THE GREENHOUSE TOMATO INDUSTRY IN DELTA, BRITISH COLUMBIA

by

ASOKA CHARLES NISSANKA MENDIS

B.A, Carleton University, 1985
M.A. Carleton University, 1988

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Geography)

THE UNIVERSITY OF BRITISH COLUMBIA
December 2007

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This focus of this dissertation is the greenhouse tomato industry in Delta, British Columbia. Using a conceptual framework assembled from Regulation theory (including the concept of food regimes) and the political economy of agriculture, I explore the origins and development of the industry in Delta. I argue that sub-national regulation has historically played a pivotal role in the agricultural development of the region. The impact of such regulation on the greenhouse industry, however, is contingent upon the specific regime of accumulation. I make the case, for example, that regulation instituted in the early 20th century under an extensive regime of accumulation acts as a fetter on the industry under a post-Fordist regime of accumulation. Furthermore, I make the argument that the emergence and consolidation of Delta’s greenhouse tomato industry can best be understood through the deployment of the concept of food regimes. Thus the local industry can be seen as part of global trends in food production and consumption and which have come to characterise the third food regime.

In this thesis I also examine the ‘nature’ of the tomato and of greenhouse production. I demonstrate that, beginning in the mid-19th century, the tomato has been transformed into an input amenable to such industrial processes as canning. Using the conceptual tools offered by the political economy of agriculture, I further argue that the technique of greenhouse production is a result of the process of ‘appropriation’. That is, the discrete elements of the agricultural production process have been appropriated by industrial capital and reassembled as a technologically intensive system of plant production. However, and using the case study, I illustrate how this process of appropriation has created a new set of ‘natural’ obstacles within a fairly distinctive form of industrial agriculture.
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ACKNOWLEDGEMENTS

This work could not have been completed without the assistance of a number of people. Trevor Barnes, my supervisor, must be credited for shepherding me through the process which led to the production of this dissertation. That there was an end is due, in no small part, to his persistence and devotion to duty. My committee members – Graeme Wynn, Juanita Sundberg and Scott Prudham – offered continued support and helped make the final product a better one. Greenhouse growers and farmers in Delta were generous with their time in their encounter with an interloper. Peter Cummins of Houweling’s and David Ryall of Gipaanda, in particular, were always willing to help. My deepest debt of gratitude is to Catherine Buck, without whom there would not have been a beginning or an end.
CHAPTER 1: INTRODUCTION

Situating Greenhouses

My interest in the political economy of agriculture was sparked during a research trip to Sri Lanka approximately two decades ago. The research was being conducted for my Master’s thesis on the historical origins of the conflict between the Sinhalese and the Tamils. In the course of my research, I delved into the history of plantation agriculture in the country. Through the existing scholarship on the history and organisation of these plantations, I came to appreciate the explanatory power of that tradition we call the political economy of agriculture. The political economy of agriculture at this time was forged primarily from the works of Marx, Lenin and the articles published in the *Journal of Peasant Studies*. Aspects of this scholarship on these plantations included their insertion into the imperial economy, the role of merchant capital, the use of indentured Tamil labour brought in from Malaysia, and the resistance of the Sinhalese peasantry to their proletarianisation. Nature and its role in plantation agriculture, however, was absent in these accounts, and in my subsequent dissertation. This happened despite the fact that one of the more significant interventions with respect to the political economy of agriculture, one which problematised nature, had been published in the *Journal of Peasant Studies* in 1978. This was the Mann-Dickinson thesis (Mann and Dickinson 1978) which had teased out some of the pertinent observations of Marx and Karl Kautsky on nature as an obstacle to the development of a capitalist agriculture.

My conceptualisation of nature at the time mirrored that of Environment Canada where I ended up as a researcher for five years. This was nature as environment, as backdrop to human activities, as a well of resources and as a sink for wastes. It was a very undialectical conceptualisation of nature. I was, however, coming to the realisation that ecological problems were not a result simply of inefficient resource use or unregulated pollution, but had more to do with the dynamics of capitalist accumulation. Environment Canada’s corporate advocacy of technological fixes and the modification of human values and attitudes as a response to ecological crisis seemed to me to be frustratingly quixotic. My undialectical conception of nature would not be usurped until I encountered David Harvey’s work when I came to the University of British Columbia. Through Harvey I re-kindled my interest in the political economy of agriculture – it had lain dormant while I was out of academia – and I came to appreciate the idea of capitalised
nature. In essence I began to take nature seriously, to understand the ways in which nature was reconstituted within capitalist production.

My original intention had been to write a dissertation on the evolution of agriculture in the Lower Fraser Valley. But, as my committee rightly pointed out, this was far too broad a topic to be undertaken for a PhD. dissertation. At the suggestion of one of my committee members, I undertook instead a study on greenhouse tomato production.¹ This was felicitous in a number of respects. In the first place, the research represented by this dissertation goes a small way towards filling a massive lacuna. Despite the fact that commercial greenhouses have existed in both North America and Europe since the early 20th century, very little has been written about them from the perspective of the social sciences. There are a two exceptions. A chapter in Harvey et. al. (2002) which analyses the greenhouse growing environment as ‘fabricated nature’ and Basok (2002) writing on Mexican migrant labour in the Ontario greenhouse industry.² Furthermore, greenhouse production turned out be an ideal case study for applying the theoretical insights that have emerged since the Mann-Dickinson thesis was published. Here was a form of agriculture that was both labour and capital intensive, didn’t use soil as a growing medium, and was spatially intensive. It had a growing environment in which control over the parameters of growth – light, temperature, plant nutrition, irrigation, atmospheric content – was automated and computer-controlled.³ There were quirks as well, despite the technological sophistication: the act of pollination was performed by an army of bumblebees and pest control was effected through the exploitation of the predatory relationship between certain insects. Contemporary greenhouse production represented, to me, a radical reorganisation of the process of growing plants. It represented a new way in which capital circulated in and through the biophysical production process at the heart of agricultural production. And greenhouse production represented a form of nature-based production ripe for an analysis through the lens of agrarian political economy.

This dissertation complements the long tradition of agrarian political economy that started with Marx and that was taken up with vigour by Kautsky (1988). Kautsky’s concern was to explain the persistence of family farming – based on labour supplied by members of the family – when

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¹ My thanks to Graeme Wynn for this suggestion.
² Although not explicit, the argument that Harvey et. al. deploy is Smith’s (1984) ‘production of nature’ which seeks the dissolution of the binary categories of ‘nature’ and ‘society’. The greenhouse environment, for Harvey et. al. is an artificial ecology, a manufactured environment in which the distinction between ‘natural’ and ‘artificial’ is lost. The chapter in Harvey et. al. (2002) is entitled The Fabrication of Nature.
³ The closest approximation in agriculture is intensive livestock production and aquaculture.
capitalist social relations dominated manufacturing. The explanation lay in the rootedness of agricultural production in land, which presented certain obstacles to capital’s penetration of agriculture. Such obstacles included the irreproducibility and immobility of land as a factor of production – machines can always be replicated and moved – and the difficulty of consolidating land due to private property rights regimes. These observations remained dormant within agrarian political economy until the publication of the Mann-Dickinson thesis in 1978 (Mann and Dickinson 1978). Building on both Marx and Kautsky, but Marx and the labour theory of value in particular, Mann and Dickinson problematised the nature-based production system at the centre of agriculture. Mann and Dickinson argued that the disunity between production time (the time required for crops to grow) and labour time (the application of labour at seeding and then harvest) posed a problem because no value was being produced while labour was idle. Within industry, production time and labour time almost completely overlap. A further obstacle within agriculture is the relatively limited number of turnovers of capital possible in a given period. In industry, turnover time, the period from raw materials to finished product, is relatively amenable to manipulation. Within agriculture, however, these turnovers are effectively limited by the relatively fixed period required by plants or livestock to grow, and there is little possibility of speeding up that process.4

Given that the agricultural production process represented an obstacle to capital, Goodman et. al. (1987) argue that capital avoids the farm itself and takes control of the input and output segments of the agricultural production process. With respect to inputs, Goodman et. al. argued that capital appropriated the production of inputs into the agricultural production process such as machinery, fertiliser and pesticides.5 Through the process of substitution, the replacement of butter by synthetically produced margarine for example, capital, while again avoiding the farms, finds an entry into the food and agricultural production process. The most recent significant intervention is Boyd et. al. (2001) who argue that while nature may pose an obstacle to capital, it also represents surprise and opportunity. Boyd et. al. make the distinction between extractive processes (mining) and those based on biological reproduction. Thus biological systems at the centre of agricultural production are manipulable in ways that extractive processes are not. In other words, the agricultural production process itself can be reorganised, hastened, intensified and otherwise

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4 Other obstacles include the perishability of agricultural commodities and problems in the deployment of machines within agriculture.

5 Kloppenburg (1988), utilising the concept of appropriation and the example of hybrid corn in the United States, to demonstrate how capital has taken control of the production of a fundamental element of the agricultural production process, the seed.
controlled resulting in increased yield, turnover time and efficiency of input use. My argument will be that technologically sophisticated greenhouse production represents a form of this type of control, although no one has yet explored this connection.

**Background and Overview**

In this section I want to introduce both place and commodity; Delta and the tomato.

Recent changes in agriculture in the Lower Fraser Valley have been profound. Historically, the region had been one of livestock raising and pastures, of cultivating crops such as potatoes, beans and peas and, to a lesser extent, of producing tree fruit such as apples. Agriculture had been established in the Lower Fraser Valley in the late 19th century and has been changing ever since. In the early 20th century, farming in the region changed from subsistence production – if there was surplus it was sold in local markets – to the generalisation of commodity production. This was facilitated and accelerated by the development of a rail network which gave farmer’s access to markets. Co-operatives were established to bolster the market power of farmers faced with a concentrated processing sector – the earliest instance was the establishment of the Fraser Valley Milk Producers Association in 1917. The mechanisation of the rural production process began with the adoption, in the late 19th century, of the steam engine harnessed to threshers and harvesters and later, in the 1930s, of the far more mobile gasoline engine tractor. Industrial inputs, in the form of fertilisers, pesticides and herbicides, were also adopted, a process accelerated by the discovery of synthetic chemicals such as DDT. In the first few decades of the 20th century, the state had begun establishing a regulatory regime to foster the development of commodity production in agriculture and an export trade. Specifically, such regulation attempted to bring order to produce marketing by funnelling the output of individual producers through a single agency.

Later in the 20th century, in the region as a whole, the number of farms began decreasing but the average size was increasing. And while livestock, field crops, and tree fruit continued to be important, there began a tendency towards a spatial intensification of agriculture. Livestock with access to pasture and field crop production are extensive in their land use. The spatially intensive use of farmland refers to the process of increasing yield per unit are of land. That is, more value is produced on less land than more traditional farming practices. Examples include livestock production where animals are confined within a structure with no access to outside pasture, mushroom farms, blueberry farms, and, of course, greenhouses. While greenhouses have been a
feature of the Lower Fraser Valley’s agrarian landscape for much of the 20th century, they had tended to be small and were ancillary to crop and livestock production. Within the last two decades, however, greenhouses in the region have become bigger and technologically sophisticated. And they have been established throughout the Lower Fraser Valley, producing tomatoes, peppers and cucumbers in massive quantities. Within this general transformation of agriculture in the region, there has been a specific development with respect to the greenhouse production of tomatoes in Delta.

John Savage, who has farmed in Delta for 50 years, raising livestock and growing field crops, states that the large greenhouses in Delta and elsewhere in the Lower Fraser Valley are ‘factories’ (Personal communication). This is a reflection on the size and technological intensity of contemporary greenhouse production. The tomato-producing greenhouses in Delta range in size from 11.4 to 35 hectares. When Casey Houweling of Houweling Nurseries built a 2.4 hectare greenhouse in Delta in 1985, it was the largest in Canada. Examining the reasons for this increase in size is one of the subjects of this thesis and is discussed in Chapter 5. Greenhouses also approximate factories in their intensive use of technology. Traditionally, greenhouses had simply been a shelter to protect plants from cool spring and fall temperatures, thus extending the growing season. Plants were grown in soil beds and inputs – fertiliser, pesticides, herbicides – had been applied manually. Through a gradual process of technological change, of increased automation followed by computer control, greenhouse production currently represents an unprecedented control over the growing environment. Plants are no longer grown in soil, nutrient supply is automated, the greenhouse atmosphere – temperature, humidity, carbon dioxide content – is controlled through a centralised computer system. Despite this technological intensity, there are also aspects of contemporary greenhouse production which surprise. I refer in particular to the use of bumblebees to pollinate greenhouse plants – a role bees perform in open field agriculture – and the use of insects to control pests.

Approximately ninety percent of the greenhouse tomatoes produced in British Columbia issue from Delta. And this statistic animated the process that resulted in this dissertation. But this concentration is a curious fact. There are, for instance, numerous large greenhouses elsewhere in the Lower Fraser Valley – in Langley, Surrey, Abbotsford for example – which do not grow tomatoes, but grow peppers and cucumbers instead, and in huge volumes. British Columbia’s field tomato industry is located in the Okanagan, where the hot and dry summers lead to high yields. Would not the advantages of growing in a greenhouse – in particular, the extension of the
growing season and the ability to protect crops from the vicissitude of weather and climate – lend themselves to a site already suited for tomato production? Furthermore, the development of the greenhouse tomato industry in Delta only began in earnest in the mid-1990s. This is not to suggest that greenhouse tomatoes were not being produced in the Lower Fraser Valley, but rather that between 1995 and 1997, greenhouse growers had relocated from elsewhere in the region to Delta to grow tomatoes. As a consequence very little greenhouse tomato production takes place outside of Delta.

Delta is located on a peninsula at the south-western extreme of the Fraser River delta. It is bounded on the north by South Arm of the Fraser River, on the west by the Strait of Georgia, on the east by the municipality of Surrey, and on the south by the United States border at Point Roberts. Prior to European settlement, Delta's flatlands and coastal shores were inhabited by the Tsawwassen indigenous peoples, of the Coast Salish First Nations. Each year, the Tsawwassen, who were semi-nomadic, established fishing camps on the shores of the river and Boundary Bay. The interior remained uninhabited. The first settlers to the area were the Ladner brothers who began farming in 1868. Colonial settlement policies enabled homesteaders to pre-empt land without initial payment. What the Ladners found was rich alluvial soil which proved to be fertile but more importantly, unlike other areas of the Lower Fraser Valley, Delta was not covered in thick forest, which facilitated the process of settlement as land did not have to be first cleared.

By 1880, all land in Delta had been pre-empted and 60 farms had been established. The establishment of a system of private property rights had resulted in the establishment of a ‘reservation’ for the Tsawwassen in 1878. This early establishment of agriculture set in motion a pattern of land use that has endured despite Vancouver’s proximity and the threat of urban sprawl. Such sprawl was contained the in the early 1970s with the passage of the Agricultural Land Reserve (ALR) Act designed to protect farmland. Of the 18,000 hectares that Delta encompasses, 10,000 hectares are in the ALR, 56% of Delta’s total land area. Much of this land has prime agricultural capabilities (Class 1 - 3), meaning it is some of the most fertile in Canada. An estimated 7,500 to 7,600 hectares are being currently farmed. Delta’s greenhouses, which conform to the definition of a farm as established by the Canadian Census of Agriculture, sit on ALR land.

The tomato’s history is considerably older than that of Delta’s settlement by immigrants. A native plant of Peru, the tomato migrated – it is not known how – north to Central America and was
domesticated by the Aztec and Inca. Encountered by the Conquistadores in the early 16th century, the tomato began its travels east to Europe. However, the tomato’s familial resemblance to the deadly nightshade plant acted as a fetter to its wholesale adoption by Renaissance households. By the 18th century, the tomatoes had established itself throughout much of Europe and had also made its return to the New World. The late 19th century was witness to increased commercial production for local and regional markets on both continents. The tomato has the distinction of being one of the first fruit to be subjected to an industrial production process. This occurred in the United States when Heinz and Campbell’s, in the early 20th century, started producing processed and canned foods – particularly soups and sauces – as a substitute for fresh tomatoes. The tomato, throughout much of the 20th century, also encountered science. Hybrid varieties were created in the 1920s and by the 1950s tomato genes had become objects of scrutiny. Tomatoes grown in fields are destined either for fresh consumption or for processing; greenhouse-grown tomatoes only end up in the fresh market. As alluded to above, the tomato, when cultivated in the open, thrives in hot and dry conditions. Delta’s summer climate, in contrast, is characterised by moderate temperatures and humid condition. But, at some point in the late 20th century, the greenhouse tomato and Delta came together.

While the puzzle of how Delta came to represent a site of sophisticated greenhouse tomato production motivated the inquiry, this thesis also represents an attempt to come to grips with the role played by, and impact upon, the various regulatory forms and institutions in the context of a changing agricultural landscape.

Sources and Method

This dissertation is based on both archival research and interviews. I will discuss each in turn.

As a prelude to the case study, as a means of setting a context, I wished to explore the historical geography of both Delta and the tomato. With respect to the former, I wanted to chart the changes in Delta’s agrarian landscape from the time of settlement. I was particularly interested in the role played by the state in the development of a capitalist agriculture in the region. While pioneer accounts held at the Delta Museum and Archives provided some background information, a far more fecund source was the various reports, bulletins and circulars of the Provincial and Federal ministries of agriculture. Dating back to the 1880s, these publications yielded statistics on production and trade, descriptions of crops and livestock and accounts of the formation of farmer’s associations. Such accounts were enriched by reports by farmers concerning the trials of
crop and livestock production in Delta, the difficulty in gaining access to markets, and the vicissitudes of the weather. As a means of disseminating information throughout the agricultural community, these publications also signalled the intentions of the state with respect to the development of a nascent sector of the economy. This was most evident in the reproduction of speeches by various state functionaries in which visions of a regional and provincial agriculture were articulated. The state’s concrete role in the transformation of agriculture in Delta and elsewhere in the region were also evident in the archival records. Within them were announcements and implementations of plans to modify the environment in the interest of developing a permanent agriculture – the building of dykes for example. These state publications also detailed the various institutions established to regulate agriculture in the province.

A similar archival exercise was conducted for the tomato. My intention was to track the transformation of the tomato to demonstrate that the current tomato has experienced profound modification since the mid 19th century. In particular, I also wanted to explore the development of a ‘Canadian’ tomato. My sources for this endeavour were the reports of the federal and provincial experimental farm systems dating back to the first decade of the 20th century. Agricultural research stations were deployed as means of adapting various commodities to Canada’s particular ecological conditions. Research was published in the form of annual bulletins that outlined research priorities and results. The tracing of the tomato’s voyages through these institutions gave an understanding of both changes in research priority – increased yield versus hardiness, for example – as well as paradigmatic shifts in plant breeding such as the ascendancy of hybrid selection.

In addition to the archival research, I conducted 25 interviews. My intention was to interview all commercial greenhouse tomato growers in Delta, and which I accomplished using a snowball technique. I established contact with a few potential interviewees who I then used to meet other producers in the industry. The interviews were semi-structured; that is my interviewing consisted of exploring general themes which, in most cases, resulted in an open-ended process of knowledge construction. There was, of course, a potential for both interviewee and respondent bias. The questions I asked, or began interviews with, were conditioned by my conceptual framework which, it can be acknowledged, is structuralist. Thus my concern was to establish the broader social and political forces which led to the concentration of greenhouse tomato

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6 Eight of the interviewees wished to remain confidential.
7 Despite repeated attempts, I was unable to make contact with Global Greenhouse Produce.
production in Delta. Although I made a concerted attempt to discover the personal motivations of greenhouse growers in the relocation of their enterprises from elsewhere in the Lower Fraser Valley to Delta, my purpose was to link these individual acts with changes occurring at larger scales. Furthermore, the relatively small size of greenhouse tomato growers in the region imposed certain constraints on the questions that could be asked. As discussed in Chapter 5, this is a highly competitive industry, with local growers vying with each other and continental competitors in an industry currently characterised by uncertainty. Based on my experience in conducting qualitative research with firms for Environment Canada, I anticipated a certain guardedness on the part of growers in the course of interviews, particularly since there were so few of them in the region. As my research progressed, I discovered each grower possessed a competitive advantage – whether in the form of a privileged relationship with large retail chains or access to a newly developed proprietary seed. While the generalities of these competitive advantages were, in most cases, public knowledge, the details were confidential. Although I cannot confirm this, and given the context of competition, it might be reasonable to suspect that growers might have structured their responses in a particular way. Again, given the small number of growers, I could not afford to alienate any of them by being too persistent in my questioning with respect to the intricate details of their operations. This was heightened by the sense that I might have to return to interviewee for clarification or further information, and this I had to do.

