FRONTEIRAS
Journal of Social, Technological and Environmental Science

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*Article*

# Science and Agribusiness in the History of Pig Factory Farming in Ontario

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**Abstract:** The article explores some of the connections between science and agribusiness in the history of pig factory farming in Ontario, Canada, between the 1950s and the present. The factory farm model of pig production submits animals to a very artificial way of life, which would not be possible without the inputs of scientific and technological innovations of the 20th century. Topics discussed include the use of antibiotics, swine nutrition, feed conversion (in)efficiency, and pork promotion and consumption. The primary sources utilized are a trade magazine, a census of agriculture, and other government and industry publications. The article sheds light on how notions such as "progress", "improvement", "modern" or "efficiency", frequently used by scientists when referring to results of pig production, are restricted to narrow or internal considerations of the industry that, in turn, can be challenged by broader analysis of aspects (social, economic, environmental) of the food system. Scientists have not just produced scientific knowledge but in some cases have also promoted ideologies about animals and the food system. These ideologies of "progress", "improvement", "modern" or "efficiency", as in the context of pig production in Ontario, only make sense if we understand the particular historical moment in the analysis, which since the 1950s has markedly been one of strong agribusiness interventionism.

**Keywords:** Pig Factory Farm; Ontario; Swine; Science and Agribusiness; Pork.

**Resumo:** O artigo explora algumas das conexões entre ciência e agronegócio na história da suinocultura industrial em Ontário, Canadá, entre os anos 1950 e o presente. O modelo industrial de produção suína submete os animais a um modo de vida muito artificial, que não seria possível sem as contribuições das inovações científicas e tecnológicas do século XX. Os tópicos discutidos incluem o uso de antibióticos, nutrição de suínos, (in)eficiência na conversão alimentar e promoção e consumo de carne de porco. As principais fontes utilizadas são uma revista comercial do setor, o censo da agricultura e outras publicações do governo e da indústria. Argumenta-se como o uso frequente das noções de "progresso", "melhoria", "moderno" ou "eficiência" por cientistas que se referem aos resultados da produção suína é restrito a considerações estreitas ou internas da indústria que, por sua

Citation:

Carvalho, M.; Science and Agribusiness in the History of Pig Factory Farming in Ontario. Fronteiras: Journal of Social, Technological and Environmental Science 2021, v.10, n.2. https://doi.org/10.21664/2238-8869.2021v10i2.p187-199

Received: 25/05/2020

Accepted: 08/06/2021

Published: 31/08/2021

vez, pode ser desafiado por uma análise mais ampla dos aspectos (sociais, econômicos, ambientais) do sistema alimentar. Os cientistas não apenas produziram conhecimento científico, mas em alguns casos também promoveram ideologias sobre os animais e o sistema alimentar. Essas ideologias de "progresso", "melhoria", "moderno" ou "eficiência", como no contexto da produção de suínos em Ontário, só fazem sentido se entendermos o momento histórico particular em análise, que desde a década de 1950 é marcado por um forte intervencionismo do agronegócio.
**Palavras-chave:** Suinocultura Industrial; Ontário; Suíno; Ciência e Agronegócio; Carne de Porco.

## 1. Introduction

In this article, I will explore some of the connections between science and agribusiness in the history of pig factory farming in Ontario, Canada. The factory farm model of pig production submits animals to a very artificial way of life, a model that would not be possible without the inputs of scientific and technological innovations of the twentieth century. In turn, these innovations do not derive from a linear or natural development of science. Instead, they are rooted in a broader historical context, in which agribusiness corporations have been gaining increasing influence on the food system. In this sense, I agree with Kees Jansen and Sietze Vellema (2004, p.10) that "technology innovation is neither an autonomous process driven by inner scientific logic nor a simple result of the operation of market mechanisms."[1] This implies that technological and scientific innovations also are depending, to some extent, on social and political choices. The analysis draws on primary sources such as a trade magazine that existed between 1965 and 1974 (*Hog Production*), a census of agriculture, and other government and industry publications.

Tony Weis (2013, p.100, 101) has proposed in his assessment of the global industrial livestock production that we should be critical of the notion of efficiency in this kind of production, for this notion is often ideologically built by focusing on very particular and arbitrary criteria. Moreover, it obscures or underestimates many externalities involved in the process. Accordingly, we should be better prepared to understand that what is described as "progress" or "modern" in scientific innovations related to animal production is often more an ideological notion of a particular social setting than real progress or advancement to the better. These and other ideas are explored in the context of pig production in Ontario throughout this article. Since the factory farming model is increasingly a global phenomenon, the analysis will be useful to understand other contexts worldwide.

