Farm Knowledge: Machines Versus Biotechnology

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Introduction

"The computer does not impose on us the ways it should be used." The well-known Canadian philosopher George Grant (1986) uses this common assertion to develop a critique of modern technology. He points out that, indeed, technology does influence the uses to which it will be put. Technologies even influence the framework(s) that people will use to evaluate them. They are part of a paradigm of knowledge that helped to spawn them, that sets our educational institutions and our "civilizational destiny." Grant shows that even the word should, as it is used in our modern technologically rational society, conveys the conditional meaning – "one should if one desires to gain some end" – whereas in traditional societies it conveyed a universal "ought" or "must," that is, that we owe others with no "ifs." Further, the ways computers can be used for storing and transmitting information have and will increase the homogenizing processes in our society. The same was true for the car, and, no doubt, other technologies can also have the effect of homogenizing work, culture, and our way of life.

This paper attempts to understand, in light of Grant's thinking, some of the results of a recent study of farmwork and technology in a set of southern Saskatchewan communities, done by a research team at the University of Regina. Clearly the influence of modern knowledge systems and technology on the Prairie farm, as with industry, has been homogenizing (Taylor, 1994). I will argue, however, using two examples, that rural people have had more success maintaining public knowledge, autonomy, and control over machinery than over biotechnology. The paper concludes by offering some proposals for change.

HOMOGENIZING TENDENCIES IN INDUSTRY

Two centuries ago, Adam Smith noted an important principle of capitalist production – dividing the task cheapens the cost. The principle, refined by Charles Babbage and taking on his name, identifies the need for managers to divide the total production of a commodity into small, detailed parts, most of which require very little skill to complete and are accomplished by cheap "detail" labor.

One century ago, his idea was being turned into a bogus "science" of management at the hands of Frederick Winslow Taylor. It had a new twist. Taylor recognized that workers possessed the knowledge of production; without breaking workers' hold on knowledge it would be difficult for managers to realize the gains promised in Babbage's principle. Broadly, Taylor's proposal for management can be summarized in three principles.

- Dissociation: Gather workers' knowledge, collate and codify it, and write it as rules for production. That is, identify the knowledge as distinct from those who hold it and who do the work.
- Separate conception from execution: Physically locate this knowledge in the planning department, where managers can take charge of it.
- Plan and control: Use this knowledge to separate the work into detailed steps. This planning will be aided by time and motion, flow control, and similar "scientific" studies. Assign workers with different skill levels and different wage levels to each step. Insist that they do their work exactly as planned.

David Noble (1977) has shown that Taylorism was part of a broader movement by large U.S. firms in the electrical, automotive, chemical, and related industries, with the cooperation of various departments of the state and some universities, to turn technology in their favor. It involved the rise of a new class of managers and engineers and resulted in large oligopolical firms having a major influence upon the development and implementation of technology in this century.

An important result of Taylor's "scientific management" and related dynamics of modern capitalism, according to Harry Braverman (1974), has been the increasing homogenization of the work force. A growing majority are being reduced to low-skill, "bad" jobs, while few have high-skill, "good" jobs. Of course, fractions of the work force have resisted this tendency, some more successfully than others. Overall, work has tended to become degraded and the work force deskilled.

The rate of productivity increases after World War II was high, as the technologies and management approaches of mass production became the norm in industry. But after the early 1970s this rate declined, setting off a major debate about its causes or even whether it was an important new trend. Typical data for Canadian business sectors are presented in Table 1. Most attention was placed on manufacturing, where average annual productivity increases dropped from 4.5 percent in the 1961 to 1973 period to 2.2 percent in the 1973 to 1986 period; but the service sector also slowed, as did agriculture.

Table 1: Average Annual Percentage Change in Productivity of Canadian Business, Selected Years

Business sector	1961–1973	1973–1986
	Output per person/hour average annual percentage change	
Services	2.6	1.3
Goods	5.0	2.2
Manufacturing	4.5	2.2
Agriculture	6.4	1.7

Source: Statistics Canada, Aggregate Productivity Measures, 1986, Cat #14-201.