As noted above, my first priority with respect to contacts was the greenhouse owners themselves. As I have already indicated, there was little existing information on the greenhouse industry in general and the greenhouse tomato industry in Delta in particular. I was fortunate in this respect to have made initial contact with the Chief Financial Officer of Houweling Nursery Peter Cummins. Cummins, who has been in the industry for approximately eight years, provided a comprehensive overview of the industry over the course of three meetings. Having received a rudimentary education into the greenhouse tomato industry, I initiated contact with the greenhouse owners, the primary intention at this point being to discern their motives for establishing greenhouses in Delta. Through these interviews I acquired a sense of the individual circumstances of the greenhouse owners as well as a fuller sense of the political economy within which they were enmeshed. The understanding of the latter led me to interviews with actors associated with the regulatory institution that coordinates greenhouse vegetable production in the province as well as to state personnel involved in greenhouse research and planning. For a

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8 My thanks to Trevor Barnes for initiating this contact.
perspective from outside the greenhouse industry, but still within the agricultural ecumene, I interviewed farmers in Delta. Given my conceptual framework (Chapter 2), particularly the use of concepts derived from agrarian political economy, inquiry into the industrial chain which facilitates greenhouse production – seeds, fertiliser, pest control – I interviewed personnel of the only firm in Western Canada. My technical understanding of greenhouse tomato production was bolstered by interviews with head growers, that is, the people responsible for maintaining and monitoring the greenhouse environment and plant growth. The final number of interviewees who were not greenhouse growers was reached when I felt that I had approached a point of sample saturation, that is, there were no new views forthcoming. With the exception of two telephone interviews, all interviews were conducted in person. The personal interviews were recorded with the consent of the interview, except in one instance when the request to record the conversation was declined.

**Outline Of Chapters**

**Chapter 2: Conceptual Framework**

In this chapter I construct the conceptual framework to be deployed in the analysis. The overall structure of the framework is informed by regulation theory and a number of its offspring. Briefly stated, regulation theory argues that capitalism’s reproduction is predicated on the existence of a set of institutions that ameliorate the tendency towards crisis by balancing production and consumption (the mode of social regulation). Regulation theory also periodises capitalism according to the specific arrangements that these institutions assume (the regime of accumulation). Within this overarching framework, I use the concept of food regimes and of local regulation. The concept of food regimes is, again, a periodisation of capitalist agriculture focused on distinctive forms of production, trade and consumption. Local regulation, as a corrective to the focus on the nation state within regulation theory writ large, allows for a more fine-grained analysis of the mode of social regulation at the local and regional level. The lacuna within regulation theory with respect to conceptualising nature leads to an adoption of concepts drawn from agrarian political economy. At the centre of these interventions is the specific role of nature – of biophysical production – within the context of capitalist agriculture.

**Chapter 3: Agrarian Change in Delta**

Delta’s agriculture, from settlement to the present, has been one of transformation. My purpose in this chapter is to demonstrate that the transition from subsistence agriculture to commodity
production was directed and enabled by the state. Articulating a discourse of province-building, and inspired by a Jeffersonian agrarianism, the state sought to establish the conditions for the development of a capitalist agriculture. While such a development was fostered in part by the general economic development of Vancouver and the rest of the Lower Fraser valley, I demonstrate how through regulation governing most aspects of agricultural production and marketing, the state transformed Delta’s farmers into commodity producers. This also signalled the emergence of the production of Fordist agricultural commodities such as butter and cheese.

Chapter 4: The Greenhouse Tomato Industry in Europe and North America

The primary aim of this chapter is to demonstrate that Delta’s greenhouse industry is situated within an international – rather than global – production complex. Through a history of the Dutch greenhouse tomato industry, established in the first decade of the 20th century, I argue that the Netherlands has become the epicentre of greenhouse tomato research and development. I also illustrate the link between the Netherlands and the local industry in terms of the adoption of innovations. Furthermore, the emergence of greenhouse industries in Spain, the United States, and Mexico is situated within the third food regime. The argument is made that the restructuring of the retail sector, particular the consolidation of retail capital, and the re-regulation of international trade created the conditions for the expansion of greenhouse production in Europe and North America. Furthermore, these changes, within North America, created a situation of strong competition which would have an enormous impact on the local greenhouse tomato sector.

Chapter 5: The Greenhouse Tomato Industry in Delta

In this chapter, I demonstrate the ways in which regulation, at all spatial scales, has shaped the greenhouse tomato industry in Delta. In particular, I illustrate the ways in which local and regional regulation has acted either as an impediment to greenhouse tomato production – the Natural Products Marketing Act for example –, or enabled it – the Agricultural Land Reserve (ALR) Act. Furthermore, the connection is made between the deregulation of the finance sector in the United States, which occurred during the third food regime, and the creation of a set of competitive requirements that Delta’s greenhouse growers would find increasingly difficult to meet. This leads to a partial de-regulation of the supply chain enhancing the competitiveness of Delta’s greenhouse growers. A further argument is made in terms of the spatial concentration of the industry. Namely, that capitalist competition coupled with the particular ecological conditions necessary for the full exploitation of greenhouse tomato cultivation resulted in this concentration in Delta.
Chapter 6: The “Nature’ of the Tomato and of Greenhouse Production

This chapter discusses the processes of substitution and appropriation with respect to the tomato and to greenhouse production. In the case of the tomato, I trace the industrial transformation of the tomato beginning, in the mid-19th century, with the process of canning. I also demonstrate how the deployment of breeding methodologies and techniques in the 20th century has resulted in the adaptation of the tomato to meet certain economic requirements. For example, within the second food regime, tomatoes were bred to meet the requirements of processors and industrial production. In Canada, breeding was characterised by a strong public research and development programme which catered to ‘national’ needs. In the case of greenhouse production, this chapter demonstrates how discrete elements of the greenhouse production process have been appropriated by agro-industrial capital. The reassembly of these appropriated discrete components results in the distinct production system that is the modern greenhouse. A production system with distinct advantages over open field cultivation. This reassembly, however, creates a new set of contradictions that manifest themselves as a vulnerability to shocks. Using concrete examples, I show how the spatiality of greenhouse production, its intensity, and the co-dependence of the various subsystems, have not resulted in the diminishment of nature’s agency within a technologically complex production process. I also make the case that, in spite of capital’s participation in the production process, which has created an artificial ecosystem within the greenhouse, nature is still of great significance. This is illustrated by the search, within capitalist competition, for the ideal growing conditions.
CHAPTER 2: CONCEPTUAL FRAMEWORK

Introduction

In this chapter I discuss the conceptual framework I use in this thesis. The framework consists of two parts: regulation theory and the political economy of agricultural industrialisation. First, regulation theory is an attempt to explain capitalism’s endurance despite its inherent tendency towards crisis. The central notion of regulation theory is that the inherent instability of capitalism has been held at least temporarily in check by the emergence of a set of rules and institutions (the mode of regulation) that regulate investment and consumption (the regime of accumulation). The result is a provisional stability that can last decades. Regulation theory was developed to explain the macro economy, but over the last fifteen years it has been applied to the development of specific sectors within the economy, one of which is the production, distribution and consumption of food. It is food regime theory as it has been called that I particularly draw upon in this thesis. As a body of literature it attempts to concretize the abstract claims of regulation theory by reference to the global, historical evolution of food and agricultural production. Within the food regime literature, there is a periodisation of capitalist agriculture based on such characteristics as trading patterns, state policies, and production practices and which as I will suggest is a compelling framework to understand the case study that lies at the heart of the thesis: the British Columbian greenhouse tomato industry.

The second part of the framework, the political economy of agricultural industrialisation, is concerned with the particular obstacles posed by nature to the development of capitalist agriculture. The original question posed by agrarian political economists with respect to this issue was why, when the manufacture of durable goods is dominated by large industrial concerns, do farms continue to be owned and operated by families? An illustration will serve here. Campbell’s and Heinz are two corporations that process and package massive quantities of tomatoes. Furthermore, both corporations operate research facilities engaged in breeding tomatoes to serve their production processes and the desired attributes of the finished commodity. Yet both eschew the actual cultivation of tomatoes; ‘independent’ farmers grow tomatoes under contract for the corporations. Agrarian political economy argues that large corporations avoid agricultural production, while (relatively) small family farms continue to dominate, because of the particular characteristics of biophysical production that make agricultural production resistant to its re-organisation as an industrial process.
This chapter begins with an account of regulation theory outlining its origins and explanatory framework. This is followed by a discussion of ‘local regulation’, the conceptualisation of which emerged as a response to the tendency of regulation theory to focus on the nation state, and to ignore the practices of regulation and their consequences at lower spatial scales. This discussion serves as a prelude to the exposition of the concept of food regimes as an instance of regulation theory. The following section then argues that one of the lacunae within the regulationist approach has been the issue of nature in general and of biophysical production in particular. Such an absence requires additional theoretical resources and which are provided by the literature on the political economy of agricultural industrialisation which is centrally concerned with the issues of biophysical production.

**Regulation Theory**

Regulation theory was founded as a critique of orthodox neo-classical economic theory – with its emphasis on market equilibrium – and as a complement to Marxist economic theory (cf. Aglietta 1979, Boyer 1990, Lipietz 1987). The essential concern of regulationists is to explain the reproduction of capitalism given its internal contradictions and its crisis-ridden nature. The regulationist analysis was initially sparked by the oil shock of the early 1970s, which induced a period of crisis characterised by, *inter alia*, declining productivity and inflation. The global economic turmoil unleashed by the oil crisis stood in stark contrast to the relative stability and prosperity of the decades following the end of the Second World War. This period was characterised by sustained economic growth, a tendency towards full employment, and rising real incomes and was founded, in part, on relatively low oil prices. For the regulationists it was the post-war period of stability that was the norm under capitalism. Periods of crisis may punctuate that stability, as which happened during the oil price hikes of the 1970s, but they are the exception. The standard is crisis-free accumulation. More generally, regulationists argue that the recent history of capitalism consists of long stretches of relatively stable periods of economic growth and prosperity and which are interspersed by short bursts of economic instability. To understand this long-term pattern of capitalist development regulationists make use of two concepts: the regime of accumulation and the mode of regulation.

The *regime of accumulation* ‘describes the fairly long-term stabilization of the allocation of social production between consumption and accumulation … [both] within the national economic and social formation under consideration and the “outside world”’ (Lipietz 1987:14). A regime,
therefore, is a stable pattern of investment and consumption, and which allows for reproduction of the economy. Its constituent elements include:

…norms pertaining to the organisation of production and work (the labour process), relationships and forms of exchanges between branches of the economy, common rules of industrial and commercial management, principles of income sharing between wages, profits and taxes, norms of consumption and patterns of demand in the marketplace, and other aspects of the macroeconomy (Amin 1994:8)

The mode of regulation ‘refers to institutions and conventions which ‘regulate’ and reproduce a given accumulation regime through application across a wide range of areas, including the law, state policy, political practices, industrial codes, governance philosophies, rules of negotiation and bargaining, cultures of consumption and social expectations’ (Amin 1994:8). The emergence of a mode of regulation, or mode of social regulation, is a consequence of the absence within capitalism of a self-regulating or self-limiting mechanism. In other words, capitalism is a ‘blind force’ (Aglietta 1979:397) containing the seeds of its own destruction. For example, the productive forces unleashed by capitalism have resulted in environmental pollution and resource depletion, both of which threaten the productive base and conjure up social opposition to particular patterns of accumulation. These and other obstacles to accumulation require a set of institutions and practices to ameliorate contradictions. Thus, the mode of social regulation mediates the contradictions and distortions resulting from capitalist competition and the process of the accumulation of capital. In addition, the forms that regulatory institutions assume are contingent upon context and are influenced by particular histories and geographies.

On the basis of these two concepts, regime of accumulation and mode of regulation, the regulationists developed a historical analysis of Western capitalism. They have identified four main phases since the mid-19th century.

**Phase 1: Extensive Regime of Accumulation (Mid-19th century-World War I)**

The period between the mid-19th century and the First World War they characterise as an extensive regime of accumulation. During this regime, capitalism grew by successive waves through its expansion into new sectors, new areas and new countries. Using the United States as an example, Aglietta argues that this geographical expansion of production, particularly westward, was enabled by the construction of trans-continental railways (Aglietta 2000). Productivity gains under the extensive regime of accumulation were achieved primarily through the extension of the working day and through the expansion of the labour force. Although there
was ‘significant use of science in production processes...firms mainly tried to apply existing knowledge to their business and did not strive to improve them continuously’ (Boyer 1988:79-80). The mode of regulation in this period was characterised by competition. As Brenner and Glick put it,

Capital–capital or inter-firm relations were characterized by cutthroat competition among many uncoordinated units, so that the investment environment displayed a high degree of risk and uncontrollability. Forced to prioritize short-term returns, management shied away from technical changes requiring large-scale placements of fixed capital and from extensive expenditures on research and development (Brenner and Glick 1991:53).

Aglietta (2000) argues that certain structural features of the extensive regime of accumulation determined the scale and pattern of consumption. In the first place, industrial workers still had ties to the rural and the domestic resulting in the ‘constitution of labour-power by a non-capitalist environment’ and which ‘makes it possible to pay very low wages...’ (Aglietta 2000:80). These low wages meant that the working class could constitute only a strictly limited market for consumer goods. Furthermore, the competitive mode of regulation was characterised by an unregulated labour market and limited unionisation which had the effect of depressing wages thus further limiting consumption.

**Phase 2: Intensive Regime of accumulation (Inter-War period)**

After the First World War, the extensive regime yielded was partially supplanted by intensive accumulation. Increased productivity was achieved through technological change and the reorganisation of the labour process. Taylorism and techniques of mass production – the latter instituted on a large scale by Ford in his car factories – transformed the production of consumer goods. The primary tension in this period between the two world wars was that between an emergent intensive regime of accumulation and the existent competitive mode of regulation. The latter, as Tickell and Peck note, ‘was unable to form a social framework where wages could increase in line with productivity growth’ (1991:195). As a consequence the economic system produced more goods (a result of productivity improvements) than it was able to consume (a result of constrained wages). As a result of ineffective demand the economic systems of the developed capitalist countries were plunged into crisis. It was not until after the Second World War that stability was restored through a more harmonious relationship between the regime of accumulation of accumulation and the mode of regulation, one that ensured the supply of goods was met by an adequate demand.
Phase 3: Fordism (1945-1975)

The post-Second World War period has been labelled by regulationists as Fordist. Under the Fordist (intensive) regime of accumulation, one of the dominant characteristics was mass production based on assembly line techniques producing standardised commodities. As Jessop notes (1991), although not all workers or branches of the economy were directly involved in mass production, ‘the important point is that mass production is the main source of its [Fordism] dynamism (1991:136). Fordism, in addition, was characterised by increased productivity due to economies of scale and technological innovation, rising wages for labour resulting in mass demand, patterns of vertical and horizontal integration, and a relatively fluid process of valorisation leading to increased profits. In essence, Fordism represented a reasonably well coordinated system of production and consumption occurring at an unprecedented scale.

The Fordist mode of regulation was characterised by heavy state involvement and which provided suitable conditions for private investment as well as sufficient consumption that allowed the goods that Fordism was so good at producing to be consumed. For example, demand for mass produced commodities was achieved through Keynesian policies which redistributed wealth through, for example, welfare and unemployment benefit programmes. The state also invested in basic physical infrastructure which facilitated the accumulation of capital. Such spending had the effect of further stimulating demand. In terms of the capital-labour relationship, the Fordist state played a central role in coordinating, brokering and creating the legal context for collective bargaining between the two parties. As regulationists have emphasised, the site of the construction and maintenance of the social bargain between capital and labour was the nation state, ‘…the pre-eminent scale where conflicts and tensions were negotiated…and compromises settled’ (Swyngedouw 2000:51). Furthermore, it was the national state which planned and directed economic development.

Fordism in Canada assumed a different form, ‘permeable Fordism’. According to Jenson (1986), the proponent of this formulation, permeable Fordism, as the qualifier would suggest, was characterised by the Canadian economy’s permeation ‘by international – or, more exactly, continental – effects. Its Fordism was designed domestically but always with an eye to the continental economy’ (Jenson 1986:78). After 1945, the Canadian state committed itself to continental integration through the export of resources and the import of capital, and to the pursuit of more open international trade relations. Surely Canada has been international from the get go given the nature of its staples economy based on foreign markets? This occurred in parallel with the paradigmatic features of the Fordist regime of accumulation, mass production
and consumption. The reliance on international markets for the export of resources and the prominent role played by international capital, American in particular, had a determinate effect on the mode of social regulation. Jenson argues that this permeability, and the resultant structural form assumed by the economy, constrained the state with respect to the deployment of a Keynesian macroeconomic strategy. The particular obstacles encountered were uneven regional development as a consequence of the spatiality of the resource economy and the repatriation of profits by international capital which meant that ‘the employment–creating or sustaining effects of high growth were never guaranteed to the Canadian economy…’ (Jenson 1986:80). Then why did it do so well during the Fordist period? The Canadian economy turned sour only as Fordism declined and we moved to post-Fordism. I realise that is a question for Jenson rather than you.

**Phase 4: Post-Fordism (1975-present)**

The first signs of the unravelling of the relatively harmonious relationship forged under Fordism were evident in the late 1960s. According to Aglietta (2000), the crisis of Fordism stems primarily from technical and social limits of the Fordist production system. Within Canada, the permeability of the national economy meant that it too entered into crisis. Continental integration imposed limits on the way the Canadian state could respond to the crisis. Jenson (1986) notes, in particular, the fact that Canada’s branch-plant economy (Levitt 1970) meant that research and development for technological innovation was not taking place domestically, and the resource-based economy was particularly vulnerable to increases in oil prices.

While technical limits were manifested through stagnating productivity and declining profits, social limits were reached as labour began to resist efforts by capital to intensify production. Profitability was further adversely affected by rising real wages – a consequence of the particular Fordist mode of regulation – as well as declining demand for mass produced, standardised commodities. For David Harvey, these problems were symptomatic of the *rigidities* of Fordism. There were problems with the rigidity of long-term and large-scale fixed capital investments in mass-production systems that precluded much flexibility of design and presumed stable growth in invariant consumer markets. There were problems of rigidities in labour markets, labour allocation, and in labour contracts… The rigidities of state commitments also became more serious as entitlement programmes (social security, pension rights, etc.) grew under pressure to keep legitimacy at a time when rigidities in production restricted any expansion in the fiscal basis for state expenditure (1989:142).
The regime of accumulation that followed Fordism, most commonly referred to as post-Fordism, was defined by the antithesis of rigidity, flexibility. "Flexible accumulation", as post-Fordism was also called, was characterised by the emergence of entirely new sectors of production, new ways of providing financial services, new markets, and, above all, greatly intensified rates of commercial, technological, and organisational innovation (Harvey 1989:147). The rigidities of Fordism, embodied in massive production complexes dominated by the long-run production of mass commodities, have yielded, partially, to small-batch short-run production in spatially diffused sites of production, specialised niche markets, the diversification of production, and frequently changing consumer preferences. The emergence of new technologies, founded on the microchip, have helped in the consolidation of both post-Fordist production and consumption. For example, computer aided design and manufacturing (CAD-CAM) have sped up the process of producing commodities which, in turn, serve the post-Fordist tendency towards the production of more individualised and short-run commodities. In contrast to the mass market of the Fordist regime of accumulation, contemporary markets of the advanced capitalist countries are distinguished by the demand for consumer goods with a complex set of attributes beyond that of durability and price. Consumers increasingly seek commodities that are differentiated by, for example, brand, quality and origin.