I explore critically the scientific ideas promoted in those years, but with respect for that historical context and those scientists, considering how incomplete scientific knowledge always is. As it has been explained the great philosopher of science Karl Popper (1995), who claimed for a humble Socratic approach to knowledge, science is always incomplete and limited, but we can improve it by using reason and critically debating its content.2. Scientific Innovations and Factory Farms

The relationship between science and pig production – as well as other forms of agricultural production in general – dates back at least to the second half of the 19th century in Ontario and other places, when agricultural colleges were established and a more systematic effort to apply recent

[1] A similar approach to science as an enterprise that is influenced by historical context is adopted by Kloppenburg (2004, p.21), who argued that "the immediate requirements of economy directly stimulate the pursuit of particular avenues of scientific research."

scientific knowledge to agricultural production was made. Nevertheless, we can argue that it is only after the 1950s and 1960s, with the adoption of the factory farm model of production, i.e., total confinement operations with high density of animal populations, that this relationship became stronger and impossible to separate. Before that, farmers raised their pigs with a much higher degree of independence from scientific innovations, although the connections between farmers, agricultural representatives, and agricultural colleges should not be completely neglected. As a matter of fact, these connections were increasing during the first half of the twentieth century. Before the 1950s, for instance, breeds and the knowledge behind them were not scientifically matured enough and the process was heavily dependent on traditional knowledge of breeders (Derry 2015, p. 91-93). Antibiotics started to be mixed with feeds in the 1950s.[2] Those feeds, chosen among those traditionally known for decades to the farmers, were also not scientifically balanced and only general technical criteria were observed. Considering all these changes, it is certainly not an accident that the term "agribusiness" appears just in 1955, coined by professor John H. Davis, from Harvard Business School (Hamilton 2009, p. 23).

To understand better this new phase of more scientific and technological innovations influencing pig production, it is useful to look to the changes in numbers that the agricultural census present, for they help reveal the qualitative shifts in swine husbandry, which has changed from a more farmer-like (or traditional) activity to a more scientifically and business-oriented enterprise. We can deduce from the census the inception of factory farms in Ontario as well as the extent to which this process was rather gradual and heterogeneous

**Table 1.** Farms reporting pigs in Ontario (1951-1961).

| Pigs (all ages) | 1951 | 1956 | 1961 |
|---|---|---|---|
| All farms reporting | 93,564 | 73,053 | 56,378 |
| 1 pig | 6,199 | 4,640 | 2,871 |
| 2 pigs | 8,835 | 6,313 | 4,238 |
| 3 -7 pigs | 16,553 | 12,141 | 8,685 |
| 8-12 " | 15,326 | 11,627 | 7,204 |
| 13-17 " | 10,391 | 7,675 | 5,333 |
| 18-32 " | 20,707 | 16,058 | 11,619 |
| 33-47 " | 8,571 | 7,365 | 6,388 |
| 48-62 " | 3,760 | 3,523 | 3,876 |
| 63-77 " | 1,502 | 1,637 | 2,063 |
| 78-122 " | 1,269 | 1,464 | 2,528 |
| 123-177 " | 289 | 341 | 851 |
| 178 pigs and over | 162 | 269 | 722 |
| **Total number of pigs** | **1,753,000** | **-** | **1,686,000** |

Source: Statistics Canada 1961; White et al. 2007, p.2-17.

[2] Regarding the use of antibiotics, Susan Jones (2002, p.107) considers it as perhaps "the 1950s' single most important development in animal production".

As it can be seen in Table 1, the number of farms reporting less than 32 pigs declined sharply between 1951 and 1961, while the number of farms reporting more than 63 pigs increased despite the considerable decline in the total number of farms reporting pigs in the same period. The fact that the agricultural census of 1961 shows the biggest pig farms of that year under the category "178 pigs and over" is a testimony of the comparatively small operations of that time.

When we aggregate the data of the census of agriculture from 1951 to 1981 we can see clearly a significant increase in the number of large pig farms.

