We analyze this topic through the prism of contracts between breeding companies and farmers.

Literature review and research question.

An increasing area of research is the studying governmentalities associated with attempts to manage nature and the role that numbers play in the governance of nature (Enticott, 2001; Fourcade, 2011; Huault and Rainelli-Weiss, 2011). In the realm of animal productions and management, previous works (Gibbs *et al.* 2009; Labatut *et al.* 2011; Labatut *et al.* 2012; Labatut, 2013) have shown how government and scientists organized national evaluations of animal performances and genetic potential, creating public metrics to “govern at a distance” and exert a powerful discipline (Foucault, 1993; Power, 1997; Sauder and Espeland, 2009) on animal and farmers populations. This apparatus of national evaluations has recently been subject to disruption. The liberalization of animal breeding markets and the development of new evaluation technologies (genomics) suggest the emergence of a new

regime of measurement (Espeland and Stevens, 2008). We argue in this paper that valuation practices involved in the Holstein breeding industry in the new “genomic era” can shed light on substantial recent changes in the government of animals and human populations.

Valuing animals.

Doganova *et al.* (2014) emphasize the analytical fruitfulness of moments of innovation for analysing valuation practices. « The “de-scription” (Akrich, 1992) of valuation devices, which can be seen as a form of critique, is made easier in moments when valuation techniques and practices are contested and new ones are proposed » (Doganova *et al.* 2014). The case of animal breeding activities is a perfect empirical case for analyzing valuation practices in as much as they have been subject to two main changes recently: first, the diversification of values that societies assign to animals (food production but also biodiversity conservation, landscape maintenance, climate preservation, etc...); second, the emergence of new evaluation methods: genomic technologies. Genomics are a breakthrough innovation in animal breeding: it radically changes how animals’ genetic and economic values are created. These two trends are not disconnected: genomic technologies are often presented by scientists as a mean to evaluate animals on more “sustainable” criteria, previously very difficult to measure, such as green-house gases emissions or resistance to diseases (Institut de l'Elevage et INRA, 2011).

Society assigns different values to animals by society and mobilizes various indicators to describe them. For instance, animals are associated to market values (their price on the livestock market), genetic values by selecting sires and high performance females through indexes calculated on a large number of criteria (milk performance, milk quality, udder, calving ease etc.), a legal value when animals are to be recognized as “non-human person” or “sentient living beings, or aesthetic and sentimental values reflected in farmers’ work (participation in animals’ competitions, knowledge of animal lineage etc.). Scholars have started to analyze conflicting values on animals. Thus, Holloway (2005) examined “intertwined modes of bodily evaluation and genetic understanding evident in relation to ‘modernizing’ tendencies in contemporary agriculture, using a case study of pedigree cattle breeding”. However, much more remains to be done to understand how new technologies in the realm of living entities and incommensurable things change the way societies value, evaluate and govern animal populations.

Cattle genetic selection: from a 5 years evaluation process to an instantaneous evaluation.

Before genomic development, animal breeding relied on breeding programs based on “progeny-testing” method. This method involved choosing the best animals compared to the real performances (recorded) of offspring and ancestors. Breeding companies bought young calves from the best cows to farmers and waited five years until these calves became bulls with enough progeny (thanks to frozen semen and artificial insemination diffused in farms all over the country) to be evaluated thanks to geneticists’ statistical models. This type of genetic selection was based on real performance (phenotypic measures) and genetic value was estimated with statistic models and official indexes calculated by geneticists from national R&D institutes. “Progeny-testing” was a very long and costly process: evaluating one bull would cost about 10 000 euros, and breeding companies would definitely keep only one bull out of ten for commercial diffusion (frozen semen). The few bulls selected at the end of the process could then become “stars” in the livestock industry. For example, Jocko Besne produced 1.730.000 sperm straws, engendered tens of thousands of daughters around the world, and there is a sculpture of him on a roundabout in Brittany. With genomic selection, since 2009, the evaluation process is reduced from five years to an instantaneous evaluation (DNA analysis). As a result, many more bulls can be evaluated at lower cost (a genomic evaluation costs less than 80 euros).