Although there has yet to emerge a consensus about the mode of regulation associated with post-Fordism (although neo-liberalism is the mode most talked about), there has been a significant transformation in the ways in which regulation proceeds. For example, the nation state has been displaced, to a certain extent, as the site of contestation, compromise and settlement. The emergence and consolidation of supra-national institutions such as the World Trade Organisation (WTO) and the North American Free Trade Agreement (NAFTA) have resulted in the expansion of the sphere of regulation towards the global. The so-called “hollowing out” (Jessop 1994) of the nation state – where welfarism is usurped by the dictates of international competitiveness – implies a regulatory restructuring within the local and regional that must be sensitive, accommodating even, to global processes of accumulation. As Jessop (1993:10) argues,

[The nation-state’s] capacities to project power even within its own national borders are becoming even more limited due to a complex triple displacement of powers upward, downward, and, to some extent, outward (1992:10).[^9]

[^9]: See below for a discussion on ‘glocalization’.
Swyngedouw (1992), in an alternate yet complementary formulation of this process of the displacement of the nation state, one which he terms ‘glocalization’, states that,

Global corporations, global financial movements and global politics play a deciding role in the structuring of daily life, while simultaneously more attention is paid to local and regional responses and restructuring processes. There is, in other words, a double movement of globalisation on the one hand and devolution, decentralisation or localisation on the other…(1993:10)\textsuperscript{10}

The dominant state form, characterised as neoliberalism, attempts to enable accumulation within this particular political economic context through various institutional arrangements (Harvey 2005). These include the deregulation and re-regulation of institutions to free the movement of capital between economic sectors, regions and countries. What has emerged in place of the institutional arrangements which marked the Fordist state is a form termed the Schumpeterian workfare state. Jessop (1994) describes it as thus:

In abstract terms, its distinctive objectives in economic and social reproduction are: to promote product, process, organisational and market innovation in open economies in order to strengthen as far as possible the structural competitiveness the national economy by intervening on the supply side; and to subordinate social policy to the needs of labour market flexibility and/or the constraints of international competition. In this sense it marks a clear break with the Keynesian welfare state as domestic full employment is downplayed in favour of international competitiveness and redistributive welfare rights take second place to a productivist reordering of social policy (1994:263).\textsuperscript{11}

In essence, the national economic development objectives of the Fordist-Keynesian arrangement have been partially superseded by an emphasis on international competitiveness facilitated by a new set of institutional arrangements within the post-Fordist regime of accumulation.

**Local Regulation**

One of the criticisms levelled at regulation theory has been its fixation on the nation state as the site of regulation, an untenable position given the regulationists’ insistence on the declining ability of the nation state to regulate the conditions conducive to accumulation (Peck and Tickell 1992, Jessop 1990). As a consequence, and from the late 1980s, there have been various attempts to develop an account of ‘local spaces of regulation’. Goodwin et. al. (1993) argue, for instance,

\textsuperscript{10} See below for a fuller discussion on ‘glocalization’.

\textsuperscript{11} This is not to suggest that the Schumpeterian state is in any sense a final form. As Jessop notes, there are variations of the Schumpeterian state and these variations are themselves reflective of the dynamic quality of post-Fordism (Jessop 1994).
that the local state and local agencies should be viewed as vehicles of ‘local modes of regulation’. The local state is seen as central to the creation, orchestration and restructuring of local spaces of regulation, particularly under Fordism (Collinge 1999). Following the post-war settlement between capital and labour, the local state was instrumental in fostering the conditions required for production and reproduction. Infrastructure for economic production, the provision and management of welfare, and the reproduction of labour were some of the major activities of the local state (Goodwin and Painter 1996). Under Fordism, the articulation of local states with the national state was characterised by a catering on the part of local states to the dictates of accumulation strategies formulated by, and for the benefit of, the nation state as a whole (Brenner 2004). Local histories and geographies, however, play a pivotal role in the constitution of economic spaces which, in the context of national accumulation systems and modes of social regulation, result in uneven development.

While early attempts to wrestle with the issues of local regulation and uneven development, Peck and Tickell (1992a; 1992b) in particular, were based on the experience of local governments under Thatcherism in the south of England, they yielded an embryonic conceptual framework applicable to a variety of local spaces. Peck and Tickell proceed from the observation that nation-states are characterised by ‘…nationally-specific couplings between the accumulation system and the mode of social regulation’ (Peck and Tickell1992:351) and that this coupling must be functional at the level of the nation-state. The variation in couplings between the accumulation system and the mode of social regulation lead Peck and Tickell to the conclusion that there must be distinctive and variegated couplings at the regional and local levels.

Regional accumulation systems, embedded within a wider spatial division of labour, presumably interact with regional and national regulatory structures in different ways, producing yet further unique regional effects. (1992a: 352)

The functionality or success of these couplings is conditioned by pre-existing local and regional histories such that ‘…the concrete form of uneven development will be contingent upon prior patterns of uneven development’ (Peck and Tickell 1992a:352). The place-based specificity of regulation is further emphasized by Storper and Walker (1989) who argue that, with respect to the emergence of new industrial spaces, regimes of accumulation and their concomitant modes of social regulation are variegated as a consequence of the ‘…large-scale social, institutional and
political arrangements of places – hence the range of regimes built on much the same technological foundations in different areas of the capitalist world’ (1989:215).12

The coherence of particular places is linked to wider regimes of accumulation and modes of social regulation (Cloke and Goodwin 1992). Thus, under the Fordist-Keynesian regime of accumulation, the coherence of localities and regions was linked to broader strategies of accumulation and regulation coordinated by the national state. Brenner argues that these strategies were aimed at promoting ‘…capitalist industrial growth by alleviating uneven geographical development within each national economy’ (2004:462). Coherence was achieved, with varying degrees of success, through the transformation of regions into the ‘building blocks’ of national economic development and through the alleviation of uneven development within national economies. That is, the role of the local or regional state, within the context of national accumulation strategies, was the encouragement of regional industrial development in the interest of achieving or maintaining full employment (Jessop 2006).

The dissolution of the Fordist-Keynesian regime then, threatened the articulation of local regulation with wider national regimes of accumulation and modes of social regulation. The ascendancy of the local and global in the aftermath of this dissolution has resulted in increased attention being placed on the issue of scale or ‘rescaling’ (Brenner 2001; Crump and Merrett 1998; Mamadouh et al. 2004; Marston 2000; Marston et al. 2005, Uitermark 2002).13 At the risk of oversimplification, it can be noted that the problematisation of scale has resulted in the movement away from the notion of scale as an ontological given to its social production and construction.

With respect to its production, Smith (2000), argues that there is nothing natural or given about scale but that it is ‘a central organising principle according to which geographical differentiation takes place’ (2000:725). For Smith, the production of scale is not arbitrary or voluntaristic. The ordering of scale is, instead, conditioned by the ‘logic of capitalist expansion…’ (Smith 2000:725). This political economy of scale has been critiqued by, inter alia, Marston (2000; 2006).

12 These formulations are resonant with David Harvey’s notion of ‘structured coherence’, that is, a complex of social relations and processes, within a locality, which allows accumulation to take place. Structured coherence …embraces the forms and technologies of production (patterns of resource use, inter-industry linkages, forms of organisation, size of firms), the technologies, quantities, and qualities of consumption (the standard and style of living of both labour and the bourgeoisies), patterns of labour demand and supply (hierarchies of labour skills and social reproduction processes to ensure the supply of same), and of physical and social infrastructure… (Harvey 2001:328-329)

13 As Crump and Merrett (1998) note: ‘Scale is a foundational concept in geography. However, it is perhaps the slipperiest and most abstract of geographical concepts…’ (1998:609).
2005) for neglecting processes of social reproduction and the household as meaningful scale, sites often absent in the literature on globalisation and scale. Marston (2000) illustrates, using her empirical work on late 19th century and early 20th in the United States, that urban middle-class women actively constructed and re-constructed scale ‘in negotiating new and extant cultural ideas about their proper ‘place’ in social life’ (2000:235).

One of the more useful products of the recent literature on ‘rescaling’ has been the idea of the fluidity of scale, its definition and redefinition. As Crump and Merrett (1998) state, from a regulationist perspective,

(If) localised regimes of accumulation evolve, they do not somehow exist apart from regulatory processes operating at other scales. Global, national and local regulatory processes are inherently and deeply intertwined. Moreover, they are not static – scales of regulation are in constant turmoil, particularly in times of economic crisis and restructuring (1998:499).

This has been most forcefully presented by Swyngedouw in his concept of ‘glocalization’ (1997). He notes that in the post-Fordist epoch, there is a contested process in which ‘regulatory codes, norms, and institutions are spatially shifted from one scale to another’ (1997:156). However, and echoing Smith (2000), Swyngedouw argues that ‘the accumulation imperative (which is, of course, always place-bound) and the quest to sustain the circulation of capital seems to be of paramount importance…’ (1997:156).

In essence, the role of the contemporary local state, within the post-Fordist regime of accumulation, is to make local and regional economies competitive in the new global economy.14 As a consequence, local states have a growing, vested interest in formulating regional labour market policies, developing education and training in competitive economic spheres, and in supporting regional innovation centres. By making themselves attractive to global capital, and through the disarticulation of local and national modes of social regulation, sub-national spatial entities enter into competition with each other. While the Fordist-Keynesian regime of accumulation had as one of its core strategies the amelioration of uneven development, the differentiation of spaces of regulation characteristic of post-Fordist regimes tends towards an exacerbation of uneven development (Goodwin and Painter 1996). Local places compete for scarce resources issuing from the central government, which forces them into ‘…the competitive

14 Two concrete examples of the reorientation of local/regional regulation towards serving the interests of global competitiveness are offered in Chapter 5 of this thesis.
process of attracting jobs and investment by bargaining away living standards and regulatory control’ (Peck and Tickell 1994:280-281).

**Food Regimes**

The concept of food regimes represents an attempt to conceptually link food production and consumption to regimes of accumulation by charting historical changes in national and international agricultural practices. In their seminal work on food regimes, Friedmann and McMichael explicitly draw on Aglietta (2000) when they note that ‘we organize our argument around the concept of the food regime, which links international relations of food production and consumption to forms of accumulation broadly distinguishing periods of capitalist transformation since 1870…’ (1989:95). They further argue that

It allows us to characterise late nineteenth century capitalism as an extensive form constructing capitalist production relations through the quantitative growth of wage labour; and mid-twentieth century capitalism as an intensive form reconstructing consumption relations as part of the process of capital accumulation… (Friedmann and McMichael 1989:95)

In a later intervention, Friedmann states that a food regime is a ‘rule-governed structure of production and consumption of food on a world scale’ (1993:30-31). Thus within the Fordist-Keynesian regime of accumulation, the ‘rules defining the food regime gave priority to national regulation…’ (Friedmann 1993:31). Friedmann also extends the discussion of food regimes by considering in detail the implications of the current post-Fordist regime of accumulation (discussed in detail below).

The periodisation of food production and consumption according to principle tendencies, governing premises, main historical features, and international and national policy features, mimics that of regulation theory from which it is derived. The analytic utility of the concept of food regimes lies in its ability to situate national agricultural production and attendant state policies within a global context. This global context encompasses changes in production practices, trade patterns and consumption trends. Given its indebtedness to regulation theory, particularly the Fordist/post-Fordist dichotomy, the concept of food regimes provides insights into the changes in food production and consumption in concert with broader economic shifts at

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15 Although Page and Walker (1991) argue, through an analysis of agriculture and industry in the U.S. Midwest in the 19th century, that the process of intensive accumulation was well in place before the advent of Fordism as conceptualised by Regulationists.
the global level. Furthermore, the identification of a “post-Fordist” food regime allows concrete links to be established between agrarian restructuring at a regional and local level and the restructuring of the global economy. Three food regimes have been identified: the first regime (extensive) which was consolidated before World War II; the second (Fordist) from the 1950s to the 1970s; and the third (Post-Fordist), current food regime, which emerged in the 1980s (Table 1).

Table 1: Schema of Food Regimes

<table>
<thead>
<tr>
<th>Food Regime</th>
<th>First (Extensive) (pre World War II)</th>
<th>Second (Fordist) (1950s-1970s)</th>
<th>Third (Post-Fordist) (1980s-present)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle tendencies</td>
<td>Culmination of colonialism. Rise of nation-state system</td>
<td>Extension of state system to former colonies. Transnational restructuring of agriculture by agro-food capitals</td>
<td>Contradiction between productive forces and consumption trends. Disintegration of national agro-food capitals</td>
</tr>
<tr>
<td>Main international policy features</td>
<td>Imperial preference, with vertical hierarchical relations.</td>
<td>Bretton Woods agreement, post-war reconstruction programmes. Multilateralism. Commodity agreements and conventions.</td>
<td>Attempts to resolve world agricultural trade issues through WTO framework.</td>
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Food Regime | First (Extensive) (pre World War II) | Second (Fordist) (1950s-1970s) | Third (Post-Fordist) (1980s-present)
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Source: Adapted from Le Heron (1989)

Extensive Food Regime (1870s – 1950)

The first food regime was founded on the export of staples – wheat and meat in particular – from the settler states of North America, Southern Africa, and Australia, to the metropolitan centre. Manufactured goods, labour and capital were, in turn, exported to these states by European nations. The movement of low cost food staples – produced by family labour on land appropriated through colonisation – to Europe underwrote the development of wage labour. The reverse flow of manufactured goods, labour and capital to the settler states enabled the development of industrial capitalism in agrarian economies. The first food regime resulted in the integration of economic sectors in the settler states, particularly in the United States, through the domestic demand for industrial goods created by settler export agriculture. The first food regime also witnessed the first flowering of industrial agriculture, a nascent agro-industrial complex (Friedmann and McMichael 1989:103). While settler agriculture was founded on family-farm labour supplemented by the seasonal use of off-farm labour, the use of industrially produced chemicals and machines drew settler family farms into the orbit of industrial capital (Goodwin, Sorj and Wilkinson 1987). The scale of these farms coupled with the dearth of labour compelled the move towards industrially sourced inputs. Given the distant markets for settler agricultural commodities, industrial capital played an indispensable role by creating the transportation infrastructure allowing the movement of commodities and people between centre and periphery. Railways facilitated the movement of agricultural commodities from farm to processor to port, while ships transported commodities to their destined markets. The first food regime corresponds to what Aglietta refers to as an ‘extensive regime of accumulation’ characterised by a waves of capitalist development into new economic sectors – agricultural implements for example – and new regions (2000:71). The role played by agriculture within this regime of accumulation – as a provider of food to the emergent working class and urban dweller and as a consumer of durable goods – is signalled ‘by the formation of the agriculture-foodstuffs complex’ (Aglietta 2000:71).
The first food regime began to be undermined by the global economic recession of the late 1920s and early 1930s. The global recession, which had been preceded by an economic boom following the end of the First World War, resulted in a breakdown of international trade and a fall in the price of agricultural commodities. During the short economic boom following the end of the war, farmers invested in new agricultural technologies in an attempt to increase yield. The result, in the context of decreased consumer demand, particularly in Europe, was a crisis of over-production and, consequently, of valorisation (Madsen 2001). The disruption to the pattern of international trade was exacerbated by the adoption, on the part of most Western nations, of protectionist measures against imports, including agricultural commodities.16 In the United States, and playing a central role in the precipitation of the global recession, tariffs on imported agricultural commodities were raised and agricultural production was subjected to distortion through state programmes that purchased at guaranteed prices and purchased surpluses (Hobsbawm 1994). While the dissolution of the trade regime which had been initiated in the late 19th century resulted in the destruction of the first food regime, certain processes which featured in the second food regime were seeded during this earlier phase.

**Fordist Food Regime (1950-1970s)**

The **second food regime**, which emerged after the Second World War and lasted until the end of the 1970s was Fordist in character. Food was mass produced, durable, and standardised.17 Canned, frozen and dehydrated, this food was manufactured for family consumption within households populated by appliances such as freezers and microwave ovens. Staples such as wheat were industrially transformed into end products, bread in particular, whose durability was enhanced through chemical preservatives. The restructuring of food retailing accompanied changes in consumption. The necessity of the daily procurement of foodstuffs – in highly perishable form with no means of preservation – was obviated through the emergence of supermarkets. These supermarkets, which accompanied the mass adoption of personal mobility through the car and the process of suburbanisation, mirrored the convenience of the foods they sold. The durability of the foods being sold, coupled with the opportunity to fulfil a households weekly food requirements at a single store, transformed the (gendered) chore of food shopping (Goodman and Redclift 1991).

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16 There was as well an increase in wheat production in Europe, Germany and Italy in particular. The threat of impending war and the global recession had compelled a move towards agricultural self-sufficiency in much of Europe, thus reducing the demand for agricultural commodities from settler states. (cf. Friedmann 1982).

17 This is not to suggest that such foods were not produced before the second food regime. For example, beginning in 1896, canned salmon was produced in Delta and exported to England (Philips 1988).
The Fordist transformations in consumption reflected a similar transformation in agriculture and food production. As noted above, the industrialisation of agriculture,\textsuperscript{18} – the substitution of ‘natural’ inputs by synthetic products, and mechanisation – had begun in the first food regime, primarily as a consequence of broader political economic forces. Within the second food regime, agricultural industrialisation, or the intensification of food production, became one of its defining characteristics. The agri-food chain, from seed preparation to end product, came within the orbit of industrial capital. The exception was the direct production of agricultural commodities, the actual ‘farming’, which was executed through family ownership and control. Despite the absence of industrial capital at the site of production, farms became larger, although there were fewer of them, and were highly capitalised. This particular regime also witnessed the intensification of agricultural specialisation, for both firms and regions, and the increased use of agricultural products as inputs for manufactured goods as opposed to end products in themselves (cf. Goodman, Sorj, and Wilkinson 1987). While most of these features appeared earlier during the first food regime, it was only within the second food regime that they became generalised and came to distinguish food production and consumption.

The pattern of international trade during the second food regime assumed a distinct form compared to the first food regime. Protectionist in nature, the international trade in agricultural commodities was conditioned primarily by American policy. As Friedmann notes,

\begin{quote}
Because the United States protected its own domestic markets, other countries were constrained to adopt similar agricultural policies focused on the national market. US trade restrictions, designed to protect domestic farm programmes, encouraged other states to focus on their own national agri-food sectors. (1993:32)
\end{quote}

The second food regime was the period of consolidation of national regulation aimed at supporting domestic agriculture through such instruments as price support and production subsidies, policies which ultimately resulted in overproduction.\textsuperscript{19} Friedmann (1993:34) suggests that domestic farm policy, particularly in the United States, accounted for the persistence of family farms while encouraging their incorporation into the circuit of agro-industrial capital. This

\textsuperscript{18} The industrialisation of agriculture is discussed in greater detail below.

\textsuperscript{19} The Common Agricultural Policy (CAP), adopted by European Economic Community in the early 1960s, is an example of multi-lateral regulation supporting domestic agriculture. Part of the rationale for the CAP was food security, a concern in light of the uncertainty created by two world wars and a global depression.
led to a technological dependence on the part of farms and to increased specialisation. In particular, the separation of livestock production from cereal production, by agro-industrial capital, is cited as one of the more significant features of the second food regime (Friedmann and McMichael 1989; Friedmann 1993). The scale, concentration and intensity of production, coupled with the necessity of producing standardised agro-food commodities, compelled this specialisation. The previous organic link between grain and livestock, the production of which occurred on the same farm, had been disassembled by agro-industrial capital and reconstituted as a series of industrial inputs which mimicked Fordist industrial production.

The fostering and protection of national agricultural economies through regulation such as price support and production subsidies has been identified as one of the main historical features of the second food regime. While this may suggest a disarticulation of national agricultural economies from the global economy, there was a countervailing process that formed the core of the international food regime. Even though agricultural commodities were restricted in their international movement, capital had no such constraints. The integration of the agricultural sectors of national economies was accomplished through the chain which stretched from the industrial production of inputs through to the processing of raw commodities into manufactured foods. Meat production was emblematic of this process. For example, soy and hybrid maize produced in the United States served as feedstock for livestock raised in Europe. Spatial constraints in Europe precluded the extensive cultivation of grains. The international integration of national agricultural sectors was further compelled by the requirement to produce large quantities of standardised, highly processed foods for sale in supermarkets. The industrial processes required for the production of these foods, and the resources required for their distribution and marketing, were only accessible to transnational agro-industrial capital represented by such corporations as Heinz, Kellog, Del Monte, Nabisco, Coca-Cola, Pepsi, Nestle, and Unilever.