**Table 2.** Farms reporting pigs in Ontario (1951-1981).

| Farms reporting | 1951 | 1961 | 1971 | 1981 |
|---|---|---|---|---|
| 1 or 2 pigs | 15,034 | 7,109 | 2,261 | 5,510 (1 to 17 pigs) |
| 178 pigs and over | 162 | 722 | 3,222 | 4,797 |
| 528 pigs and over | Not available | Not available | 513 | 1,546 |
| 1,128 pigs and over | Not available | Not available | Not available | 331 |
| **Total number of pigs** | **1,753,000** | **1,686,000** | **2,362,000** | **3,166,000** |

Source: Adapted from Statistics Canada 1961; Statistics Canada 1971; Statistics Canada 1981; White et al. 2007, p. 2-17.

A bulletin published probably in 1959 by the Ontario Department of Agriculture (1959), is revealing of this transitional period of swine husbandry that the numbers of the agricultural census suggest. Designed to provide advice to farmers and technicians, the bulletin presented a mix of traditional (or older) and modern scientific knowledge regarding pig production.[3] Another publication of 1975 by the Canadian Pork Council (1975, p. 21) also points out that "during the past 20 years industry technology has exploded with a proliferation of new ideas, concepts and designs". In addition, this last publication demonstrated that the new way of pig production had economic consequences whose far-reaching effects went beyond the farm gate:

A few years ago it was difficult to obtain a loan because hog production was considered a fairly high risk. However, with improvements in technology, management practices and buildings, hog production is rapidly becoming a recognized industry with a good financial track record (Canadian Pork Council 1975, p. 26).

### 3.Antibiotics, Nutritional Science and Manure

One key scientific innovation that if not made them possible, then at least greatly facilitated these concentrations of pigs in totally confined barns that became a central feature of factory farming from the 1950s onwards was the antibiotic. It was used preventively both in order to avoid diseases that can appear in high densities of confined animals and in order to promote more accelerated growth. In the pages of *Hog Production*, a trade magazine launched in 1965 in this context of spreading of the factory farming model in Ontario, several advertisements of antibiotics can be seen since the first issues. Referring to the Canadian context, Dr. G. F. McNaus, from Elanco, a veterinary division of the giant pharmaceutical Eli Lilly & Company, explained in 1970 the recent changes of that time in livestock production, including swine:

[3] It can be inferred that the year was 1959 because the bulletin presents several recent developments and tables for the years 1957 and 1958. (Ontario Department of Agriculture 1959)

> The addition of antibiotics to the rations of livestock has been practiced for the last twenty years. It has only been during the last five to seven years that antibiotic use has become as widespread as it is today. This increased usage parallels the development of the huge poultry, swine and cattle feedlot operations. As the size of the operation increases, so also does the threat of disease outbreak resulting from the many stresses common to livestock production. It is now standard procedure to add antibiotics to the feeds to prevent disease and thus assist in maintaining a profitable enterprise (McNaus 1970, p. 6, 7).

In the rest of the two-page article, the author continues to address other aspects of antibiotics and the risk that its usage in animal agriculture would contribute to the promotion of resistant bacteria that could be dangerous for human health, an issue still debated today. If this issue proves to be definitely a dangerous path to public human health inaugurated with factory farming, this kind of innovation will be seen in the future not as progress, but as a misleading way of scientific development of the 20th century. In this regard, the World Health Organization affirms that the era of post-antibiotic – in which common infections and injuries can kill - is near, and that is "a very real possibility for the twenty-first century (Reardon 2014)."

Another important kind of scientific knowledge which was essential to the formation and development of pig factory farm in Ontario and elsewhere was the development of nutritional science used to provide a more efficient feed so that pig productivity could be enhanced. The publication "100 years of pork progress", by Aker et al (1988), and published by the Ontario Ministry of Agriculture and Food, explained how the scientific approach to pig food changed from the food itself to the nutrients that it contained. Instead of thinking about corn, wheat or skim milk, for example, the approach changed to amino acids and their quantities, vitamins and minerals. This kind of approach paved the way to the corn-soybean meal enriched with synthetic vitamins and minerals after the 1950s. This publication highlighted the convenience derived from the new approach and technology: "Supplying vitamins and minerals for a grower diet was once a lot more difficult than emptying a 25kg bag into a feed mixer as it is done today (Aker et al 1988)."