The data suggest a major shift, which has come to be associated with a crisis of Fordism. There are competing explanations. "Numerical control," the predominant technology of production during and after World War II, had perhaps run its course. Consumer markets may have become too differentiated for the conventional mass-production techniques. It is also likely that the great font of workers' knowledge was becoming exhausted (Lipietz, 1992). The importance of workers' knowledge to productivity is revealed in the strategies used to overcome the downturn, that is, "flexible specialization," "responsible autonomy," and other labor processes that claim to recenter workers' knowledge and control of production activities.

So the basis of production and of accumulation and profit is labour, which is based in part on the ingredient knowledge, not concentrated in the hands of management or in the academy or in a computer but distributed among those who actually do the work. This is a body of local, public knowledge. When it is weakened, productivity is threatened. Of course, there may be other important reasons for protecting local knowledge. It may ensure a way of life. It may be moral.

Parallels in Farming

As in industry, farm production is based on the knowledge and skill applied by farm families that do the work. Critics of the degradation of work in industry, such as Braverman, hold up farming as the counterexample. The structure of the farm sector means that farm families take the production decisions, because they own or control the property, and are in virtually perfect competition with each other, so they have a strong incentive to increase productivity. Hence they adapt, cope, invent, and innovate.

Where does the knowledge to farm come from and what are the trends? Answers to this question will show that farming is not as much a counterexample to industry as industry's critics may think. In the past, farming knowledge was passed down from generation to generation, that is, it was a "folk" or community knowledge. As farming becomes more commercial and industrial, however, the populations of successive generations of farm families have declined. Today, farming knowledge is produced and disseminated by state agencies such as universities and government research stations. But this source of knowledge is being diminished government cutbacks. For example, $4 billion has been cut in Canadian federal transfers to the provinces since 1994-1995, putting a strain on universities. Federal agricultural research has also been cut. In part, these cuts are to be replaced by contract research for private companies. But this change compromises the public nature of the knowledge. Dean Michael Martin, of the College of Agriculture, Food and Environmental Sciences, University of Minnesota, speaking to the U.S. Agricultural Outlook Conference recently, claimed that basing university research on private contracts "shortens the time horizons . . . of scientists . . . . You get a lot of problem solving but not necessarily a lot of knowledge discovery . . . . [It turns] very good scientists into very bad accountants" (quoted in *The Western Producer*, March 6, 1997).

In addition, the knowledge of how to farm is produced and disseminated by agribusiness companies. This source has been increasing in importance. Here the knowledge tends to be proprietary, protected by patents and intellectual property rights embedded in trade agreements. Sometimes this knowledge erodes folk knowledge, for example, by patenting knowledge that was previously folk knowledge, requiring end-use contracts from farmers, which limits their opportunity for innovation, modification, and generating new knowledge, or by patenting invention "processes," which limits the methodologies available to both farmers and public scientists for generating new knowledge (Shiva, 1997). The companies are becoming very large and the industries very concentrated, resulting in control of this knowledge by the few, with a strict orientation to accumulation (Heffernan, 1996).

Increasingly, the knowledge of how to farm is being removed from farm families and embedded in the industrial processes that manufacture farm inputs and process farm outputs, in the computer programs and Internet systems that facilitate and direct farm management, and so forth. Hence, farm technology, work, and knowledge are becoming more homogeneous and controlled by large companies, while local producers' knowledges are being eroded. This may explain the productivity slowdown shown in Table 1 and the tendency noted by some for yields to hit a plateau. But the process has not been monolithic. Fractions of farmers have resisted this tendency with varying degrees of success. A comparison of some social aspects of machinery technology with biotechnology can serve to illustrate this point.