In the early 1970s the second food regime entered a period of crisis. The crisis of capitalist accumulation – the crisis of Fordism – which distressed the global economy had as one of its victims the second food regime. The combination of the collapse of Bretton Woods system – which imposed some order on the global economy –, soaring grain prices which were a consequence of increased fuel costs and the U.S.-Soviet grain deal, and the antagonism between states and between states and capital over domestic agricultural protectionism, led to a serious disarray in international trade (Friedmann 1993). Within this context, the institutionalised overproduction characteristic of the second food regime – encouraged by domestic policies in the
advanced capitalist states and enabled by technological change – was threatened by the retrenchment of state support for agriculture (Pritchard 1998). Furthermore, as Friedmann stresses,

(T)ransnational corporations outgrew the national regulatory frameworks in which they were born, and found them to be obstacle to further integration of a potentially global agro-food sector. (1993:39, emphasis in original)

**Post-Fordist Food Regime (1980-present)**

The demise of the second food regime has created the space for the emergence of a new – third – regime of global food and agricultural production. Like the Post-Fordist regime which with it is associated, the third food regime is still evolving. Given the centrality of the concept of stability as a defining characteristic of a regime – food or accumulation – it would be premature to consider a third food regime as a fait accompli. However, there are tendencies and processes emergent on the global stage – some of which have consolidated themselves – that allow the current period be distinguished from the second food regime. This despite the fact that aspects of the second food regime such as the mass production of durable foods continue to be a feature of the contemporary landscape of food and agriculture.

One of the more significant features of the current agro-food landscape is the transformation in consumption patterns. While the second food regime was characterised by the mass consumption of standardised industrially produced foods – Fordist in character – current food consumption patterns bear the hallmark of heterogeneity. Within the last two decades, the food market has been fractured into a multiplicity of niches catering, for example, to consumers desirous of organic, ‘premium’, fair-trade, ‘exotic’, and ‘embedded’ foods. As Marsden (1998:110) puts it, ‘…food markets are becoming more differentiated on the basis of a range of socially constructed food quality criteria’. The perceived ills of conventional or productivist provisioning systems – primarily ecological, social and cultural –, and increased consumer concerns about food safety and nutrition, have resulted in the emergence of alternative food networks (AFNs) 20 (Murdoch et. al. 2000). Such networks, which constitute links between producers, consumers, retailers, and other agents, exist in tandem with conventional food networks. The anonymity of industrial production – reflected in the ‘fetishised’ agro-food commodity (Goodman 2004) – is rejected in

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20 For example, food ‘scares’ such as the possibility of the transmission of bovine spongiform encephalopathy (BSE) from infected meat to humans, has resulted in the emergence of an organic meats sector eschewing industrial production practices.
favour of *transparent* agricultural production systems. Such transparency is ‘…met by schemes to assure quality, provenance and traceability, organic agroecological production practices, and forms of direct marketing’ (Goodman 2004:5). Thus the emergence of niche markets for food mirrors that of the fracturing of markets for consumer goods under the current regime of accumulation (Harvey 1989b).

One key attribute of AFNs is the shortness of some of the supply chain (Marsden et. al. 2000; Renting et. al. 2003). In contrast to the long, complex, and rationally organised chains of agro-industrial production, short supply chains can be represented by the link between local production and local consumption – farmer’s markets for example – or the circumvention of the agents of agro-industrial capital, such as the provision of fair-trade commodities. Short supply chains constitute a delinking from the global agricultural commodity production complex and have the capacity to ‘…resocialise or respatialise food, thereby allowing the consumer to make new value judgements about the relative desirability of foods on the basis of their own knowledge, experience, or imagery’ (Renting et. al. 2003:398). For farmers affected by national agricultural deregulation – one of the consequences of the retrenchment of the neoliberal state with respect to national economic development – including the erosion of price support and subsidy programmes, and the unequal exchange between farmers and an increasingly concentrated agro-food capital, short supply chains represent a means of survival and of capturing value. In essence, the shorter the chain between producer and consumer, the greater the value retained by the primary producer.

Renting et. al. (2003) suggest that the length of the supply chain is a more accurate measure of the alterity of a food than its quality attributes. Short supply chains imply the vertical desegregation of production and more horizontal networks of food provisioning. Conceptually, the adoption of the criteria of short supply chains as an essential characteristic of alternative foods confronts the appropriation by agro-industrial capital of ‘quality’ foods. For example, the most prominent of the alternative foods, organics, are firmly entrenched within the circuits of agro-food capital. Guthman (2004), for example, has documented this process within the context of organic farming in California. Guthman argues that the price signals provided by the retailing and processing sector have attracted large farms with no ideological commitment to organic farming. Agro-industrial capital’s entry into organic production, coupled with high land rents resulting from successive rounds of investment, have compromised the ability of low-input, small scale organic producers to adhere to their principles while competing in the market.
The unshackling of capital, finance capital in particular, through deregulation effected by neoliber states at the behest of such supra-national bodies as the World Trade Organization – one of the hallmarks of the Post-Fordist regime – has resulted in the transformation of capitalist agriculture. Since the demise of the second food regime, there has been an unprecedented concentration of capital within the agro-food sector (Friedmann 1993). What distinguishes the present structure of the global agro-food industry from that of the second food regime is the control exercised by a single corporation, or a cluster of associated corporations, over the whole chain of food production from the creation of seeds to the retailing of foods. In other words, a complete vertical integration. Such integration is accomplished not just through mergers and acquisitions but also through exclusive contracts with farmers, joint ventures, partnerships and, less formalised relationships, such as agreements and side agreements. Within the second food regime, control by corporations was primarily restricted to discrete sectors of the system such as the production of livestock feed or processing. As Heffernan (1999) puts it:

In a food chain cluster, the food product is passed along from stage to stage, but ownership never changes and neither does the location of the decision-making. Starting with the intellectual property rights that governments give to the biotechnology firms, the food product always remains the property of a firm or cluster of firms. The farmer becomes a grower, providing the labour and often some of the capital, but never owning the product as it moves through the food system and never making the major management decisions. (1999:3)

To invoke the language of the regulationists, agricultural production within the ‘third regime’ is characterised by a certain flexibility. Harvey (1989:147) defines flexible accumulation as the

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21 This is not to suggest that there were not any vertically integrated agri-food corporations prior to the third food regime. For example, in the 1970s, McCain’s Foods of New Brunswick was a fully vertically integrated corporation by the 1970s. As Winson (1985) notes: ‘Potatoes are grown on McCain land (Valley Farms Ltd) enriched by McCain fertilizer (McCain Fertilizers Ltd) using McCain seed (Foreston Seed Co. Ltd). Harvesting is done with McCain machinery (Thomas Equipment Ltd) and the harvested potatoes are either stored in McCain facilities (Carleton Cold Storage Co. Ltd), sent to McCain’s plant for processing (McCain Foods Ltd) or sold fresh. In the latter case, the potatoes are handled by McCain shippers (McCain Produce Co. Ltd) which use McCain trucks (Day and Ross Ltd) to move them to McCain storage facilities (Bayside Potatoport Ltd) at the point of shipping. The processed potatoes can similarly be moved in McCain trucks (M. & D. Transfer Ltd) for shipment abroad where one of McCain’s sales distribution systems (McCain International Ltd) handles the marketing’ (1985:432).

22 The restructuring of the retail sector is discussed in greater detail in Chapter 5.

23 Heffernan (1999) identifies three major globalised clusters: Cargill/Monsanto, Novartis/ADM, and ConAgra. Cargill/Monsanto combines Cargill’s extensive seed capacity with Monsanto’s biotechnology expertise. Novartis is a recent Swiss merger of CIBA-Geigy and Sandoz; it has agribusiness operations in 50 countries, focusing on crop protection chemicals, seeds, and animal health. This merger, followed by the acquisition of Merck, makes Novartis the leading agrochemical firm, with 15 percent of the global agrochemical market. ConAgra: with diversified interests ranging from “farm gate to dinner plate,” a ConAgra subsidiary can be found along most links of the food chain. Heffernan (2002) documents similar patterns in the U.S. dairy and retailing sectors.
‘…emergence of entirely new sectors of production, new ways of providing financial services, new markets, and above all, greatly intensified rates of commercial, technological, and organizational innovation’. Thus the rigidities of Fordist production and consumption patterns have yielded to more fluid processes characterised by a capillary capital seeking out markets. Technological innovation, molecular in particular, has allowed agro-industrial capital to create seeds, processing techniques, and foods that allow it to thrive in an increasingly fractured market, and to compete, within those markets, against short supply-chain producers. Within AFNs, organisational innovation, essentially a levelling out of the supply chain, has allowed producers to meet the requirements of a plethora of niche food markets. In the agro-industrial sector, which is structurally markedly different from the AFNs, organisational innovation encompasses the concentration noted above while, and this may seem ironic, possessing the ability to be transnational in their corporate constitution, multinational in their sourcing, and global in their consumer marketing strategies (Konefal et. al. 2005). However, unlike manufacturing, there are limits to the degree of flexibility that can be achieved: limits imposed by the bio-physical nature of agricultural production. The relative immutability of the growth cycle of plants and animals confronts capital in its attempts to reduce turnover time which, as Harvey notes, is ‘…always one of the keys to capitalist profitability’ (1989:156).

That these two systems of production – agro-industrial and niche – exist under the same regime is a reflection of the transitory quality of the both post-Fordism and the third food regime. As Ilbery and Bowler observe, ‘…the two diverging pathways coexist’ (1998:57), due to the (C)hanging characteristics of the global labour force, which is fracturing the demand for food. On the one hand is the growth of new ‘Fordist’ consumers in NICs [newly industrialized countries], served by large specialised agri-industry farm complexes. On the other hand is the development of ‘green’ consumerism within social elites in developed countries served by smaller specialty producers.

In sum, regulation theory and its offshoot, the concept of food regimes, forms one of the two conceptual pillars of my analysis. Its utility lies in its ability to provide a framework for understanding the historical transformations in agriculture in Delta, in particular the emergence of the greenhouse tomato industry. Furthermore, the conceptual tools offered by regulation theory, the notion of local regulation for example, for my case study. That said, and as already alluded to, regulation theory and its off-shoots fail to deal conceptually with the biophysical basis of industrial agriculture represented, for example, by greenhouse tomato production. It is for this reason that I now turn to the political economy of agricultural industrialisation.
Critique Of Conceptual Framework

As Hart (1998) puts it, ‘the first and most obvious problem with [regulation theory] resides in the argument that forces emanating from the “core” are determinate’ (1998:336). Hart offers the examples of Korea and Japan whose experience, she notes, ‘challenge key assumptions of regulation theory… (1998:336). This tendency on the part of regulationists towards what Barnes (1996) terms ‘totalization’, is the result of the construction of a general model of economic structure and change based on a handful of spatially and temporally delimited cases. Thus the concept of Fordism, read off from the history and geography of the United States in the 20th century, acquires a universalism characterised as the ‘tendency to derive sweeping systematic claims from quite specific studies or stylizations of firms or industrial sectors’ (Hart 1998:336). For example, in her critique of Lipitez’ (1987) notion of peripheral Fordism, Amsden (1990) notes that his method is ‘one of trying to understand the periphery in terms of the center’ (1990:9). In other words, Lipietz imposes an alien conceptual framework on ‘peripheral’ social formations and, in doing, elides the place-based specificity that (partly) conditions paths of capitalist development.

Brenner and Glick (1991), in their sustained theoretical and empirical critique of regulation theory, argue that

The general weakness of Regulation Theory…is its failure to take adequately into account the broader system of capitalist social-property relations that forms the backdrop to their succession of institutionally defined phases (Brenner and Glick 1991:105).

This failure, claim Brenner and Glick, and the resultant construction of discrete historical epochs such as that represented by Fordism, leads to a general neglect or de-emphasising of, in particular, the dynamic effects of inter-capitalist competition. For example, and with respect to the extensive regime of accumulation and its demise, Brenner and Glick argue that the regulationists’ insistence on an epochal break founded on the nature of technological change and the labour process is a misrepresentation of capitalist development. While the regulationists insist that the transition between the extensive and intensive regimes of accumulation was partially determined by a wholesale transformation in the control over the labour process – from workers to capitalists (Taylorism) – Brenner and Glick note that the capitalist labour process has, since before the Industrial Revolution, ‘been transformed and re-transformed through new techniques…’
(1996:58). The impetus for technological change throughout the history of capitalist development was the necessity for individual capitals to survive in a climate of competition (Marx 1992).

The notion of discrete historical epochs based on certain key distinctions has been further challenged by Page and Walker (1991). Using the American midwest in the 19th century as their empirical case, Page and Walker state that Aglietta’s ‘reinterpretation of U.S. development is based on a profound misreading of American, and especially midwestern, history’ (1991:308). The crux of Page and Walker’s argument is that, contra Aglietta, the midwest United States was not characterised by extensive accumulation. That is, the distinctive features of capitalist development were not the expansion of the frontier, resource extraction, stagnant industrial productivity, or low consumption. Page and Walker argue, for example, that ‘American industrialisation and mass production had been in motion for over a century before [Ford’s] experiments with the moving assembly line’ (1991:308). They point to an extensive complex of innovative manufacturing industries in the region thus vitiating the regulationist claim of technological stagnation in the 19th century. Furthermore, claims of underconsumption are countered by the marshalling of evidence demonstrating that ‘mass consumption of standardised goods had been the hallmarks of American commerce throughout the nineteenth century…’ (1991:309).

In more abstract terms, Gibson-Graham (1996) argues that regulationism, despite its claim that the form assumed by the model of development (which consists of the regime of accumulation, mode of social regulation and their relationship) is a matter of contingency, is characterised by a conception of the social formation as a bounded totality.

Independent of and prior to the actual social formations to which it gives form, the model of social development is a social skeleton or template that organises and arrays specific social existences and practices. Particular forms of capitalist society may be generated by “historical accident” and open-ended political and ideological struggles, but the general form of capitalist society is a theoretical given (Gibson-Graham 1996:153).

With the demise of Fordism, the conceptual framework which undergirded the description of the Fordist epoch – and which was a product of concrete historical analysis – is recycled or resurrected to serve the characterisation of the post-Fordist period. Gibson-Graham labels this tendency structural essentialism which, in effect, inhibits the construction of ‘alternate visions and projection’ (1996:154). Furthermore, Gibson-Graham argues that the centering of the process of capital accumulation within regulation theory has a similar effect. The role of the various
elements of the mode of regulation is to facilitate continued capitalist accumulation. As a consequence of this centering, in moments of crisis – reaching the technical limits of production, for example – the shocks experienced at the centre, within the process of accumulation, radiate out to ‘destabilize the entire social and economic formation’ (Gibson-Graham 1996:155). The privileging of the accumulation process – which results in a centripetal relationship with other elements of the social formation in moments of stability and a centrifugal one in moments of crisis – again delimits both the subject and space of politics. The collective subject – the capitalist worker, for example – is defined in relation to the accumulation process and which tends towards the marginalization of identity politics. That is, political movements founded on, for example, gender, race or sexuality ‘cannot alter society’s fundamentally capitalist nature’ (1996:157).

Gibson-Graham’s critique of regulation theory reflects her general critique of the discourse of the ‘idea’ capitalism in general, and Marxism in particular. One of her central arguments is that Marxists identify a whole range of social practices and institutions, from commodification to industrialization or whole nations, as "capitalist". This tendency towards totalization is coupled with an essentialism, as identified above, in the form of capital accumulation as the motive force of history. These conceptualisations result, she further argues, in subordination, domination or marginalisation of other distinctive forms of economic production (modes of production), particularly the growing category of self-employed workers and domestic labour.24

The concept of food regimes has also been subjected to its share of criticism, the most trenchant of which have issued from Goodman and Watts (1994) and Moran et al. (1996). Their central claim is that the construction of food regimes is flawed as a consequence of the concentration on too few commodities and countries. Thus the reading of the second food regime from the intensive production of food in the West is, at best, a partial and abstract approximation of the patterns of global food and agricultural production. Given that the concept of food regimes is directly derived from the regulationist practice of periodisation – the periodisation employed by both schools is identical and the food regimes concept is an attempt to deploy a conceptual schema founded on an analysis of industrial production to the case of agriculture – the nature of the critiques of the concept of food regimes is not surprising. In particular, as critics claim, the food regimes concept, through its tendency towards abstraction, obliterates national differences. As Goodman and Watts state,

24 For a critique of Gibson-Graham and other post-Marxist writers see Glassman (2003).
How coherent is a regime…in which there are widely different patterns of local replication [of US patterns of regulation of the agri-food sector] and integration [of national agri-food sectors into the global complex] and a panoply of ‘intensely national’ modes of regulation (1995:214).

Furthermore, as Moral et al. argue,

(T)hose who write about the food regimes underestimate the importance of social forces and processes which produce significant legislation such as that supporting producer control of agro commodity chains … We contend that an understanding of such national and sub-national legislation is essential to interpret the international variability in the organisation of national agricultures and food systems and especially the way in which they maintain some elements which appear to be remnants of previous food regimes (1996:247).

The food regime literature’s projection of the circumstances of agri-food production in the West, in essence its Eurocentrism, has led to a relative underconceptualisation of the tendencies in the so-called developing world. This is most apparent in the emphasis placed on the role of consumption within the third food regime. As Phillips (2006) notes, this theoretical focus reflects ‘a bias towards privileged subjects, toward those consumers who can really afford to consume (2006:46). The issue of, for example, contemporary food (in)security is absent from the food regime literature.

Given the charges levelled against regulation theory and food regime theory, why persist with the use of the conceptual framework outlined above? At the most general level, as Steinmetz (2003) puts it,

Regulation theory [is] useful descriptively for characterizing the contingent articulations among an array of seemingly unrelated practices and tracing the ways in which these partial regularities are cobbled together into a structure that can temporarily promote capital accumulation (2003:331).

In this sense, regulation theory avoids the errors of interpretation resulting from more economistic and deterministic forms of Marxist theorisation. By problematising the reproduction of capitalism, regulation theory is, as a result, attentive to the role played by a wide variety of social institutions and processes. That these institutions and processes vary across time and space is a further attraction of regulation theory. Thus for Smith (1989) one of the appeals of regulation theory is that it provides ‘a vision of social change that incorporates the geographical unevenness of development…’ (1989:149). In other words, regulation theory is sensitive to the possibility that there are ‘many alternative contingent combinations of economic and non-economic factors that might operate to support continued or expanded accumulation, with varying degrees of effectiveness’ (Goodwin 2001:73). As a consequence of this openness, Tickell and Peck (1992)
suggest that regulation theory ‘can provide geographers with an extremely valuable framework for analysing changes in the nature of contemporary capitalism (1992:213). Similar claims can be made for utility of the concept of food regimes. For example, in his spirited defence of the food regimes approach, LeHeron (1993) argues food regimes can assist in ‘tracing the historical and geographic expression of various capitalist tendencies, particularly as they relate to specific spheres of productive activity’ (1993:76). More recently, Roche et al. (1999), suggest that the approach ‘continues to offer much promise as a way to discuss the principles of organisation or structuring relating to food in different periods of capitalist history’ (1999:411).

Regulation Theory and Nature

In general, scholarship adopting a Regulationist approach has been relatively silent on the issue of nature. This lacuna has not escaped attention. For example, as Prudham (2002:193) notes,

…despite (the) proliferation of research on new combinations of research and on new combinations of economic activities and their social regulation, it is puzzling that Regulationists, on the whole, have not adequately addressed the question of nature….

And in a similar vein, Gandy (1997:340) makes the following observation:

In its classic theoretical formulation, the mode of social regulation does not include an ecological dimension: its primary elements are restricted to the macro-economic regulation of the wage relation, the money form, competition, the state and international regimes … As a consequence, there is a lack of theoretically and historically grounded approaches to the study of environmental regulation in the context of shifting relationships between state, capital and society. (Gandy 1997:340)

25 As the penultimate chapter makes clear, the concept of nature deployed in this thesis is that found in the ‘social production of nature’ literature (Braun and Castree 1998; Smith 1984; 1996). Seeking the dissolution of the society-nature dualism inherited from the Enlightenment, and inherent of much environmental thought, the production of nature thesis focuses on the ‘social relationship with nature’ (Smith 1996:50). Within the context of a globalised capitalism, Smith argues that under capitalism, nature is appropriated, that is: ‘Nature becomes a universal means of production in the sense that it not only provides the subjects, objects and instruments of production, but is also in its totality an appendage to the production process’ (Smith 1984:49). The production of nature thesis emphasises the manner in which capital and nature constitute one another through the production process; a constitution which is historically and spatially differentiated. This is not to deny nature’s materiality, however. As Harvey (1996) notes, ‘Created ecosystems tend to both instantiate and reflect…the social systems that gave rise to them, though they do not do so in noncontradictory ways (i.e. stable) ways’ (1996:185, emphasis in original).