In this context of swine nutrition, one much praised and cited development is the increase of feed conversion into meat throughout the twentieth century. Again, the publication "100 years of pork progress" mentioned how that rate improved in Ontario from 4 or 4 and a half kg of feed to 1 kg of meat in the late 1930s to less than 3 kg of feed in the late 1980s (Aker et al 1988). What is never mentioned in this kind of calculation is that more than half of nutritious grains are simply wasted in form of manure and through movement, dissipated heat, and other physiological processes. In other words, factory farms consume more food than it produces.[4] If we think of the notions of "efficiency" and "productivity" considering how the pig production contributed to feed people in Ontario and other countries (through export) in the broader social context of the food system, we see how narrow or ideological these notions of "progress" or "improvement" are. In this sense, we can even consider factory farming as an "anti-food" system. In fact, this discussion about the wasting of precious grains in factory farming dates back at least to the book "Diet For a Small Planet", by Frances Moore Lappé, published in 1971, in a time where this model of production was still in its

[4] The total amount of feed used to confined animals, most commonly a mix of corn and soybeans, is in general richer in nutrients (calories, amino acids, total protein, carbohydrates, minerals and vitamins) than the output in meat that they produce. This is not surprising if we consider that animals are not very efficient "biological machines" converters of plant material. The only nutrient that plants cannot provide to humans is vitamin B12, which since its discovery in 1948 has been much easier and cheaper to provide through microbial fermentation than through meat production.

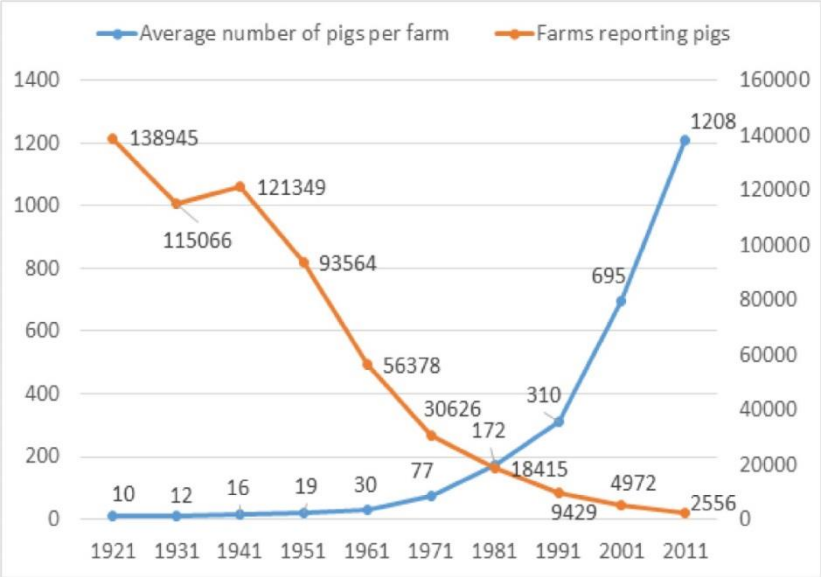
early steps in the developed world (Lappé 1971). It is also interesting to note in this kind of discussion that scientists usually omit or forget that plants can also be improved so that they can be more efficiently converted into energy or any particular nutrient for humans.

One topic related to these notions of feed conversion (in)efficiency is how manure has sometimes been misleadingly portrayed as a "fertilizer". With the increasing size of factory farms, manure disposal became a rather serious issue, for even if manure was spread over the ground it caused strong and unpleasant odour. Moreover, the excess of manure could easily contaminate the soil, groundwater, streams, not to mention the residues of drugs used in animals that would eventually end up mixed with it. We can see through the pages of *Hog Production* that the problems related to manure received more attention in the late 1960s and early 1970s, following neighbour complaints about odours and concerns about water quality (Spencer, 1970, p. 14).[5] In the issue of March 1966, in an advertisement of slotted floors, it was presented the advantage of collecting manure so that it could be used as "fertilizer" (Hog Production 1966). On the other hand, in an article of December 1969, the author explained that, when compared to synthetic fertilizers, manure was not economically viable to be used as a "fertilizer" (Dale & Mentzer 1969). Even though different positions on the subject have been reproduced in the publication, the prevailing view was that manure could be used as a sort of fertilizer. Considering these examples provided by primary sources, it is understandable that scholars sometimes fall into the simplistic idea that animals are magical producers of "fertilizers", while in fact they just use energy from plant material and transform the remaining part of it into a form of pollution or at best, into a less concentrated form of energy and nutrients after the inevitable losses in heat, movement and physiological processes.[6]