Genomic selection is a change in the evaluation method used to select animals, not a technology for modifying DNA. This new “valuation technology” is based on DNA analysis to estimate the genetic value of animals with genome-wide dense markers on DNA chips. The first step consists in collecting data to create a “reference population” (a subset of animal population with large number of bulls and cows with genotypes and phenotypes). It allows to link genotype (gene sequences) to phenotypes (animal performances expressed) with equations’ predictions. These equations allow estimating the genetic value (Estimated Breeding Value – EBVs) of unphenotyped animals (young bulls, heifers, and even unborn animals such as embryos) using genotyping technology. Lastly, genetic indexes are calculated for each targeted performance criteria (milk production, fertility, etc...). These indexes are considered as the reference for animal genetic value on the genetic market for breeding companies and farmers.

Breeding program efficiency to produce genetic gain on defined performance objectives depends on the identification of the best animals in the animal population, which is distributed across all farms worldwide. This procedure exploits the potential to produce generations with higher genetic values. In a competitive environment, breeding companies have to be the first ones to find a promising cow in farmers' herds and to establish contracts on this animal with the farmer.

Breeding contracts: a mean to study animal valuation.

Contracts are an interesting object of study for examining value and valuation at the crossroads of sociology, economics, law and management. They support inter-organizational cooperation and reorganize markets. As a socio-technical mean of calculation and mediation between different types of values (not only economic ones), contracts account for and value something that does not already exist.

In the breeding industry, breeding companies establish partnership with farmers to valorize interesting animals through contracts. They sign a contract on a young cows to make them produce embryos or young calves with selected and sexed semen from the best bulls available on the breeding market (on bulls catalogues). A variety of contracts exists, corresponding to different levels of interest or value of females as identified by breeding companies. They can be called "strategic", "resource", "reference", etc... according to the nature of the value given to the cow object of the contract and its potential to give birth to more or less high value animals. A contract's stratification implies rights and duties for contractors. Their content, rewarding (royalties) and fulfilment system provide contracts with an ability to materialize values assigned to animals in the genetic creation process. Contracts on breeding animals are both an instrument of coordination between breeding companies and farmers and a process ranging from their design to their intended and unintended uses. They involve different types of actors: the managers of the breeding program in the breeding companies who design the contracts, the breeding program technicians who identify the animals and visit the farmers to sign the contracts, the farmers, the animals, etc...

Research question.

How valuation processes are involved in contract design and use (for example in the case of life insurance contracts) is an important but incompletely understood issue. This question has been mainly addressed in financial studies, through the development of valuation

methods and models in the realm of financial accounting and economic mathematics. Our aim is to open the black box of contracts designed for setting agreements on living entities and intangible goods, and to focus on the nuts and bolts of design and implementation processes of valuation contracts on animals. How are contracts designed? How are animal values integrated into contracts and predicted by them? How do contracts redefine actors' power and knowledge (both human and non-human)? Through breeding contracts, how do genomics as a new "valuation technology" increase or diminish calculation capacities of certain kinds of actors? How do contracts extend the jurisdiction/authority of specific actors?

Focusing on new valuation practices and qualification of breeding animals, we question the evaluation of difficult commensurable entities (animal, embryo, mating) and the impacts of these valuation and qualifications on government of living entities.

Research design

Data collection and analysis.

This case study focuses on the selection of Holstein cattle in France and especially on how breeding companies and the farmers evaluate and value the best animals for genetic creation. This breed was the first in France and worldwide to be selected with genomic technologies in 2009. Three French breeding companies manage a Holstein breeding program and use contracts to find the best cows and sires in farms for the next generation of the animal population.

The data collection was carried out in three stages. First, contracts ("partnerships" and "genetic creation" documents) were collected from breeding companies. In a second step, other information was gathered through observational sequences and ethnographic interviews with technicians in farms. Finally, several semi-structured interviews were conducted with breeding programs' managers from breeding companies other technicians involved in the genetic creation and farmers involved in the breeding program.