26 Exceptions to this general tendency include Altvater (1993) and Bridge and McManus (2000).
Furthermore, Bakker emphasises that ‘…researchers within the Regulation School tradition have for the most part remained silent on the question of the relation between capital and nature’ (2000:7). However, although the food regime literature does not engage with a discussion of the biophysical process at the core of agriculture, it does provide an entry. This is particularly true of the discussion of the second food regime and its subsumption under Fordism. A key concept is that of productivism, of raising agricultural productivity through an increased use of inputs. Productivism was synonymous with a ‘…continuous modernisation and industrialisation of agriculture’ (Ilbery and Bowler 1998:57) and a productivist logic pervaded the system of mass production within the Fordist regime of accumulation. As an example of productivism in the second food regime, McMichael and Friedmann cite livestock production which, after the Second World War, was ‘…transformed … from handicraft and extensive techniques of husbandry to intensive, scientifically-managed continuous production systems’ (1989:107). Furthermore, Friedmann situates the tendency towards industrialisation within the Fordist mode of social regulation:

Commodity price support programmes both protected family farms and encouraged their relations with agro-food corporations. By supporting prices, the legislation rewarded large family farms. Farms increased productivity and scale through technologies bought from key vehicle and chemical industries (1993:34).

In this formulation, particularly through the notion of buying technologies from corporations, Friedmann borrows from the agrarian political economy literature. But what is lacking is further conceptualisation of the impact of productivist and other sorts of regulation on nature within the agricultural production process. In the following section, I introduce certain concepts from the agrarian political economy tradition. This exercise is necessary given the tendency within regulation theory to be unspecific about the nature that capital is forced to confront in agriculture. These concepts are discussed in some detail because they constitute key analytical tools and which I will take up subsequently in my case study of greenhouse tomato production.

**Agrarian Political Economy**

Agrarian political economy is a large enterprise oriented towards an exploration of what Kautsky called the ‘agrarian question’, that is, the larger dynamics undergirding capitalist agriculture (cf. Bernstein and Byres 2001; Buttel 2001; Marsden et al. 1986; Watts 1996). Agrarian political

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27 As discussed in the next section, Friedmann utilises the notion of appropriation developed by Goodman et. al. (1987), who are included in her references.
economy eschewed the narrow focus of neo-classical agricultural economics on farm business
efficiency, the descriptive studies of rural communities practised within rural sociology, and
traditional agricultural geography's concern with agricultural land-use patterns. Instead, agrarian
political economy – inspired, *inter alia*, by Marx and Kautsky – sought the sources of agrarian
change in broader structural forces operative at all spatial scales. This has led to a focus on the
processes and consequences of the integration of sites of agricultural production into a globalised
system, the development of agri-business and agro-food chains and the roles of capital and of the
state (Le Heron 1993). One of the consequences of this development was that agriculture,
traditionally conceived as site-specific production, assumed a new and expanded definition to
include the multiplicity of linkages upstream and downstream of the farm. These linkages range
from inputs such as agro-chemicals and machinery to post-production processes such as freezing
and preservation. However, what has been missing, with the exception of one contribution
discussed below, is the construction of linkages between what happens on the farm, in terms of
the production process, to the institutional context of agricultural production.

In general, the early political economists (Marx (1981); Kautsky (1988); Lenin (1967)) posited
that the development of the productive forces in agriculture would lead, inexorably, to the
dissolution of the peasantry and to the creation of two rural classes – the landed bourgeoisie and a
rural proletariat. Agriculture, like manufacturing, would eventually be characterised by
generalised wage labour and an increased development of the agricultural productive forces. The
political desirability of the complete capitalist transformation of agriculture notwithstanding, the
classical Marxists recognised that the pace of industrialisation of agriculture was slow and
uneven, as attested to by the existence of petty commodity production. As Marx noted, the
production of agricultural commodities was ‘…subject to certain organic laws involving naturally
determined periods of time…’ (Marx 1981:213). The source of this retardation and unevenness
was the fact that agriculture was a form of nature-based production.

Although broached by Kautsky in his *The Agrarian Question*, first published in 1899, a
systematic analysis of the centrality of nature to capitalist agriculture in general, and agricultural
industrialisation in particular, did not emerge until 1978 with the publication of Susan Mann and

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28 Petty commodity production is defined as the production of goods for the market by people who own the
means of production (e.g. farms) but who may or may not hire waged labour. Capitalist farms are
defined by their generalised – as opposed to occasional – use of wage labour: that is, wage labour is a
structural requirement for the farm. For discussion of these distinction, see Winson (1996).
James Dickinson's seminal article “Obstacles to the Development of a Capitalist agriculture.”

The principle concern of the Mann-Dickinson thesis was to explain the persistence of an (anachronistic) family farming within late capitalist formations. Building on the work of Marx in particular, the Mann-Dickinson thesis asked ‘…why some branches of agriculture become more capitalist more rapidly than others’ (Mann 1990:32). Mann and Dickinson argue that ‘nature’, within historically specific conditions, poses certain barriers to the industrialisation of agriculture. The result is the partial and uneven industrialisation of agriculture. The relevance of the Mann-Dickinson thesis to the project at hand lies, then, in the central importance accorded to nature. The various historically contingent obstacles posed by nature to capital allow a point of departure, as I will demonstrate later in the thesis, for the analysis of contemporary greenhouse production. The following is a brief presentation of main component of the Mann-Dickinson thesis in terms of the obstacles to capital; the disunity of production time and labour time.

The distinction between production time (the total time required for the production of a particular commodity) and labour time (that period which involves the direct intervention of living labour) is a function of the pace of biological production. When labour is not directly involved in a particular component of the production process, no value is being created for the capitalist. This proposition is based on Marx’ labour theory of value, the cornerstone of Marxist political economy. In essence, the labour theory of value states that the exchange value of a commodity is equal to the sum of the value of (dead) labour transferred from the instruments of production to the commodity, the value created by living labour (as determined by social necessity) and, the surplus value created by living labour (the value, appropriated by the capitalist, in excess of the reproduction needs of labour). For a discussion of the value theory and the attendant controversies see Sheppard and Barnes (1990).

Thus, according to the Mann-Dickinson thesis, there is no value being created throughout the agricultural production process since the cultivation of a crop requires significant labour only at certain moments in the production process. Labour is initially required for preparing land for cultivation and seeding and, after the crop has matured, for harvesting and preparation for shipping. While the crop grows, labour needs are minimal. The long production time engendered by most agricultural commodities also serves as a disincentive to capital because it affects the turnover time of capital and, consequently, the rate of profit. Turnover time can be defined as the time taken for one complete circuit of capital; that is, the time taken for the transformation of money capital into productive capital – a combination of the instruments of production and labour – through the stage of commodity capital and back into money capital. In

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29 See Mann (1990) for a response to critics of the Mann-Dickinson thesis.

30 This proposition is based on Marx’ labour theory of value, the cornerstone of Marxist political economy. In essence, the labour theory of value states that the exchange value of a commodity is equal to the sum of the value of (dead) labour transferred from the instruments of production to the commodity, the value created by living labour (as determined by social necessity) and, the surplus value created by living labour (the value, appropriated by the capitalist, in excess of the reproduction needs of labour). For a discussion of the value theory and the attendant controversies see Sheppard and Barnes (1990).

31 While the gap between production time and working time within industry has almost been effaced by the use of technology and by the ability to reorganise the labour process, the same cannot be said for the production of agricultural commodities.
essence, this circuit must be completed in order for accumulation to occur; accumulation (profits) is a consequence of the engagement of labour at some point in the circuit of capital.

While the Mann-Dickinson thesis posits the issue of nature in agriculture as an obstacle to capitalist penetration, a later intervention by Goodman et al. (1987) demonstrates the ways in which capital circumvents nature in agricultural production. Goodman et al. (1987) propose a ‘theory of agro-industrial development’ which suggests that capital’s inability to devise a unified production process in agriculture, to usurp nature’s dictates over the production process, has led to two strategies: appropriationism and substitutionism – strategies which attempt to work around nature.

The industrial transformation of agriculture has occurred historically through a series of partial, discontinuous appropriations of the rural labour and biological production processes (machines, fertilisers, hybrid seeds, fine chemicals, biotechnologies), and the parallel development of industrial substitutes for rural products. This dual movement is represented by the emergence of agro-industrial sectors supplying farm inputs and the diversification beyond the farmgate of food and fibre processing and distribution (1987:2-3).

The outright replacement of living labour in the labour process and the intensification and acceleration of the biological production process are a consequence of capital’s strategy of appropriation. Capital’s inability to completely reconstitute biological production on the farm in the image of industry has led to its appropriation of discrete components of the production process. Plant hybridisation, genetic technologies, mechanisation and agro-chemicals represent a partial, yet monumental, incursion into the sphere of agricultural production. The clearest

32 This is not an issue addressed by the Mann-Dickinson thesis.
33 Goodman et al. use of the term must be distinguished from the way Marx used it. Appropriation, for Marx, referred to the process through which the surplus value produced by labour ended up in the possession of capitalists (Marx 1973). While Goodman et al. use of the term incorporates this meaning, by definition since it is always industrial capital which does the appropriating, its more particular meaning is the spatial shift in production of a particular agricultural product, whether originally by wage labour or the farm family, from on the farm to off.
34 If there has been a decrease in production time as a consequence of new technologies, it has occurred in the laboratory, not the field. The pace of conventional plant breeding is governed by nature: test crops must undergo the complete cycle of production from seeding to maturation in order to determine the outcome. Several generations (turnovers) are required in order for the desired characteristics to emerge. Engineered breeding however, which operates at the molecular level, allows the manipulation of cell characteristics within the seed itself thus significantly reducing the number of turnovers. See Conway (1997:140-162).
35 In his classic study of corn hybridisation in the United States, Kloppenburg (1988) demonstrates the ways in which capital appropriated the seed itself. Seed saved by farmers after a cycle of crop production had traditionally been replanted in the next cycle. The development of hybrid plants however forced farmers to buy new seeds every year. This was due to the fact that seeds produced by hybrid plants tend
example of this appropriation within agriculture is intensive poultry production. As Goodman and Redclift note,

> It is in the automated, controlled environment of the ‘factory farm’ where the similarities with industrial process engineering and mass production are strongest (1991:110)

The appropriation by industrial capital with respect to livestock production includes hybridisation, the production of growth hormones and the various mechanical systems of feed delivery. As Goodman and Redclift have demonstrated, a causal link between regulation and the appropriation of the agricultural production process can be established. This is not to suggest that this causality is uni-directional. For appropriation has resulted in the accumulation of pesticide residues in fruits and plants and traces of growth hormones and antibiotics in meat; a few of the unintended consequences of the manipulation of nature. This in turn has resulted in the regulation of food safety.

A related process that allowed capital to circumvent the farm was substitutionism. Substitutionism characterises capital’s attempt to weaken or sever the link between agricultural production and the provision of foodstuffs. According to Goodman et al., there are two tendencies within substitution. The first is the industrial manipulation of raw agricultural products – processing, canning, freezing, dehydrating – yielding such commodities as powdered milk and canned meat. By obscuring the agrarian origins of these commodities and by presenting the commodity as an industrial product, certain characteristics such as convenience and durability become attached to a particular industrial process or trademark (Goodman et al. 1987:60). A step beyond this industrial processing, essentially preservation, is the substitution of an industrial commodity for an agricultural end product. The early and classic example is margarine which was created from relatively cheap vegetable oils and substitutes for butter.

to be sterile. Kloppenburg provocatively suggests that the commodification of the seed and the consequent separation of the farmer from the means of production represent capitalism’s triumph over agriculture. A dissenting view is suggested by Benton (1996) who argues that nature in agriculture is essentially non-manipulable and that the labour process in agriculture is oriented towards optimising conditions of growth. The organic processes themselves are, according to Benton, impervious to intentional manipulation.

36 See Boyd (2001) for an historical account of the appropriation of poultry production in the United States.

37 The obstacles posed by nature in agriculture have been circumvented by other factions of capital, not just industrial capital. For example, in his study of agriculture in California in the early 20th century, Henderson (1999) demonstrates the ways in which finance capital extracted value from farmers through the exploitation of ethnic ties.
The concepts of appropriation and substitutionism provide key analytic tools for a political economic investigation of structural and technological change in agriculture. The significance of this form of investigation, both in general and specifically to the thesis, lies in the refusal to reify technology – to accord it an autonomy independent of its social context – but to locate technological change within capital’s strategies of accumulation. As well, the work of Goodman et al. reveals that while nature may represent an obstacle to capital at the site of production, it presents opportunities to capital within ancillary processes.38

A more recent intervention by Boyd et. al. (2001), and building on, *inter alia*, Mann and Dickinson (1978) and Goodman et. al. (1987), argues that the physical properties of natural resources, the time required for biogeographical (re)production processes to occur, and the fact that natural resources are extensive in space, found in particular locations, and vary in quality, all affect the capital accumulation process in unique and interesting ways … our objective here is to explore how nature matters to the dynamics of industrialisation.

(2001:556)

In contradistinction to existent approaches to the problem of nature, Boyd et. al. stress that capital confronts nature not just as an obstacle, but also as opportunity and surprise.39 Intensive livestock production, as discussed above, serves as an example of nature presenting an opportunity to the industrial production of antibiotics.

Furthermore, Boyd et. al. make the critical distinction between the formal and real subsumption of nature. The formal subsumption of nature refers to capital’s confrontation of an essentially non-manipulable nature. The clearest example of this is mining as an extractive activity, one which encounters a finite biophysical stock of ore. Other than finding a new deposit of ore, there is no meaningful way of increasing that stock. Land-based agriculture is a further example where ‘capital is forced to circulate around nature, and machines must be deployed in a way that adjusts to the landscape’ (Boyd et al. 2001:563). Production in such a context cannot be reorganised to facilitate the flow of capital through nature.

38 Recent developments in the literature, however, have revealed that while nature may present an obstacle to capital (or a faction of it) it may also afford opportunities other than appropriation and substitution. Henderson (1998:111), for example, argues in his study of agriculture in California that ‘…while capitalist society, through its agriculture (*inter alia*), commodifies and exploits nature directly, it also exploits the very condition where nature poses interruptions or ‘obstacles’ to its exploitation…These so-called obstacles…open up temporal and spatial channels for the extraction of surplus…’ In the instance of California agriculture, one of the channels was occupied by a credit system which ‘…put capital back into production’ and which drew small producers into the orbit of capital.

39 See Prudham (2005) for the deployment of this approach in an analysis of logging in Oregon.
The real subsumption of nature, however, ‘...refers to systematic increases in or intensification of biological productivity (i.e., yield, turnover time, metabolism, photosynthetic efficiency)...Nature, in short, is (re)made to work harder, faster, and better’ (2001:564). The deployment of the concept of the real subsumption of nature allows a specification of the ways in which ‘capital circulates through nature as opposed to around it’ (2001:565). Furthermore, Boyd et al. note that the deployment of the concept of the real subsumption of nature ‘...highlight[s] the way that competitive pressures lead firms to augment productivity through the systematic intensification of biological growth’ (2001). The manipulation of genes represents, for Boyd et al., the clearest example of the real subsumption of nature: ‘Clearly, the capacity for transcending the species barrier afforded by the new biotechnologies represents a massive expansion of capital’s ability to subordinate biological processes to the dictates of industrial production’ (2001:565).

I made the claim above that there was a particularly relevant instance of the attempt to link biophysical production to its regulatory context. This is found in Goodman and Redclift (1991) who argue that technological change in agricultural production ‘...is due less to the revolutionary nature of innovation per se than the institutional incentives to early adoption and technological competition introduced by the state’ (1991:93). In particular, and using the United States as an illustration, Goodman and Redclift focus on farm support policies in the 1930s which, by regulating commodity markets and stabilising producer prices, reduced the economic risks attendant with farming. This made farming a viable accumulation strategy which then led to competition expressed through the adoption of technological innovation. Through technological innovation – improved seeds, fertilisers, farm machines, etc. – farmers could garner a competitive advantage. This created an opportunity, an expanded market, for agro-industrial capital. At the centre of this process of industrialisation was the development of hybrid seeds. Although such seeds had a dramatic increase of yield, they tended to be more susceptible to pests and disease. This dictated the need for the increased applications of agro-chemical if farmers wanted to reap the increased yield promised by hybrid seeds. The regulation of agriculture in the United States in the 1930s, which led to its industrialisation, was consolidated during the Second World War and became the cornerstone of agricultural policy after the war. This particular mode of regulation of agriculture, however, led during the second food regime to overproduction, which in turn depressed prices. As a consequence, farmers were forced into a further round of adopting technological innovation which created new opportunities for agro-industrial capital. Goodman and Redclift however, are quite explicit about the fact that this industrialisation of agriculture did
not constitute Fordist production at the level of the farm: ‘Nature and the culture of “agri-culture” have yet to succumb to industrial control and process engineering’ (1991:102). For Goodman and Redclift, nature in agriculture presents an obstacle to its Fordist transformation.

**Conclusion**

The analysis of place-based processes such as the restructuring of economic sectors – the emergence of the greenhouse tomato industry in Delta in this case – will be well served by the insights, both theoretical and methodological, of regulation theory writ large and of ‘local regulation’. While regulation theory operating at the spatial scales of the nation-state and the globe allows the contextualisation of social and economic changes operating at the local and regional levels, ‘local regulation’ offers a more nuanced analysis of such changes. The periodisation of capitalist development since the early 20th century – through the distinction of particular regimes of accumulation and their concomitant modes of social regulation – suggests the general conditions required for the successful and sustained accumulation of capital. The impact of these general tendencies on places, however, is not immediately obvious. Local and regional geographies of regulation are complex as a consequence of the imbrication of regulatory practices issuing from institutions operating at a multiplicity of scales. Thus post-Fordist regulatory forms that compel competitiveness are layered over existent local and regional regulation of a Fordist/Keynesian bent. The task ahead is to untangle this regulatory interweaving with the aim of illuminating the effects, contradictory or otherwise, on economic restructuring.

Greenhouse production represents a particular, and produced, agri-nature, one that has been inscribed by the logic of capital. Spatially delimited, intensive, and seemingly impervious to the caprice of climate, greenhouse production is an approximation of industrial capital's ideal: a ‘factory in the field’, to borrow Carey McWilliams’ (1944) evocative phrase. The complex of theoretical and conceptual tools derived from agrarian political economy will be deployed in an attempt to address the issue of whether greenhouse production represents a resolution of the contradictions identified by the Mann-Dickinson thesis.

The analysis in the following chapters seeks to establish the forces and conditions through which greenhouse production – an instance of the intensification of agriculture – has come to be a fixture in Delta. By combining regulation theory and its derivatives, and the conceptual tools of
agrarian political economy, I hope to specify the regulatory complex within which a particular form of agricultural intensification – the greenhouse – is manifested.
CHAPTER 3: AGRARIAN CHANGE IN BRITISH COLUMBIA AND DELTA

Introduction

Agriculture’s role in British Columbia’s development has been overshadowed by the contributions made by mining, forestry, and fisheries. Even though the province is graced with land suitable for agricultural production – the Fraser Valley, parts of Vancouver Island, the Okanagan, the Peace River District – agriculture developed relatively slowly. This was due to the proximity of resources such as trees, metals and coal, and fish, and the relative ease with which they could be extracted and exported. While the extractive activities, in the second half of the 19th century, were already being animated by industrial capital, employed wage labour, and had adopted mechanisation, agriculture was still in its ‘pioneer’ stage. That is, settlers, primarily immigrants, were producing for a combination of subsistence and market needs. In the event of surplus, agricultural products were taken to local markets, an onerous task in the absence of a developed transportation network. Furthermore, while the mining, forestry and fishing industries were, almost from inception, embedded in the international economy – salmon for example was being exported to Britain where it was used as a source of protein by the emergent urban population – agricultural products – with the exception of fruit produced in the Okanagan – were destined for markets within the province. British Columbia had, as well, a trade deficit in food. In the last decade of the 19th century, the value of the province’s agricultural exports was a mere tenth of imports.