FARM MACHINERY

Role of patents and control of knowledge

Major struggles over patents ensued between individual inventors and between firms in the 1800s. But the firms were small, competition was severe, and patent holders were often quick to license their patents to manufacturers who would work them. Indeed, much of the Canadian industry took root by licensing American and other patents. After World War I, patents became less important, at least until the advent of computer control, even though there were major improvements in auto electrics and battery technology, rubber tires, hitching systems, hydraulics, transmissions, diesel engine design, and injection systems.

Response of farm families

While rural folklore is replete with stories about late adopters of machinery – especially tractor power – on balance, farmers enthusiastically embraced it. The tendency for farm families to capitalize their household income into machinery is well known. At the same time, farmers followed characteristic patterns of resistance. For example, they pushed for machinery regulation such as the Nebraska Tractor tests in the United States, the Royal Commission on Farm Machinery (Barber Commission), and the Prairie Agricultural Machinery Institute (for testing machinery) in Canada. They organized distribution and manufacturing cooperatives such as Canadian Co-op Implements, whose policy was to provide full product documentation and to try to use off-the-shelf parts in its manufacturing. Farmers invented machinery; our study area in southern Saskatchewan alone has yielded inventors of the swather, air seeder, several inventors of the disker, and many modifications of manufacturer's machines.

Role of the state

The state became heavily involved in promoting machinery by generating and disseminating knowledge about machinery. Farm machinery was essential to the Canadian project of opening the Prairies to European settlement. The dry land farming movement, originating in Kansas and Nebraska, was promoted in Saskatchewan by no less a figure than the premier. Elaborating on this initiative, the Prairie provinces gave a major role to the agricultural engineering departments of their universities, emphasizing that the universities were to work closely with farmers. Such a "people's university" was one result of the progressivist element of the agrarian movement so important to prairie politics.

Further, in general, the law did not constrain farmers' machinery innovations.

The farm machinery companies adapted to this balance of power between themselves, farmers, and the state by adopting a stance of relative openness about their technology. One small example is that the post-World War I farm tractor training courses given by the manufacturers were amazingly detailed. Clearly the expectation was that farmers themselves would do major overhauls of their machinery.

So a relatively "open architecture" developed for farm machinery, and knowledge about machinery became part of rural folk knowledge and skill. The two world wars helped to develop mass knowledge about machinery, especially among farmers.

BIOTECHNOLOGY

Role of patents and control of knowledge

Patents have been essential to the success of the major companies in this industry from the start. Initially, the companies were not much oriented to farming. Even today, farm products tend to be only part of their broader business. Since the commercialization of hybrids, and especially since the advent of genetic engineering, however, there has been a frenzy of patenting and struggles over patents have become more intense. The firms are very large, the industries are oligopolies, and maintaining market share is any firm's major goal.

Response of farm families

Traditional agricultural biotechnologies have existed in the public domain for many centuries, for example, in selective breeding and the use of yeast and bacteria to produce foods and beverages. Farm families have been active in reproducing this knowledge, for example, in breeding new strains of crops and livestock, as purebred livestock and elite and registered seed growers, in breed associations, and even in 4-H clubs.

The role of the state

The state has also been active in traditional biotechnologies and has been closely allied with farmers through the research and extension activities of the experimental farms and universities. This initiative was crucial to the success of the Canadian Prairie frontier by producing new crop varieties better suited to the shorter growing season and resistant to drought, disease (rust), and insects (sawfly). As with machinery, this was part of the agrarian ideology of progressivism. This link between folk and public knowledge was dominant in agriculture in Saskatchewan until the 1970s. The law made the introduction of new varieties subject to regulation and close supervision but it did not make understanding the technology more difficult, and innovation by farmers was still possible, especially if they were tied into a network with university and experimental farm scientists.

The case of chemicals

Before World War II, chemical use on the farm was an item of local and public knowledge, but after the war, chemicals were modified for agriculture and patented. They were widely adopted by “progressive” farmers, but the farm community had scant understanding of their makeup, properties, or how they worked. University scientists understood chemical technology well, but their traditional alliance with farmers changed. Extension and research work focused simply on the use of chemicals, and, increasingly, chemicals were invented by the companies.