Combined with all the other developments in swine nutrition, antibiotics meant that pig producers now had a more reliable pig feed and output productivity. Therefore, they could invest more money in other aspects of industrial livestock production, like installations with temperature control, slotted floors that would facilitate manure handling, as well as automatic feed and water equipment. The fact that the total capital value of Ontario farms went from 2.5 billion Canadian dollars in 1951, to 6.9 in 1971 and 31.3 in 1981 (Norry 1985, p. 85) is fairly revealing about this understanding of how farms were becoming more like factories, i.e., operations more dependent on high investments in buildings, equipment and drugs provided by several corporations. Considering this growth of agribusiness, it is also useful to see how the total provincial, federal and private sector investments in agricultural research, production-oriented extension and agricultural education in Ontario went from 9.9 million Canadian dollars in 1950, to 58.19 in 1970 and 141.48 in 1980 (McEwen & Brinkman 1985, p. 118). All these numbers for the general situation of Ontario farms are also suggestive for the swine industry in particular, in which there has been an increasing trend since the 1950s for larger operations to be concentrated in the hands of fewer producers as well as for an increased dependency on scientific and technological innovations.

[5] It is also likely that the discussions in Ontario about the problems caused by manure from factory farms were influenced by discussions that were taking place in the United States. About this issue, and with a case study in Iowa, one of the centers of pig production in the United States, see Anderson 2009, p.131-137.

[6] One example is Mark Essig in his study on the pig, when discussing the role of pig manure in traditional Chinese agriculture. There is a passage in which he argued that "the pig functioned as a composting machine, transforming coarse vegetation into precious fertilizer." Essig 2015, p.116.




**Graph 1.** Average number of pigs per farm and number of farms reporting pigs – Ontario (1921-2011). Source: SOURCE: White et al. 2007, p. 2-17; Brisson 2014, p. 9.

In this context of increasing concentration we can see, for example, in the pages of *Hog Production* in 1965 a two-page article titled "How To Feed 1000 Pigs!: With One Man and $40,000". The farm was located in Waterloo County and "the proud owner is Donald Engel who has just gone into producing hogs in modern and big way" (Hog Production 1965, p. 15, 16). The article presents several pictures to show the reader what should be presented at the time as a marvel technology.

To maintain and increase the profits of this industrial livestock complex related to pig production, it was essential to have support from private and public research institutions. One important form of government support were the six laboratories set up in Ontario to diagnose diseases in animals, train veterinarians and assist in research, with five of them located in agricultural colleges (Hog Production 1970b).

Among the pig producers and breeders, it was created in 1966 the Canadian Swine Council (later, Canadian Pork Council), representing all the provinces according to the amount of production, and funded through a collection of one cent per hog marketed (Hog Production 1972b, p. 14). The Council asked the provincials and federal government for more money into pig research based on the economic justification that while hogs "formed 12 per cent of total cash receipts, hog research only received two percent of research allocations." To the economic survival and prosperity of the swine industry, it was stressed "the pressing need of improved research" so that "maximum producer efficiency" could be achieved (Hog Production 1972b, p. 13). Accordingly, not only were the funds considered insufficient, but also the Council was demanding a reorganization of the research funding logic at colleges:

> Eric Alderson, Past President of the Canadian Pork Council, says that the granting of research funds usually depends on the reputation and location of the researcher who has applied for the grant. The Council feels that priority should be given to research into areas of greatest importance to the industry (Hog Production 1972b, p. 13).

Consequently, it was suggested the formation of a national hog research council to set up and organize research programs.

**4. Pork Consumption Promotion**

Another important topic that is fairly expressive of this view of science as a tool for agribusiness interests is the search for expert endorsement for pork consumption promotion. The Pork Council "asked the Government Food Advisory Services and the Food Research Institute for assistance in better portraying pork as the high-quality nutritious food" (Hog Production 1970a, p. 3). The Ontario Pork Producers Marketing Board also set up an "information arm", the Ontario Pork Institute, and in 1972 expended $150,000 in a campaign to promote the consumption of pork. The campaign targeted several different people and utilized various methods to accomplish its goals, such as radio, television, and press interviews, but it also included the scientific community through "textbooks for use in home economics and food science classrooms" (Hog Production 1972a). This expenditure amounted to one million Canadian dollars in 1979. In a document from 1991, again it was reinforced the importance of engaging the scientific community to promote pork:

> Promotion activities today are more exciting than ever. New point-of-purchase materials are developed to inform the consumer that pork is a lean meat. Health and nutrition specialists receive up-to-date material on the value of pork in the diet, while more fine restaurants are including pork dishes on their menus. Education kits are continually updated, refined and streamlined to meet the needs of today's schools at all curriculum levels (Ontario Pork 1991, p. 19).