Delta in the 19th century was a ‘pioneer’ settlement, in the mode of other such settlements in the Fraser Valley. Originally founded on mixed agriculture, Delta’s agrarian economy was characterised by the production of a narrow range of crops: primarily hay and grains, some of which was destined for livestock which. Later developments, primarily during the early decades of the 20th century, saw a gradual change characterised by the industrialisation of the production of particular commodities, the generalisation of commodity production, and a diversification of

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40 The concept of subsistence has been problematised with American historiography. Kulikoff (1992) defines subsistence as ‘an economic level achieved with a nearly complete absence of exchange’ (1992:19). In a review of a debate over the nature of exchange relations in American agriculture, Kulikoff notes that historians ‘deny the development…of subsistence agriculture…’ (1992:19). Within American agriculture, production for farm consumption proceeded in concert with the sale of products on the market and the barter of goods between farm households. Farm households were also sustained through occasional wage labour.
the agrarian economy. These changes took place in the context of a province seeking to establish a capitalist economy capable of competing on the international stage. Such a transformation was enabled and directed by a state that articulated a discourse of ‘province building’. Given the trade deficit in agricultural products, the agrarian sector was the target of specific regulation aimed at fostering capitalist production within the sector. In other words, commodity production became generalised throughout much of the province within the context of an extensive regime of accumulation.

The chapter begins with a discussion of the development of the provincial economy in the context of both national and international development. Attention is then focussed on agricultural development in the province with particular scrutiny applied to the role of regulation in that development. Fruit production in the Okanagan is used as an example. Attention then shifts to Delta, beginning with the transformations effected by settlers in their attempt to carve out an agrarian existence along the Fraser River. This is followed by an analysis of the role of regulation in generalising commodity production in Delta, using dairy production as an example. The chapter concludes with a discussion of technological change in crop cultivation and an outline of structural changes, concomitant with the industrialisation of agriculture, within Delta’s agrarian economy up to the Second World War. This latter section also includes a brief account of impacts of global processes on Delta’s agriculture. The chapter is informed by both regulation theory and the literature on agricultural industrialisation, particularly the concept of appropriation. The concept of appropriation is deployed in particular in the section on the mechanisation of agriculture in Delta. One of the main arguments in this chapter is that, beginning in the early decades of the 20th century, the state directed and shaped the development of agriculture in the province.

**The Social and Economic Context of Early Agriculture in British Columbia**

Although parts of British Columbia were eminently suited for farming endeavours, large scale settlement for the express purpose of farming only began with the gold rushes. The initial, Fraser River, gold rush in 1858 resulted in the influx of approximately 30,000 prospectors who stimulated the settlement of British Columbia, thus creating a demand for agricultural commodities. Another gold rush in the early 1860s in the Cariboo region further contributed to demand and led to the creation of additional markets. The significant effect of the rush for gold on agriculture is noted by Perry:
Violent and temporary as it was in its effects, the gold rush did bring commercial agriculture into being in British Columbia. Gold valued at 39,953,168 dollars was extracted between 1858 and 1876, and of this sum probably little more than the amount paid to agriculturists actually remained within the province (1939:74).

The demand created by the gold mining enterprises had created an embryonic ranching industry in British Columbia, particularly in the Thompson River valley west of Kamloops and in the Nicola Valley (Ormsby 1982:154). Livestock for these ranches was imported from California and Oregon. Ormsby (1982) notes that British Columbia’s agricultural production during the 1860s could not meet demand – primarily from the mining population and the constellation of settlements established around mines– and that most agricultural commodities had to be imported, primarily from Great Britain and the United States. However, the gold rushes stimulated the development of a transportation infrastructure which had a direct effect on agriculture. The establishment of rudimentary roads that remained passable throughout the year stimulated dairy farming in the Eastern Fraser Valley and ranching in the Okanagan which ameliorated, to a partial extent, the trade deficit in agricultural commodities. When the Cariboo gold rush ended in 1865, many of the prospectors stayed in British Columbia and established ranches in the Okanagan and small farms along the coast. During the gold rushes, and as a consequence of their ports, settlements such as New Westminster and Victoria experienced a spurt in growth – Vancouver at the time was little more than a collection of lumber mills along the Burrard Inlet.

The economic growth attendant with the gold rushes created a larger and more stable population base, which, with the demise of gold mining in the province, was supported through industries such as forestry and boat-building. The settlement encouraged by the gold rushes created stable markets for agricultural products. This stood in marked contrast to the ephemeral markets created by the gold rushes alone. While most agricultural commodities were still being imported, the arrival in the 1870s of agricultural settlers from Britain and the United States, who established farms along the Southeast Coast of Vancouver Island and in the Lower Fraser Valley, bolstered the ranks of local agricultural producers. This settlement was partly a consequence of land regulation, namely the Land Ordinance of 1860 which allowed the occupation of 65 hectares of unsurveyed land by prospective settlers. Although much of their early production was subsistence in nature (Barman 1991:88 Wood 1987:142), settler farmers were soon able to exploit

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41 As Barman (1991:79) notes, ‘The Cariboo gold rush of the early 1860s generated the largest road building project.’

42 See below for a fuller discussion.
the province’s changing economic conditions. Changes wrought, in particular, by the arrival of the Canadian Pacific Railway.

The arrival of the Canadian Pacific Railway (CPR) line in Vancouver in 1887 – a condition of British Columbia’s union with Canada – resulted in an economic boom in the province. As Seager notes, the CPR was ‘…a large and, in time, ruthlessly efficient engine of capital accumulation’ (1996:208). It spurred settlement, and facilitated the import of capital and the export of commodities. However, McDonald (1981) argues that, despite the boom, the completion of the trans-continental railway did not result in an immediate reorganisation of British Columbia’s economy. There was little additional investment apart from capital from the CPR and its directors, and the patterns of resource extraction and their exports – primarily salmon, lumber and coal – did not change, although the volume of trade increased. One significant effect of the railway was that it led to the growth of Vancouver. Migrants, from Eastern Canada, the United States, Britain and Asia had been attracted to Vancouver before the completion of the trans-continental railway in anticipation of a boom and a consequent increase in the value of land (McDonald 1981). Between 1891 and 1901, Vancouver’s population increased from 17,709 to 27,010 while British Columbia’s population increased from 98,173 to 178,657. A mining boom in the Kootenay’s between 1887 and 1895, again facilitated by the CPR and the extension of the railway network into the interior, further contributed to provincial coffers, stimulated migration and eventual settlement, and led to the creation of larger local markets. The CPR, built by industrial capital with grants and concessions from the state, represented an instance of what Marx termed the annihilation of space by time (Marx 1973: 539). What had once constituted an overland journey of months could now be accomplished in approximately a week. In addition to allowing the enhanced movement of people across the country, thus spurring settlement, the CPR reduced the circulation time of commodities produced in British Columbia. Destined for markets elsewhere in Canada, the United States and Europe, the CPR, by accelerating the movement of those commodities and the realisation of the value embedded in those commodities, increased the profits of British Columbia’s industrial capitalists.43

43 As Harvey puts it: ‘There is, therefore, considerable pressure to accelerate the velocity of circulation of capital, because to do so is to increase the sum of values produced and rate of profit. The barriers to realization are minimized when the ‘transition of capital from one phase to the next occurs at the speed of thought’. The turnover time of capital is, in itself, a fundamental measure which also indicates certain barriers to accumulation. Since an accelerating rate of turnover of capital reduces the time during which opportunities pass by unseized, a reduction in turnover time releases resources for further accumulation’ (Harvey, 1999: 86).
Agrarian settlement was also proceeding. As Barman notes, ‘By the end of the century the Fraser Valley was almost completely filled up’ (1991:186). Stretching from Hope in the east to the Strait of Georgia in the west, the valley is approximately 160 kilometres long and is hemmed in on the north and east by mountain ranges. Covering an area of approximately 400,000 hectares, the Lower Fraser Valley contains 121,00 hectares of arable land, 30% of the provincial stock of arable land. Agriculture first began in the Lower Fraser Valley in 1827 when the Hudson’s Bay Company cultivated grains and vegetables outside Fort Langley. It was not until 1862 – four years after the first gold rush – that systematic private settlement for agricultural purposes took place in Chilliwack and Sumas. An absence of forest ground cover and a proximity to the markets represented by Yale and Hope proved attractive for settlement. By 1866, 1966 hectares of land had been settled and the output of agricultural products included 300 tones of hay and 326 tons of grain (Winter 1968:106). Settlement, primarily agrarian, then spread westward, particularly on the alluvial plains of the Fraser, again exploiting the absence of forest. By 1871, there were 286 farms spread throughout the Lower Fraser Valley. By this time, the Lower Fraser Valley was the most developed agricultural area in British Columbia.

The economic boom of the late 19th century continued into the first two decades of the 20th century. For example, between 1900 and 1911 government revenues from natural resource industries – forestry, fisheries, agriculture, mining – increased ten-fold from $528,000 to $5.6 million (Urquhart 1965:219). Much of this increase in revenues was derived from logging, which experienced unprecedented growth in this period. For example, between 1901 and 1910, the quantity of lumber cut in British Columbia grew by 374% (McDonald 1981:371). In 1913, total provincial revenues were $10.2 million, a little less than a quarter of the total revenues received by all provincial governments. Although some of the demand for British Columbia’s forestry products was local, the majority of it went to the Prairie provinces. The massive settlement of the Prairies – approximately a million people settled between 1897 and 1911 – resulted in a demand for cheap raw materials, a demand British Columbia was able to satisfy. Again, the population grew. While the population of British Columbia more than doubled in the first decade of the new century, the population of Vancouver quadrupled, reaching a 100,000 in 1911, thus becoming Canada’s fourth largest city.

44 It was not until 1946 that revenues from natural resources exceeded the amount garnered in 1911.
Partly as a consequence of the establishment of a rapidly growing population, there was, in the last two decades of the 19th century rapid growth in agriculture. For example, between 1881 and 1901, the number of farms in British Columbia increased from 2,743 to 6,501 while the total acreage of farm land increased from 178,000 to 605,000 hectares (Urquhart 1965). In 1881 only 18.3% of males in British Columbia were employed in agriculture; the average for the rest of the country was 57.8% (Perry 1939:82). Despite this, in 1891 agriculture was the single largest employer in British Columbia, engaging 18% of the workforce. This was slightly less than all the natural resource extraction industries combined – fishing and trapping, logging, mining – which engaged 23.2% of working males. Until the development of large local and external markets, and a means of getting goods to those markets, farmers produced agricultural goods that were primarily for farm consumption. Harris and Demeritt (1997) label British Columbia’s agriculture at the time as “semi-subsistence family farming”.

Throughout the period from 1891 to 1941, the family farm, weakly connected to the market, remained the common unit of agricultural production in British Columbia (1997:227).

The extractive industries on the other hand contributed directly to British Columbia’s gross provincial product. The value of mineral exports in 1900, for example, was almost $12 million. Agriculture, however, was languishing. For example, in 1890, British Columbia imported approximately 232 tons of butter and cheese from other countries while exports amounted to 12 tons (British Columbia Department of Agriculture 1891). The value of all agricultural products imported amounted to approximately $1.7 million while the value of exports was less that a tenth of that amount – $120,697. Between 1890 and 1900, the quantity of butter and cheese imported

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45 Ontario, in stark contrast to British Columbia, had 204,054 farms in 1901 (Urquhart 1965). In Ontario there was one farm for every 10 people, while in British Columbia, one farm for every 27 people.

46 In the Maritimes, Quebec and Ontario, the average was approximately 50%. In the Prairies, 66% of males were employed in agriculture. By 1901 there were fewer people employed in agriculture across Canada.

47 The difficulty of making meaningful comparisons within British Columbia’s resource sector is noted by Seager: ‘Any attempt to compare the output of each sector of the resource economy – mining, energy, forestry, fishing, agriculture – must confront the central problematique of economic history: the fragmentary nature of the measured economic activity of the past’ (1996:233). An absence of data on the total output of the forestry industry is a case in point.

48 In the context of the United States, Allan Kulikoff, historian of early America, notes that: ‘By the late nineteenth century…family farms that combined ownership and labor and therefore needed only to sustain the household and renew the means of production to reproduce themselves dominated American agriculture’ (Kulikoff 1992:54).

49 Since the data is tabulated from customs returns, these figures do not include imports from and exports to other provinces.
increased from 232 tons to 642 tons, approximately a threefold increase (British Columbia Department of Agriculture 1891; British Columbia Department of Agriculture 1903).50

The value of agricultural exports hints at the structural conditions of farming in this era. As Ormsby notes:

Until 1921 [which marked the end of the short post-war recession] agriculture in British Columbia was in the experimental stage, and farmers were governed in planting their crops by the size of the local market. Most of their attention went to solving the problems of cultivation. Once they had mastered the technical side of agriculture, they began to produce for markets outside the local field (1982:160).51

The desire to make British Columbia’s agricultural commodities competitive in the world market compelled the provincial government to act. As early as 1912, a royal commission was set up with the mandate to examine proposals for removing some of the obstacles facing producers (Ormsby 1981). The commission’s report, after its members had visited Europe, the United States and the Antipodes, emphasised ‘…the importance of introducing new methods of cultivation, of opening new areas to settlement, of establishing a system of agricultural credit, and of having the provincial Department of Agriculture undertake new functions such as the collection and dissemination of information about markets’ (Ormsby 1981:161). The onset of the First World War frustrated any attempts to implement concrete policy. Despite early land regulation aimed at promoting pioneer settlement and farming, it was not until the 1920s that regulation aimed specifically at the agricultural sector made its appearance in British Columbia.

While the development of a capitalist export agriculture was an avowed aim of the state, a more fundamental project was the development of self-sufficiency in food provision in the province. The agricultural development of the province was perceived as the key to its economic development through commodity production as opposed to subsistence farming. As J.H. Turner, the Minister of Agriculture in 1894, commenting on the establishment of the Department of Agriculture in 1891, stated:

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50 Export data for 1900 is unavailable.
51 As Sandwell (1999) notes, there is a paucity of scholarship on British Columbia’s agricultural history. She argues that: ‘Margaret Ormsby’s two articles on agriculture in the province, published about fifty years ago, still remain the central work in the field’ (1999:7).
During the fiscal year ending 30th June, 1892, we imported agricultural products to the value, with duty, of $2,659,698. This does not include the cost of importation, in itself a large sum, and certainly sufficient to cover the cost of placing our own products on the market. The practical working of this is that the urban population is paying this enormous sum for necessaries of life which rightfully belongs to the tillers of the soil and all those connected with any branch of the agricultural and pastoral industries…[we are brought]…face to face with the humiliating fact that we are importing much of what we can readily and profitably produce within our own borders…It is a well known axiom that as long as a country sends out its gold in payment for agricultural products, so long will that country be poor… (British Columbia 1894:1600).

Although not explicit in the text, but perhaps mindful of the movement of grain from the Canadian Prairies and the United States which was underwriting the formation of the European working class – the central aspect of the first food regime – Turner may have been anticipating a similar structure of provision within British Columbia. As noted above, Vancouver and its environs were growing while Victoria, as a consequence of its port, was still economically dominant. While primary resource extraction was still the engine of growth, manufacturing – particularly the secondary processing of wood products which occurred in urban locales – and the service sector were in the ascendency. For example, between 1891 and 1911, the proportion of workers in manufacturing, the service sector and construction all increased. During the same period, the number of workers in both agriculture and the resource sector decreased (McDonald 1981:379). The former category of workers was primarily urban based.

Turner also alluded to a particular relationship between the state and farmers. Essentially one of corporatism, this relation would consist of

Agricultural societies, Fruit Grower’s Associations, Dairymen’s Associations and all kindred societies…[forming]…part and parcel of the Department of Agriculture, and should, in fact, be advisory boards whose reports should be embodied in those of the Department. (British Columbia 1894:1601)

As will be discussed below, state intervention in agriculture in the late 19th century was focussed on three aspects that were to establish the pattern of agricultural production in British Columbia well into the 21st century: the enabling of the acquisition of land as the basis of production; the regulation of marketing or supply management; and the fostering of co-operative responses, on the part of producers, to bolster their market power.\footnote{52 For a catalogue of the early state’s intervention into agriculture see Gosnell (1914)}
By the turn of the century, the spatial pattern of British Columbia’s agriculture, a pattern which endures to this day, had been established. Shaped by a combination of settlement history, economic development, and the landscape, British Columbia’s agriculture is characterised by regional specialisation. Wood (1987) had identified these specialisations as:

- dairying and medium intensity mixed farming in the Lower Fraser Valley and Southeast Vancouver Island;
- extensive livestock ranching on the Interior grasslands;
- speciality agriculture such as intensive berry and horticultural crops in the Lower Fraser Valley and the Saanich peninsula of Vancouver Island, and grapes and tree fruits grown in the Southern Interior Valleys, particularly the Okanagan valley.

A fourth specialisation, one which did not emerge until later in the 20th century, was large scale grain farming in the Peace River Region. While, at the turn of the 20th century, the lowlands of the Fraser Valley were well settled and had reaped the benefits of a proximity to major transportation mechanisms, other areas were in the early stages of agrarian development. The Peace River area was a case in point. Located in a remote part of the province in the shadow of the Rockies, the Peace River area ‘…was among the last agricultural areas of the province to be developed on a large scale’ (Dalichow 1972:121). Until a railway link was extended to Dawson Creek in 1942, the wheat produced in the region had to be transported to the nearest railway station in Alberta.

Despite the agrarian promise offered by these and other regions, much of British Columbia was unsuitable for agriculture. Of British Columbia’s total land area of approximately 93 million hectares, only 2% is considered arable.\(^{53}\) The major limitation restricting the quantity of arable land in British Columbia is topography. An agricultural limit of a thousand metres means that the major areas with agricultural potential are restricted to the valleys of the coastal mountain range, the central interior plateau and the Tramontane Plain in the north-east section of the province (Dalichow 1972). There were, as well, within each of the developed agricultural areas, a number of natural impediments to cultivation including a surfeit of water, a paucity of water, short growing seasons and irksome ground cover. By the end of the 19th century many of the conditions

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\(^{53}\) This figure does not include the approximately 5 million hectares of rangeland suitable for ranching and livestock raising (Dalichow 1972).
imposed by these natural obstacles had been eliminated or ameliorated. For example, fruit growing in the arid Okanagan depended, as it does now, on extensive irrigation systems. By 1920 the most visible component of the irrigation systems was the conveyance works. Consisting of steel pipes, concrete-lined canals, and metal flumes on wooden trestles, these conveyance systems transported the volume of water required by orchards, across rugged terrain, from distant reservoirs. This successful re-engineering of the Okanagan landscape, which resulted in a 675% increase in the acreage under fruit cultivation between 1901 and 1921, displaced ranching as the major agricultural activity of the region (Ormsby 1939:65).

If the Okanagan fruit industry represented one of the earliest instance of specialised agriculture in British Columbia, it was also the first to be subjected to agricultural regulation. The fruit industry in the Okanagan, in the first two decades of the 20th century, had been characterised by periodic crises of overproduction. The development of new areas of production, improved techniques that resulted in productivity gains, and competition from growers in the State of Washington had depressed commodity prices. State intervention in the form of the South Okanagan Lands Project, an exercise in province-building and an instrument for the re-integration of soldiers who had returned from the First World War, created land suitable for orchards through the construction of irrigation works (Garrish 2001). This had the effect of increasing production in an agricultural sector already subject to overproduction.

The marketing of tree fruit in British Columbia had been the responsibility of the British Columbia Fruit Growers Association (BCFGA). Created in 1888 and charged with the responsibility of promoting the interests of all of the province’s fruit growers, the BCFGA promoted an individualistic approach to marketing. This suited the growers in the Lower Fraser Valley and southern Vancouver Island more than it did the growers in the Okanagan. Coastal growers had both more favourable growing conditions – a reduced probability of killing frost and sufficient rainfall – and easier access to markets – namely Victoria and Vancouver which were close and well served by transportation links. The growers in the Okanagan, however, many of whom were farming on marginal land, thus increasing the risk of permanent failure should prices fall below an acceptable level, had to transport their commodities either to the coast or, increasingly, across the Rockies and into the Prairies and beyond. The complexity of the supply chain – primarily the consolidation of shipments, packaging, and transportation – created a monopsony, i.e., there were few intermediaries who could market and sell commodities, particularly on distant markets. The unequal power relationship between producer and
intermediary in the Okanagan thus led to demands for a system of centralised marketing (Garrish 2002). As Farrell puts it, this unequal power relationship led to the

...conviction that price gains could be secured if some intermediate bargaining agency could be set up between the numerous farm producers and the few buyers or processors. Especially if there was one dominant buyer, the small sellers and their local agents could, through organisation, avoid taking a low price or narrow margin for their produce (1949:617).