So the “architecture” of biotechnology was not as open as that of machinery because most crop and livestock breeding was done by scientists. Nevertheless, farm people were often intimately involved and generally understood the process. An exception to this pattern after World War II was farm chemical technology.

Local Knowledge in the Current Conjuncture

Computerized farm machinery has introduced a new threat to local knowledge and control. Proprietary knowledge is coded in the computer. Modular design is integrated with computer control systems. But farmers, drawing from past experience, are resisting. One strategy is purchasing used machinery while developing individual knowledge and community knowledge networks to facilitate repair and sourcing parts. The next stage will involve cracking computer codes and the growth of third-party suppliers. The law, combined with the structure of the industry, slows this process down but does not stop it. To date, computerized, modular machinery appears to offer no or few advantages that are important to farm families – better margins, safety, flexibility, control – so this is a viable coping strategy. In time, computerized control will become an element of farm folk knowledge.

Genetic engineering and new chemicals also introduce a potential threat to local knowledge and control. Proprietary knowledge is embedded in the product and sometimes also in the patented processes that produced it. Use by farmers is limited, and modification is prohibited by contract. Farmers are struggling to advance lines of resistance but without much success. Purchasing used products or chemicals is either illegal or not an option, hence adoption tends to be all or nothing. Community networks have developed but only limited extensions of knowledge and control have resulted, for example, finding new uses for diluted applications of popular chemicals, or pursuing legal actions against manufacturers when a product appears to fail. Facilities for reverse engineering the products are not widely available in the public domain and local groups have come to legal and financial grief in pursuing this path. Indeed, the manufacturing process is not well understood and almost never attempted by farmers. In general, patent law and the law regulating the manufacture and sale of genetically engineered and chemical products constrains farm innovation in these areas. Further, the research and invention capacities of the state have increasingly been captured by private firms. Hence, unlike farm machinery, under present trends it is doubtful that the new biotechnology will soon become embedded in farm folk knowledge.

Options

Certainly, modern agricultural technologies do influence their use. Critics of tractor power pictured it as a “widow maker” and “agent of the devil,” perhaps with good reason. There are also grounds for concern over the thought of gene splicing labs in every farmyard. Even though biotechnology may have much deeper consequences than machinery for farming and rural life, the resulting social structures will be worked out in the characteristic struggles among farmers, companies, the state, and others.

The general point is that local farm knowledge is being eroded and, given its relevance to the viability of farm communities, ways have to be found to revive it. One well-known trend is revealed in out-migration of young people that our farm communities have raised, educated, and disciplined to the nonfarm labor market. In Saskatchewan, over 50 percent of the net farm migrants in recent decades left before the age of 30; for the most part, this source of population, knowledge, and skill regeneration is lost to the farm community forever. If public and local knowledge is to remain viable, at least a couple of options can be suggested.

In modern agriculture, independent public universities and state research agencies have been crucial generators of knowledge. The current trend to curtail this role and replace it with private generation of knowledge has to be stopped. As a corrective, the Canadian Consortium for Research proposes that the state develop a comprehensive science and technology plan, increase investment in science and technology, increase support of the research granting councils, improve funding of indirect research costs in the universities, increase support for social science and humanities research, improve students' access to postsecondary education, and restore funding for government labs and research.

Folk knowledge is knowledge shared and passed on by custom. Access to it and innovation based on it is also by custom and the observance of norms, traditions, and obligations, particularly about continuing to share it and pass it on to future generations. It is pluralist and democratic in its epistemological strategies. It is rooted in the everyday experience of production. Both the body of knowledge and its innovative potential need to be protected. A Canadian analogy is Indian land systems, which were also rooted in custom. The current effort to resolve Indian and Metis land claims involves the courts accepting evidence of customary use. This model can be adapted to the protection of the folk knowledge of farm populations. This would entail the protection of local knowledge in the law and trade agreements, as well as limiting the proprietary knowledge claims of companies through patents and TRIPs (PLEASE EXPLAIN ACRONYM).

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