In the efforts of promotion, the Pork Council allied to institutions such as the Beef Information Centre, the Canada Sheep Council and the Canadian Meat Council in order to portray meat as an obligatory type of food that "should be included in a balanced diet" (Beef Information Centre et al. 198-?.) Supported by powerful lobby institutions of the US, like the American Meat Institute, pork and meat in general were described as a source of "complete proteins" by scientists, while plants were considered only "incomplete proteins" (Canadian Pork Council 1975, p. 98). In contrast, since the 1980s, with more extensive and reliable scientific studies of populations that do not eat meat, it became clearer that plants can provide more easily all the amino acids required than it was thought before and that meat is rather a matter of option. At the same time, it has become more evident to see how this scientific knowledge about protein fitted well in economic strategies to increase or at least maintain meat consumption levels among the public (American Dietetic Association and Dietitians of Canada 1980; American Dietetic Association 2009; Leitzmann 2014). It is also interesting to note that, since the 1950s, scientists have already known that a plant-based diet mainly composed of corn and soybeans fitted very well for pigs – whose nutrient requirements and physiology are very similar to humans and that are classified as omnivore animals - in rapid growth (Cromwell 2009).

Not only was this expert endorsement useful to pork and other meat promotions in a more direct way, but also it was crucial to guarantee that meat was put in a special place in dietary guidance recommended by the Canadian government. As noted by Rima Apple, who studied what she described as the "ideology of meat" throughout the 20th century, meat has been portrayed as one of the most important "groups of foods" (Apple 2010, p. 136,137; Health Canada 2019).

As it can be seen in Figure 1, meat and animal products occupy half the space of the food groups, which is revealing about the lobbies of livestock industries. It also helps to explain the enormous increase of meat and other animal products on the food habits developed through the course of the second half of the twentieth century (Weis 2016).


Figure 1. "Groups of foods" according to an informative leaflet – 1980s. Source: Beef Information Centre et al. 198-.

Besides the issue of protein, the pig industry was also concerned about the issue of fat, for the position of the American Heart Association since 1964 was to link excessive animal fats (which are in general more saturated and contain cholesterol) intake to heart disease (Canadian Pork Council 1975, p. 100). An article regarding this issue was published in *Canadian Pork* (former *Hog Production*) in January 1973, titled "Speak Out Or Lose Markets":

> Exclude animal fats from the diet and you will help prevent heart disease. This has been the cry from many scientists and many groups such as The American Heart Association. In a paper presented to the American Meat Institute Foundation in Chicago this year, however, George V. Mann, of the Department of Biochemistry Vanderbilt University School of Medicine, Nashville, Tennessee, dammed these statements calling them a shameful chapter in medical science (Pembry 1973, p. 12).

We understand better these efforts to promote pork taking into consideration that while the consumption of beef and particularly that of chicken was increasing in those years, pork remained more or less constant on a *per capita* basis, but still growing in total consumption, considering the population increase.

**Table 3.** Meat consumption per capita (kg) in Canada (1935-2000)

| Years | Pork | Chicken | Beef | Total* |
|---|---|---|---|---|
| 1935-1939 | 18.0 | N/A | 24.8 | 53.4 |
| 1940-1944 | 25.4 | N/A | 27.4 | 63.5 |
| 1945-1949 | 22.8 | N/A | 28.7 | 61.9 |
| 1951-1955 | 23.4 | N/A | 27.9 | 60.6 |
| 1960 | 25.9 | 9.5 | 31.7 | 74.4 |
| 1965 | 23.6 | 10.0 | 37.9 | 82.9 |
| 1970 | 29.0 | 14.2 | 38.3 | 91.7 |
| 1975 | 25.6 | 13.0 | 47.4 | 95.1 |
| 1980 | 32.2 | 16.9 | 38.8 | 95.5 |
| 1985 | 29.0 | 19.3 | 37.9 | 94.0 |
| 1990 | 26.1 | 22.1 | 34.0 | 89.8 |
| 1995 | 27.8 | 24.8 | 31.8 | 92.3 |
| 2000 | 28.7 | 29.1 | 32.0 | 98.2 |

Source: The Special Committee on Farm Income 1959, p. 7. White et al. 2007, p. 4-3.