Voluntary systems of centralised and orderly marketing had, in the early part of the century, failed due to the ability of growers to market their commodities independently, thus disrupting the price.

Agitation on the part of Okanagan growers, and the desire of the state to exploit what was developing into a specialised, export-oriented agricultural sector, led, in 1927, to the Natural Products Marketing Act which covered all agricultural commodities. As Booth notes:

This act introduced a new principle in marketing as far as Canada was concerned, namely, that when a certain majority desired to place the marketing of their product under the direction of a committee or board, the minority must submit. Among the powers conferred by the act were those (1) permitting regulation of a product to market and (2) determining the price at which the product should sell under stated conditions (Booth 1936:61-62).

The Act – which was eventually replaced by the federally administered Natural Products Marketing Act in 1934 – had the effect of stabilising prices and, consequently, grower’s income. However, as Barman notes, ‘…the province’s fruit growers continued to be undersold by American producers, who had also turned to co-operative marketing in the face of overproduction’ (1991:243).

While the state’s ultimate intention with respect to orderly marketing in the Okanagan fruit industry was territory building – that is, the encouragement of settlement and the development of capitalist agriculture, an export agriculture in the case of the Okanagan – price stabilisation, or the setting of a minimum price for commodities, had the effect of increasing the agricultural base. As both Marx and Kautsky have illustrated, the average profit of an agricultural sector is determined by the productivity of marginal land. Any profits above the average rate, accruing from, for example, enhanced soil fertility or proximity to transportation networks and hubs, constitutes surplus profits. The survival of enterprises established on marginal lands is
determined by the ability to garner a certain price for their commodities. The marginality of an enterprise, in terms of its productive base, is also a measure of its vulnerability to price fluctuations. Periodic crises of a failure to realise value result in the destruction of the most vulnerable enterprises. That land is then either alienated from agriculture, which in the context of a relatively underdeveloped economy may remain unproductive, or is absorbed by a larger, more profitable enterprise. Regulation imposing order over marketing, or indeed the market, by guaranteeing a certain price, also guarantees the survival of marginal enterprises assuming their costs of production is low enough. In this manner, and compared to the effects of unbridled market forces, a larger agricultural productive base is maintained.

**Early Agriculture in Delta**

Encountering Delta was, for the early settlers – the first being Thomas and William Ladner who started farming in the area in 1868 – an encounter with a landscape with agricultural potential. Delta’s location on a peninsula at the south-west extreme of the Fraser River accorded it a physiography that was to prove advantageous to early agrarian endeavours. The striking aspect of the vista confronted by the early migrants was the relative absence of thick forest. Although such forest existed at higher elevation – in, for example, what is now North Delta – the alluvial plains of Delta were carpeted by long grasses interspersed with groves of trees. The grasses were a consequence of the hydrology of the area: routine flooding and a high water table, coupled with the deposition of fine and fertile alluvial soil, fostered the growth of grasses and other vegetation while constraining the growth of forest. Trees were often found in areas with adequate drainage.

A flat, sparsely treed terrain as represented by Delta existed in marked contrast to the landscapes encountered by settlers elsewhere in the Fraser Valley. The lush vegetation of the river banks signalled the fecundity of the soil while the absence of thick forest obviated the need for enormous investments of labour (Siemens 1968; Harris 1997:86), thus implying the relative ease with which fields could be established54. A further attraction of Delta to early farmers, and again in contrast to much of the rest of the country, was a longer growing season, the consequence of a relatively mild climate. On average, Delta experiences approximately 180 frost-free days and, due to the mild daytime temperatures in winter, and a growing season of approximately 230 days. Fodder crops – hay, oats – benefited the most from this long growing season in terms of the

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54 One factor confounding the establishment of fields was the existence of buried stumps and logs washed down by the river and deposited on the alluvial plains. Theses stumps and logs had to be laboriously dug up and burned before cultivation could begin.
number of annual harvests. Both the quantity and quality of the fodder were a factor in the subsequent emergence of Delta as a leading livestock and dairy producer.

The Fraser river, the source of the fertile soil, also facilitated transportation which, before the construction of adequate roads and bridges, was critical for early agrarian endeavours. Access to markets, New Westminster being the closest as well as the largest and most important during the early settler period, along the river, while a number of sloughs allowed access inland to various farms. Other major markets were Victoria and Nanaimo. The proximity of the river was, however, a mixed blessing. While it aided embryonic agriculture in the area, the river also proved to be a burden in other respects. As noted above, the fertility of the soil and the lushness of the vegetation was a consequence of chronic tidal flooding and a high water table. As one early farmer noted: 'Water is superabundant…and the problem here is to get it off the land' (British Columbia Department of Agriculture 1894:1598). A Provincial report on agriculture notes that,

> It seems odd that one part of the Province should be so destitute of water as to necessitate enormous expense for irrigation, and that another should have such a superabundance, both naturally and from precipitation, as to necessitate an equal if not greater expense to get rid of it. (British Columbia Department of Agriculture 1893:788)

The early farmers responded to the problem by building dykes around individual farms. Such dykes were initially crude, consisting of dirt laboriously piled around the perimeter of farms. Given that the rudimentary dykes were frequently breached, methods of drainage had also to be implemented. These consisted primarily of underground ditches covered by cedar planks (Winter 1968:109).

However, it wasn’t until the spring flood of 1894 and a subsequent high tide in January, 1895, that a collective response to the problem of excess water in Delta emerged. The flood devastated fields and crops and, by sweeping away Canadian Pacific Railway lines, interrupted rail access to the coast. The scale of damage and the probability of repetition galvanised the nascent community into the first systematic attempt in the area to control nature in the interest of, primarily, agriculture. A recognition of the threat posed by flooding to settlements in the low-lying areas of the Fraser Valley had prompted the provincial government to pass the Draining, Dyking and Irrigation Act in 1873. Much of the Lower Fraser Valley was affected by flooding, including Sumas, Chilliwack, Richmond, Delta, parts of Surrey and Coquitlam. This Act, which offered partial funding and included mechanisms for cooperating within and between
municipalities, enabled the construction of dykes which protected the whole of Delta (Gosnell 1914).

The pattern of property relations defining Delta’s agrarian settlers’ legal relationship to the land was established by the settlement policies of the latter half of the 19th century. In an attempt to encourage agrarian settlement, and to entice prospective settlers away from the United States, the colonial state, in 1860, allowed the pre-emption of crown land. Recognising that most settlers had little capital, the state allowed lots of 160 acres to be staked out and, if the land had been improved, the settler had the first right of purchase when offered for public sale. If unclaimed, adjacent plots of land could also be purchased at a low price, assuming the condition of the improvement of the original land had been met. The pre-emption of land was initially open to both whites and natives, but by 1866 the right had been revoked for natives. Early pre-emptors included the Ladner brothers, Thomas and William – after whom the embryonic settlement was named – who claimed land in 1868 and were the first to drain and dyke their land (Philips 1988:15). As Thomas Ladner’s son notes “…Delta, at the time the Ladner brothers moved there, was entirely unimproved. There was not a road, a ditch, or a fence to be seen’ (Ladner 1979:14). After clearing enough land for subsistence needs, the Ladners consigned the rest of the land to raising livestock. Demand for animal products from mining towns in the Interior enabled the Ladners and other settlers to realise value on their surplus. By 1880 all land, except for what is now known as Burn’s Bog, was pre-empted.

The initial spatial pattern of settlement reflected the centrality of water transport to Delta’s new residents. By 1872, all lots along the river and the two main sloughs which cut into Delta – Chilukthan and Crescent sloughs – had been pre-empted (Taylor 1958). In the absence of railways or proper roads, steamers that plied the Fraser River provided the only reliable means of access to New Westminster which, at the time, was a market for surplus produced in Delta and was a source of provisions. Although the CPR had yet to be built, and Vancouver had yet to become more than a lumber camp, the construction of a wharf by the colonial state in 1873 facilitated both further settlement and a limited increase in commercial agriculture. By 1882, however, there were only 60 farmers in Delta, less than half the number of pre-empted plots. While the relative ease with which farms could be established in Delta, and its proximity to the river, determined the rapid and complete pre-emption of land in the area, land speculation played a role in that process. Policy governing the acquisition of land, dating from 1848, had initially allowed the purchase of large tracts of unsurveyed land without having to fulfil settlement
conditions, that is, to improve the land. (Little 1996). Speculators from Britain, colonial functionaries and principals of the Hudson’s Bay Company were the main speculators. The passage of the Land Act in 1860 was an attempt to regulate the process of land acquisition and settlement. While speculation probably alienated some land from productive use, the absence of a developed transportation network and difficulties in draining and dyking the water-sodden terrain also retarded the process of agrarian settlement in Delta (Philips 1988:21).

Legislation enabling the pre-emption of land was a cornerstone of colonial settler policy and reflected both discursive and material processes. Settler policy in British Columbia – influenced by a Jeffersonian vision of the role of agriculture in the settlement of ‘new’ lands – was animated by a racialised discursive construction characterised by a particular agrarianism. Sandwell, in her discussion of the process of settlement on Salt Spring Island, argues that ‘…nineteenth century administrators, journalists, and immigration officials evinced a strong belief that small scale agricultural production on the family farm would provide the social, economic, and moral backbone of the colony and the province’ (1999:84). In, other words, commodity production, founded on the family unit, was to provide a bulwark against the depredation of the province by laissez-faire capitalism. Clarkson, a historian of British Columbia, argues that colonial politicians, namely Reformers such as Amor De Cosmos and John Robson,

… idealised property-based democracy and economic equality for yeoman small holders, artisans, tradesmen, merchants and entrepreneurial businessmen. The prospect of industrial monopolies, widespread wage labour and a large landless proletariat was abhorrent to them … In the face of emerging capitalist productive relations, Pacific north-western reformers moved to establish the preconditions necessary to develop an independent producer economy and electorate (1997:390).

55 While Jefferson envisioned an America founded on family farms, he also expected an expanded role for those family farms. Such farms, for Jefferson, were to produce enough of a surplus to constitute an export sector comprised of the movement of agricultural commodities to sustain the urban working class in Europe. In this way, Jefferson anticipated the United State’s role in the first food regime. For a discussion of Jefferson’s economic philosophy see Dorfman (1940). Clarkson notes that in British Columbia, ‘…nation-builders required “white” families to establish a permanent and expanding Anglo-Saxon population (they defined nation in racial terms)” (1997:391).

56 De Cosmos and Robson, among others, were opposed to the Hudson’s Bay Company’s monopolisation and control of British Columbia’s economic and political institutions. Influenced by classical laissez-faire liberalism, reformers, as nation-builders, sought the construction of a province founded on individual economic liberty (Clarkson 1997). The Reformer’s antipathy to both urbanisation and proletarianisation also reflected that of Jefferson.
However, the desire to create an ordered society founded on small agricultural producers in order to repel industrial capitalism produced, through pre-emption and homesteading, a particular space marked by dispossession. Settlement policy represented a form of primitive accumulation characterised by the herding of First Nations peoples into reserves (Harris 1997:2004). Delta was originally inhabited by the Tsawwassen, a distinct group of the Coast Salish of south-western British Columbia. In the 1850s, there was a community of approximately 35 Tsawwassen living in a relatively permanent community near the site of the present reserve. This reserve was established in 1878 and encompassed an area of 243 hectares. Harris (2004), in his elegant analysis of the process of resettlement in British Columbia, argues that industrial capital, represented by mining, forestry and railroad interests, ‘…introduced new relationships between people and with land’ (2004:172). As far as Natives were concerned, this new relationship was one of dispossession, of severing Natives from their means of production leading, in the hope of industrial capital, towards their proletarianisation. Reserves served this purpose by rending the relationship between Natives and the land, both in terms of access to use value and to cultural meaning. Pre-emption and homesteading also represented the introduction of a formal property rights regime, although Native groups had had understandings between themselves with respect to territorial resource use.

One of the instruments the colonial state had at its disposal in the establishment of a formal property rights regime was the survey system. Surveys of parts of the Fraser Valley were initially conducted by the Royal Engineers who, between 1859 and 1863 (when they were disbanded), surveyed roads and bridges and established the boundaries of a number of towns. In 1864 the office of Surveyor General was created, filled by an elected official who also held the title of Chief Commissioner of Lands and Works. Throughout much of its early history, the process of surveying the province was plagued by a shortage of funds. As a consequence, some of the more desirable land in the province was pre-empted before it had been surveyed. This was true of Delta, particularly of lots adjacent to waterways. As a consequence, the boundaries of these lots tended to be influenced by the contours of waterways (Taylor 1958). The survey system, where possible, laid out lots in a more orderly fashion, one which approximated a grid. Viewed through

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57 A smallpox epidemic along the coast a few years earlier had depopulated the village (Taylor 1958). For a discussion of the geography of depopulation as a consequence of disease introduced through contact, see Harris (1997:4-30).

58 In addition to the cold economic logic of industrial capital, the process of primitive accumulation in British Columbia also represented an aspect of the ‘civilising mission’ of the colonial state. Introduction into the rigidities of the industrial workplace, as wage labour, was to inculcate in Natives the values of thrift, time discipline and materialism (Harris 2004:172).
a Foucauldian lens, the survey system imposed a discipline on the landscape. The relatively unbounded space of the Natives was in the process of being ordered and classified. Natives were confined to their own bounded space. As Harris (1997) notes, pre-emption and surveys ‘…introduced exclusions that established where people could and could not go…Suddenly there were survey lines and fences on the land…Native people suddenly found that they could not go where they had…’ (1997:101). Furthermore, the introduction of a regime of formal property rights in British Columbia created a space for development: ‘Farmers could acquire land knowing their title was secure and the colony was safe for settlement’ (Harris 1997:101).

The settlement of Delta and other areas in the Fraser Valley, was enabled by the state. Land was rendered accessible for farming in two specific ways. In the first, through regulation supporting local governments, dykes were built to protect low-lying areas from floods. The state’s actions in this respect, through the expansion of farmland, represented a moment in what was an extensive regime of accumulation. Just as critical as the control over nature was control over access to land. State regulation established a regime of private property rights that paved the way for agrarian settlement.

59 The Office of the Surveyor General was complicit in determining the nature of this space. For example, Joseph Trutch, who held the office from 1864 to 1871, displayed a marked hostility to Native concerns. Trutch rejected native land claims based on traditional use rights, and endeavoured to make reserves as small as possible in order to free more land for settlement (Stadfeld 1999).
Expanding Agriculture

Having tempered nature to some extent – particularly in modifying the landscape – and garnered the support of the state, the early farmers sought the expansion of their activities (Siemens 1968:38). Early agriculture in Delta, in the last two decades of the 1800s, was devoted to livestock rearing and the cultivation of hay and oats. While most of the grains produced were destined for local consumption, some of it found its way to Nanaimo and Victoria. However, as Ladner concedes, ‘…there was not a large market for Delta’s feed products’ (Ladner 1979:62). This was due, primarily, to the absence of developed transportation links and competition from Northwest Pacific grain producers. The emphasis on cattle-raising in the area was due to the existence of the mining camps of the interior and the large and lucrative market they represented (Ormsby 1939:64). In 1882 there were 60 farms and cattle ranches in Delta (Taylor 1958:26). By 1892, and as a consequence of further settlement, the number of farmers had increased to 148. The stock for the cattle ranches was imported from the Great Plains region of the United States after having been driven overland into the Fraser Valley. There was a practical reason for importing stock. Other than enabling the material conditions of production, the state, at this point, had provided little or no technical assistance to farmers. Even though a minister of agriculture had been appointed in 1873, it wasn’t until 1894 that a Department of Agriculture had been created (Gosnell 1914). Until then, the state had confined itself to,

...the traditional instruments of agricultural encouragement, chiefly the financing and supervision of agricultural societies, the assistance of shows and exhibitions, and whatever elementary beginnings there were by way of agricultural education (Fowke 1946:156).

On the other hand, the federal government, through the Department of Agriculture, was concerned with nation-building.

From Confederation until the late 1950s, regulatory policies and expenditures were designed to promote national development by populating western Canada [that is, primarily the Prairie provinces] thereby confirming Canada’s hegemony over that region, and providing a market for central Canadian industrial goods (Skogstad 1987:37).
In the absence of a systematic deployment of state resources towards agricultural research, farmers were compelled to rely on such institutions as agricultural exhibitions for the acquisition and exchange of knowledge.  

Table 2: Agricultural Production, Delta, 1893

<table>
<thead>
<tr>
<th>Agricultural Product</th>
<th>Grains and Cereals</th>
<th>Fruit</th>
<th>Root Crops and Vegetables</th>
<th>Dairy Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (tonnes)</td>
<td>12,099</td>
<td>5,884</td>
<td>4,009</td>
<td>10.4</td>
</tr>
<tr>
<td>As % of total production of Lower Mainland</td>
<td>22.2</td>
<td>1.2</td>
<td>16.5</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Data source: British Columbia Department of Agriculture (1894:1806)

An indication of the main crops produced in Delta in 1893 is offered by Table 2. At a regional level, Delta was a significant producer of grains and cereals such as oats and hay, as well as root crops, particularly potatoes. These figures also indicate a relatively undiversified agrarian economy dependent on a few major crops, two of which were for livestock. The cultivation of crops such as potatoes, berries and fruits was primarily for farm consumption. Dairy production at this time was in its infancy – there was only one dairy farmer – although butter was being produced, as a by-product of livestock raising, for consumption on the farm. The state, though, had already signalled its intention to foster the development of a dairy industry in the Fraser Valley (British Columbia 1893:948). The reason for this exhortation to farmers was province-building and agricultural self-sufficiency; dairy products such as butter and cheese were still flooding in from eastern Canada. Through dairy production, farmers were to be transformed into commodity producers and introduced into the burgeoning capitalist economy of the young province. Compared to livestock production, which the Dairy Commissioner at the time considered an inefficient use of land – that is, an extensive agriculture – ‘Dairy farming provides

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60 The annual reports issued by the British Columbia Department of Agriculture do, however, report visits by agricultural experts from both within and without the country.

61 These table have been constructed on data published in the British Columbia Department of Agriculture’s annual reports. The geographical scale represented in the data is labelled as the Lower Mainland which, spatially, is more extensive than the Fraser Valley. In addition to the Fraser valley, which finds its eastern limit at Hope, the Lower Mainland includes Vancouver and its environs and extends up Howe Sound towards Squamish. The primary agricultural area, however, remains the Fraser Valley. The number of farms is based on the number of returns, which form the foundation of the data.

62 For example, in 1893, approximately 10,000 kilograms of butter had been produced in Delta (British Columbia Department of Agriculture 1994:1806).
remunerative occupation for a larger agricultural population’ (British Columbia 1893:948).

Table 3 reveals that approximately a quarter of the land in Delta was under cultivation, suggesting under-utilisation, with much land sitting idle as a consequence of speculation and the difficulties associated with pioneer farming. Compared, however, to the production figures, and to the proportions of the land owned and cultivated to the total for the Lower Mainland, there is a suggestion of a greater efficiency of agricultural activity. The number of cattle owned in Delta, for example, was only eclipsed by the much larger Chilliwack-Sumas area. If the land classified as prairie or pasture is taken into consideration, as a source of fodder for livestock, the percentage of land utilised for agricultural production in Delta, compared to the Fraser Valley total, increases from 6.6 to 9.7. In other words, Delta in the last decade of the 19th century, and on a regional scale, appears to have been a relatively productive and efficient farming area. This can be attributed to the relative ease with which farming and livestock production could be effected. Furthermore, the grasses resultant from the fertility of the alluvial soil in the lowland of Delta lent themselves to livestock production.