To analyze the valuation practices involved in animal breeding, we followed two steps. First, we opened the black boxes of contracts by describing how they were designed and written, how they embodied animal present and future values. Second, we analyzed contracts and valuation "in use" and their effects on actors' power and knowledge.

Findings

The contracts we studied are partnership agreements between a breeding company and a farmer. Their purpose is to define the rights and obligations of the parties related to “exclusivity” or “priority” granted by the farmer to the breeding company for a specific animal object of the contract: a female (heifer or cow) belonging to a farmer. The breeding companies select a first group of females according to the genetic value of their parents. These females are then genotyped and evaluated thanks to genomic evaluation. This evaluation can be paid by the breeding companies (for the females with the highest potential) or by the farmer (when the genetic potential is less important). The result in terms of genomic evaluation and genetic interest (pedigree’s originality, feature’s superiority...) for the company’s genetic needs determines whether or not the female can be subject to a contract. Thus, diverse types of contracts correspond to the range of females’ valuation: strategic contracts for “strategic females”; contracts references for “reference females” or resource contracts for “resource females” etc. Then, the female is not used for its *production capacities* but for its *reproduction capacities*: it is used to produce embryos and calves.

The first part of the contracts is devoted to the definition of animal categories ("female", "herd", "generation"...), evaluation and reproduction methods (" genetic analysis ", " genotyping...), actors and organizations ("Station", "network" ...). For example, a "strategic female" is defined as a "female valued by [the company] to its major genetic value and exploited in its breeding program, being the subject of an application contract ‘exclusive strategic’ or ‘strategic priority’ ". We will develop in the full paper the role of these definitions and their hidden hypothesis on animal values, how they evolved since the development of genomic technologies, and how participants interpret them.

Once the contract is signed, the farmer receives a first pay of 1,000 euros, including 250 euros "for the female renting or its female reproductive system renting". This part shows what is valued in a cow for breeding programs: it can be the female in itself, or more specifically its “reproductive system”. In terms of commoditization of nature, we should distinguish commoditization of animals as a whole and commoditization of specific “functions” or specific parts of animals. What breeding companies rent are ovaries, not cows. Concerning embryos collection, the farmer has the choice to keep his young cow in his farm (and the breeding company collect embryos on the farm) or to give it to the company’s “embryos production station”. The embryos sales conditions in the contract indicate the

existence of two embryos' classifications ("optimal" and "capital"), which determine the rights and marketing conditions defined on these embryos. Once female and male calves resulting from insemination or embryo transfer are born on the farm, they are genetically evaluated (genomics). If the first genetic evaluation of a male calf is of interest for the company, it is reserved and must stay in the farm until removal. The farmer receives a first payment by the company, based on a price by animal's weight. If the animal is then qualified to be a future breeding bull, additional compensation is given to the farmer. The choice between these modes of compensation has been made at the time of signing the contract, i.e. before insemination: a pre-definite compensation or compensation based on the benefits made by the company on the bull future semen's sales.

Discussion and concluding remarks

This study shows that after genomic selection development, issues surrounding the valuation of animal genetic resources have increased. These strategic resources are the subject of evaluation and qualification process through the use of tools (contracts) by breeding companies and farmers. Contracts are one of the instruments for commoditization of living entities.

First, the market for animal genetics is segmented: bulls and their semen are marketed in different categories (production, longevity, quality, equilibrium, etc.). We discuss how market segmentation of male (genotyped sperm's straws) and females (genotyped heifers and cows) has effects on sires' evaluation.

Second, we discuss how "valuation technologies" can have effect on the type of entities to be valued. With genomic technologies, animals can be evaluated much earlier. Thus, the "strategic" animals are much younger than before: cow and tested bulls are of less interest to breeding companies and clients. The strategic animals are heifers, very young sires and even not yet existing animals: embryos.

Contracts constitute a micro and macro lenses to understand how an industry value animals on the market. This paper shows how contracts can help us better understand valuation practices, which is a "common object" of study in economic and organizational theory, but which has barely been employed to study the relations between nature and culture from a sociological point of view.

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