* From 1935 to 1955 the total does not include chicken, and includes pork, beef, veal, lamb, mutton, offal and canned meats. From 1955 to 2000 the total includes pork, chicken, beef, fowl, turkey, veal and lamb.

In this context of a battle for markets between different sectors of the meat industry, we can find more examples of this quest for scientific support for pork in Ontario. In May 1974, *Canadian Pork* presented a short report called "Skinny Pork":

> A promotion campaign entitled "Shape Up With Today's Pork" will be launched May and June for the calorie conscious by the Ontario Pork Institute. The idea comes from a study by meat scientists at the University of Guelph which shows that pork has less fat, fewer calories and more protein than other meats. The Ontario Pork Institute points out that pork has been placed on the diet sheets of leading weight control organizations in Ontario (Canadian Pork 1974, p. 3).

When we contrast these promotions and the scientific endorsement that was sought with the now extensive body of scientific literature showing the health burden (in individuals and health care systems around the world) of the Western diet, or what Tony Weis called "meatification" of diets, we ponder on how vulnerable scientists and the scientific standards of nutrition could be to agribusiness interests.[7] David Cantor et al., in their historical study of meat and human health, concluded that what occurred throughout the 20th century was a "growing tension between regulatory efforts designed to promote and protect the meat industry, and regulatory efforts designed to protect the public health." In addition, they point out that the state, which also usually seeks expert advice to inform decisions, "often seems divided in its loyalties between the people and industry" (Cantor et al. 2010, p. 28).

[7] Two good articles that made extensive literature review to show the health burden associated with increased meat consumption and other aspects are: Tilman & Clark 2014; Springmann et al. 2016. Also related to this increased meat consumption in the 20th century is the increase in the consumption of processed meats. In this regard, the World Health Organization recently concluded that processed meats cause cancer and red meat is a "probable carcinogen" (Simon 2015).

The development of animal welfare science in Ontario since the 1980s is another important topic in the relationship between science and agribusiness in this context. Following an increasing public interest in the problems that factory farming inflicted upon pigs and other animals, governments, producers and scientists responded to the issue with the formation of the Expert Committee on Farm Animal Welfare and Behaviour in 1986. However, since then, instead of proposing goals to reduce or eliminate factory farms in Ontario, the scientific response to it has been more of a compromise with the economic expansion of the industry, rather than a firm stand on supporting more sustainable and ethical ways of food production. Since the first report of the Committee it was clear that the type of research conducted should be the one that complies with "both production and welfare standards" (1987 Report of the Expert Committee on Farm Animal Welfare and Behaviour, Canada, p. 2).

## 5. Final Considerations

Scientists have not just produced scientific knowledge but in some cases also have promoted ideologies about animals and the food system. These ideologies of "progress", "improvement", "modern" or "efficiency", as we saw in the context of pig production in Ontario, only make sense if we understand the particular historical context in which they lived, which since the 1950s has markedly been one of strong agribusiness interventionism. We also provided some examples in this article of how scientific knowledge was mobilized to fit into economic strategies of agribusiness. Therefore, we argue that, in order to evaluate the results of pig production and other agricultural sectors with a more complete understanding of its motivations and consequences, we should think beyond the experts' usual horizon and include broader considerations of social, economic and historical contexts. In turn, this leads to the importance of including the analysis of the social scientists in order to have a clearer idea both of what the food system was in the past and of what the food system that we would like to build for the future will be like. Another important topic explored in the article were the problems that a close partnership between science and agribusiness can entail and how a certain degree of scientific independence from economic considerations needs to be cultivated in order to avoid these problems.

Since scientists are always subject to the influence of ideologies, it was not our intention in this article to judge or to denounce the scientists quoted here as evil or frauds. Instead, we aimed at pointing out problems and pathways to improve knowledge through connections with other scientific debates that are available, although usually not put side by side. Those connections between science and ideologies are often more complex than what we explored here, and the only hope is to apply criticism and try to improve it, rather than to expect to reach a perfect form of knowledge (Popper 1995).

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