Table 3: Land Utilisation and Number of Cattle, Delta, 1893

<table>
<thead>
<tr>
<th></th>
<th>Number of farms</th>
<th>Total land owned (ha)</th>
<th>Cultivated land (ha)</th>
<th>Prairie or pasture (ha)</th>
<th>Number of cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>111</td>
<td>4,266</td>
<td>1,038</td>
<td>2,596</td>
<td>1,442</td>
</tr>
<tr>
<td>As % of total area of Lower Mainland</td>
<td>7.6</td>
<td>3.7</td>
<td>6.6</td>
<td>11.8</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Data source: British Columbia Department of Agriculture (1894:1803)

There is also evidence that, as a proportion of the total for the Lower Mainland, agriculture in Delta was relatively capital intensive (Table 4). Although Delta only had 7.6% of the farms in the Lower Mainland, the capital improvements of farms – which does not include capital improvements to land, most improvements were the product of living human labour – was, proportionally, twice as great. Agricultural machinery and implements consisted of ploughs and threshers that were drawn by horses, as well as rare instances of steam-powered machinery.63 Buildings were primarily those required to maintain livestock such as barns for hay storage. By the mid 1890s, Delta’s agricultural land was the most expensive in the Fraser Valley. (Gosnell

63 See below for a fuller discussion of technology.
The already fertile soil, coupled with improvements through drainage and dyking, increased the land rent of the area relative to the rest of the Valley.

Table 4: Value of Property, Delta, 1893

<table>
<thead>
<tr>
<th></th>
<th>Value of agricultural machinery and implements ($)</th>
<th>Value of buildings and improvements ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>35,031</td>
<td>155,408</td>
</tr>
<tr>
<td>As % of Lower Mainland</td>
<td>15.8</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Data source: British Columbia Department of Agriculture (1894:1803)

Up until the early to mid 1890s, farming in Delta was primarily oriented towards farm consumption. As one pioneer account of Delta notes,

Sales of veal and beef provided the only revenues from the earliest farm operations in Delta. Sales were made to butchers in New Westminster and Victoria, but only as buyers could be found and transportation arranged’ (Ladner 1979:43).

And as Taylor, a historian of Delta, notes:

‘The early agriculture in Delta was not the commercial type that [now] prevails… Rather the type of economy prevalent for the first years after settlement was what could be described as subsistence. The main interest was in providing sufficient food for the immediate farm family. What could be marketed in the limited markets of the day provided a cash income with which to purchase the necessities which could not be purchased on the farm’ (1958:26).

While the mining settlements existed as a market for some commodities, and large population centres on the south coast existed for others, the absence of a developed transportation network inhibited the development of agriculture. This was compounded by the fact that most agricultural commodities were perishable. Delta was ill-served by both roads and railways, the reliance still being on water travel. The closest railway line was the New Westminster Southern Railway, which ran from New Westminster to the American border, and which was an arduous 10 kilometre trek over rudimentary roads. The next few years, however, were to be witness to a number of developments which transformed Delta’s farmers from being engaged in subsistence agriculture into commodity producers. The most central of these development was the emergence
of dairy production. While the state had already revealed its intentions with respect to the development of agriculture in the province, its direct intervention was yet to come.

**Dairy Production**

In the early part of the 20th century, dairy farming was to supersede livestock rearing in importance. The quality of hay and oats grown in Delta, and the rate at which it could be harvested\(^\text{64}\) – a competitive advantage – had already resulted in the development of livestock raising. But, as the Dairy Commissioner puts it, more was possible: ‘Dairy farming enlarges the earning power of land per acre’ (British Columbia Department of Agriculture 1894:1893). In essence, what the Dairy Commissioner was advocating was a more intensive use of land. The development of dairy farming in Delta and elsewhere in the Fraser Valley took place within a broader political context characterised by the increased political power of farmers. As Seager notes, in the last two decades of the 19th century, ‘…British Columbia’s agriculturalists became increasingly conscious of a distinct class interest and organised to express it’ (1996:232). Furthermore, many of the politicians of the day had been farmers and their constituency in the Fraser Valley was rural and agricultural. The creation of the provincial Dairymen’s Association in 1896 represented an instance of this mobilisation. The formation of such producer associations, co-operative in nature, was enabled by the state through the passage of an Act, in 1896, ‘…which enabled farmers and others to combine for commercial purposes on a very cheap and expeditious basis’ (Gosnell 1914:547). In the same year, the Dairy Associations Act was passed, providing for the incorporation of a provincial Dairy Association, the incorporation of Cheese and Butter Associations, and the establishment of co-operative creameries.

Agricultural change in Delta then, was first signalled by the establishment of a creamery co-operative in 1896 – partially subsidised by the provincial government. Impetus for the co-operative came from the Dairymen’s Association, and the Delta cooperative creamery was one of a number of such operations established in the Fraser Valley.

In its first year of operation the creamery processed 34,000 kilograms of milk (Gosnell 1897:377).\(^\text{65}\) A further factor that enabled the transformation in production was the construction in 1903 of a railway link, part of the Great Northern Railway, from neighbouring Port Guichon to

\(^{64}\) In 1895, for example, the yield per acre of timothy hay and clover in Delta was approximately a third more than most other agricultural regions in British Columbia (British Columbia Department of Agriculture 1896:1140-1141).

\(^{65}\) For a detailed history of the dairy industry in the Fraser Valley see Maclachlan (1972).
Cloverdale. The Great Northern Railway lines in the Fraser Valley were an extension of a private American transcontinental railroad. The railway offered access to New Westminster, a hub for a number of railways, as well as to the American border. As a consequence, the long-awaited access to proximate urban markets was realised. The local road system was also improved, the existing planked roads – which limited speed – were upgraded to gravel surfaces.

Dairy processing is inherently water intensive and the construction of a municipal waterworks system, in 1910, was a further stimulus to the industry. Fresh water for drinking and cooking had been obtained from collected rainwater, while water for livestock had come from drainage ditches and sloughs. The waterworks was essentially a reservoir fed by springs which flowed from the hills surrounding the lowlands. The significance of this new system of water delivery to dairy processing and the production of butter and cheese was that it was consistent and reliable. The creamery established in Delta housed an industrial process, one that produced a standardised commodity of consistent form and quality, an early example of one aspect of what was to be Fordist production (Goodman and Redclift 1991). The abstract markets of the urban centres demanded this. The municipal waterworks supplied an input that met the requirements of this industrial process. The creamery also introduced industrial work relations into Delta’s agriculture. For the first time, permanent wage labour, as opposed to the casual labour represented by farmhands, became a feature.

The pursuit of the collective interests of dairy farmers by the Dairymen’s Association also led to an attempt to improve breeding stock. In 1900 the Association, in concert with the state, imported selectively bred dairy stock from Ontario which was then auctioned off at New Westminster. This attempt to expand the source of dairy animals beyond the local was a response to the burgeoning industry as well as an anticipation of future needs.

The development of the dairy industry in Delta represented an early instance of the industrialisation of agriculture. The establishment of a provincial Dairymen’s Association was

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66 In 1890, the dairy Commissioner for Canada, J.W. Robertson, argued the following: ‘As soon as possible more cooperative creameries and cheese factories should be established…When the butter is made in creameries, it will have a uniform quality and excellence, which will enable it to become an article of commercial importance’ (British Columbia Department of Agriculture 1893:947).

67 See Cohen (1984) for a discussion of the impact on women of the transformations in dairy production. Cohen demonstrates how this industry evolved from one of mainly household consumption to market orientation, with an attendant change in the place of women in those markets. In particular, she contrasts the role of women in dairy’s two dominant sub-sectors, namely butter and cheese.
mirrored, at the federal level, by a Dominion Dairy Commissioner in 1890 who ‘…undertook a considerable programme of assistance to the Canadian dairy industry’ (Fowke 1946:214). The major concern was quality which, given that most dairy products were made at the farm level under diverse conditions and with varying degrees of competence, tended to be uneven. By promoting a policy aimed at consolidating dairy products manufacturing – primarily butter and cheese – the state and the industry hoped to exercise control over the finished product. As Cohen notes, the centralisation of production was made possible by the cream separator.

By the end of the last decade of the nineteenth century several important changes occurred which were significant for transferring butter production from the farm to the factory. The change usually considered to be most important was the introduction of the centrifugal cream separator to Canada, the first one having been brought to the country in 1882 from Denmark. This new technology revolutionized the old methods of recovering cream from milk and radically reduced the amount of labour for farm women in the process of butter-making. However, while the separator made butter-making on the farm easier and contributed to a more reliable product, its advent also made the use of factories more practicable. (Cohen 1984:327)

Creameries were thus equipped with modern machines, courses were offered for butter and cheese makers, travelling (demonstration) dairies were despatched to agricultural regions – to British Columbia in 1896 – knowledge and techniques garnered through experimentation were disseminated and, varying forms of state assistance were made available to creameries that wanted to modernise. The concern with quality – viewed as essential for exports – manifested itself in a factory system of production. The state also engaged in policing the commodities being produced, being motivated, in particular by public health concerns (Harris 1997:241).

The establishment of creameries in Delta and elsewhere in the Fraser Valley represented an early instance of the industrialisation of agriculture. This was through the process of appropriation, one of the routes through which capital, as Goodman et. al. (1987) have argued, engages with agri-nature. The machines used by the creameries appropriated the handicraft nature of the labour, which had been performed on the farm by women, through mechanisation. In this respect, appropriation was successful, and was enthusiastically supported by the state through partial funding and education programmes.

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68 The Dairy Associations Act, for example, offered loans payable over 10 years at an annual interest rate of 5 percent.
A parallel process is that of substitution, where an agricultural product is replaced by one that is manufactured. The iconic example is margarine, and in this respect, industrial capital was less successful in imposing its will. For the replacement of butter by margarine proved to be a highly contested process. Between 1886 and 1948, the sale of margarine in Canada was banned. Initially, the production and sale of margarine had been restricted through measures such as onerous taxes. But agrarian interests persevered,

Despite margarine’s affordability, the dairy interest argued that the nation’s fledgling butter industry required protection form this new product and that no level of margarine consumption should be tolerated. When coupled with the growing concern over food safety, the [Federal] government retreated from its moderate position and proposed prohibiting the import of margarine…(T)he Canadian government ultimately passed a complete ban on the sale of margarine in 1886. (Barnes 2001:395)

There was consumer demand for margarine because of its price: it cost less to produce than butter, and was often half the price (Dupre 1999). In 1948 the ban was lifted, but there was a restriction on its colour which varied by province. In Ontario, the colour restriction was only lifted in 1995. Margarine’s eventual legalisation represented the power of industrial capital (Barnes 2001) and the relative weakness of agrarian interests at both the provincial and federal levels (Fowke 1946; Skogstad 1987).

What the ban on margarine, and other regulatory acts at both the provincial and federal levels, did was to create the space for the emergence and development of the dairy industry. Taking full advantage of this regulatory climate was the Fraser Valley Milk Producer’s Association (FVMPA) which represented the collective interests of the dairy farmers in the region. The FVMPA was formally incorporated in 1913; incorporation having been enabled by the Dairy Associations Act of 1897. Further legislation in 1911 created the material basis for the formation of producer associations by creating a structure of share capital supplemented by state loans to the extent of 80 percent of the subscribed capital (Fay 1923). The financial structure of associations, dictated by the state, denied the transfer of shares – they could only be withdrawn – thus restricting ownership to member producers.

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69 In the United States, the sale of margarine was not prohibited as long it was not yellow.
70 As Dupre notes: ‘Margarine consumers were hurt by anti-margarine policies. To be sure, the product accounted for only a small portion of the household budget. Nevertheless, these policies restrained the consumer’s freedom of choice, especially in the lower income groups’ (1999:358).
The FVMPA grew out of the Lower Mainland Milk and Cream Shippers Association which had representation throughout the Fraser Valley. This latter association had been created as a response to anarchic marketing conditions that had depressed the price of milk and dairy products. A contemporary report notes that ‘Milk has been selling in Vancouver at the lowest price of any city in Canada…’ (Fay 1923:244). The uncertainty over the market price of milk and dairy products had retarded the development dairy herds by fretful farmers. The passage of the Dairy Associations Act, coupled with producer agitation for orderly marketing, resulted in the creation of the FVMPA. Although created in 1913, the activities of the FVMPA were delayed until the end of the First World War, with operation only starting in February of 1917 (Fraser Valley Milk Producers’ Association 1967).

After having signed up 80% of the milk producers in the region, the FVMPA began as a bargaining agency dealing with milk producers, primarily in Vancouver. The FVMPA then entered into the distribution and retailing of milk, buying up the plants of existing distributors and consolidating the marketing process (Fay 1923). Milk processing was to follow with the construction of creameries and an evaporated milk plant. By 1920, the FVMPA controlled two processing plants and a condensing plant. In 1925, it built a plant in Sardis to manufacture butter, powdered milk and cottage cheese. In 1918, the Delta Creamery was closed and replaced by an evaporated milk plant. This plant was bought by the FVMPA in 1925 and functioned until 1928 when it was closed due to the consolidation of milk processing at the plant in Sumas (Taylor 1958). The production of evaporated milk, along with condensed and powdered milk, represented a further instance of Fordist food production taking hold in the region. Although not organised by industrial capital in the Fraser valley, and not strictly a product of substitution given its ‘natural’ basis, evaporated milk became a substitute for fresh milk. With a much greater shelf life, critical in the absence of the generalised use of domestic refrigerators, more portable, and safer as a consequence of the inherent pasteurisation of the manufacturing process, evaporated milk had a number of characteristics to recommend it to early urban consumers.

The processing of commodities represents a narrowing of the supply chain. That is, a multitude of producers deliver their output to a central processing plant. Given its aversion to direct engagement with nature on the farm, as argued by the Mann-Dickinson thesis (Mann and Dickinson 1979), one of industrial capital’s portals into the sphere of agricultural production is the processing of Fordist commodities (Goodman et. al. 1987). Corporations such as Nestle and Campbell’s, for example, had their origins as food processors. However, the regulatory climate in British Columbia, particularly the imposition of orderly marketing and the enabling of
cooperative producer associations, acted as a barrier to industrial capital. While industrial capital was dominant in the supply of the machines necessary for large scale milk production and processing – milking machines, refrigeration, separators, pasteurizers – as well as feed supplements and pharmaceuticals for livestock, processing in the Fraser Valley remained outside its orbit.

To summarise, the significance of the dairy industry to Delta’s agricultural sector lay in its tendency to transform farmers engaged primarily in production for subsistence into commodity producers. While most farmers had produced some agricultural commodities for the market, the primary activity for production for self consumption. With the consolidation of the dairy industry under the control of the FVMPA, the further development of transportation and other infrastructural networks, and the rapid growth of Vancouver and its environs, commodity production became generalised throughout Delta’s agricultural sector. Despite the generalisation of commodity production in Delta, farms remained family owned and operated although, as noted below, they did become fewer but larger. Furthermore, state regulation played a pivotal role in the generalisation of commodity production throughout the region.

**Mechanisation on the Farm**

In this section I discuss the process of appropriation of a discrete aspect of the agricultural production process, namely the replacement of human and animal labour through mechanisation.

In addition to the technological changes in dairy processing, there were also technological changes in farming. Draught animals – horses and oxen – had historically supplied the motive power for such agricultural implements as ploughs, harrows, mowers, thresher and hay presses (Ladner 1979:44-45;60-61).\(^{71}\) Harvesting, for example, was accomplished by a grain binder drawn by a team of horses. In the first powered thresher, which made its appearance in Delta in 1878,

...power was derived from a circular machine driven by...three pairs of horses. Each pair was hitched in front to a sweep. The horses moved in a circle and a man on a platform in the centre used a long whip to keep them at a steady pace. Power was transmitted to the threshing machine by a shaft leading from a bevel gear system under the platform (Ladner 1979:65).

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\(^{71}\)The first draught animals in Delta were oxen and the first horse made its appearance in 1874 (Ladner 1979:64).
Despite these advances over manual methods, there was still a need for labour. Labour, however, was scarce, and when available, expensive. A contemporary account notes:

Owing to the scarcity of farm labour in British Columbia, labour is principally performed on farms by Chinese and Japanese, although white men are invariably preferred when available. There is no very definite scale of wages as yet. Chinese and Japanese receive from $10 to $20 per month and white men from $15 to $30. The demand [for labour] is irregular (Gosnell 1897:396).

Chinese labourers were hired on farms between fishing seasons; the Delta Cannery, built in 1878, was a large employer of Chinese workers. Occasional labour was also supplied by members of the Tsawwassen Nation whose reserve was adjacent to Delta. The particular rhythm of biological production – dictated by nature – determines particular labour requirements. The cycle of ploughing, sowing, cultivating and harvesting is interspersed with long periods where labour is redundant. At peak times, harvesting for example, the requirements for labour intensifies. The irregularity of labour demands, and its consequent effects on supply, created an intractable problem for the farmer. Mechanisation was one way of reducing the demand for labour (Mann 1990).

The next stage in the mechanisation of field agriculture was steam power, which made its first appearance in the fields of Delta in 1884 through the agency of John Oliver, in the form of a thresher. As Oliver's biographer evocatively puts it:

He [Oliver] must have looked with pride on this monster of smoke stack, tubes, wheels, and pistons. Here was a thing compounded of metal woven into intricate patterns, yet all working in unison – a thing cold and dead yet to be warmed into a fierce semblance of life when heated by roaring fires and vibrant with hissing steam…There was a thrill in guiding and releasing the torrent of power which flowed through the long belt to the howling mill, where the sheaves were torn to shreds in the iron-toothed cylinder and the grain came pattering down through a spout while the straw was hurled in dusty heaps from the farther end (Morton 1933:49).

Animated or not, the steam thresher had to be dragged around by teams of draught animals – yoked to the past – effectively limiting the size and power of the engine. Before transportation from one farm to another, the thresher had to be dismantled and teams of horses and oxen were

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72 Because threshing was a relatively stationary operation – some threshers were stone-built fixtures in the field – it lent itself to early developments in steam power, that is, before the development of self-propelled steam powered machines.
required to haul such components as the separator, bundle wagon, water tank and coal wagon. Transportation was also often arduous given that the heavy machinery was difficult to move on surfaces other than a hard-packed road (Williams 1987:9). Steam thresher also had their labour requirements. An engineer had to operate the steam engine, a person at the water tank, two to ensure the sacks were completely filled with grain, a person to sow the sacks and one to pile them and, two or three to load the wagons (Ross 1979:134).

However, it was not until John Oliver acquired a steam-powered traction engine in the late 1890s that agriculture in Delta started shedding some of the characteristics of pioneer agriculture. The significant advantage of the traction machine – in this instance a precursor to the compact and agile gasoline or diesel tractor – was its mobility without recourse to draught animals. Traction engine based agricultural machinery was more efficient than the steam-powered implements that it replaced. It diminished the requirement for labour, which was not always available when needed and, through the ability to plough more land, it increased productivity. These productivity gains, however, were not as great as those realised through the supercession of horse-driven or powered machinery over manual agricultural implements.

Although there is no data on the adoption of steam-powered farm machinery in Delta, a study conducted by the U.S. Commissioner of Labor in 1889 suggests that the productivity gains offered by steam over horsepower on wheat farms in the Pacific Northwest were minimal. As Shannon notes with respect to the study: ‘…steam operations took only 21 fewer minutes for the making of 20 bushels of wheat to the acre than were required by the horses; and the man-labour cost was 5.75 cents higher’ (1961:144). A comparison of the efficiencies of human versus equine labour on the other hand, revealed an approximate twenty-fold increase in productivity for every dollar spent on labour in the harvesting of oats (Shannon 1961:142). More substantial gains in productivity were realised with the adoption of the lighter and smaller gasoline tractor in the 1920s.

The adoption of new technologies, however limited, incurred new burdens, the most significant of which was the induction of the ‘…farmer into a mechanical and corporate world’ (Williams 1987:11). In other words, appropriation. Steam-generated power had a voracious appetite for combustibles such as coal which, unlike fodder for animals, had to be sourced off-farm. The relatively complex technology also meant that in the event of mechanical failure there was no recourse to the local blacksmith; spare parts had to be secured from the factory. The large initial capital outlay required for the new technology often compelled an indebtedness to banks and it
was only the large and prosperous farmers in Delta – Harry Burr, John Oliver, John Kirkland, Thomas Ladner – who could initially afford this new technology.\textsuperscript{73}

Notwithstanding the brief flirtation with large steam powered machines in the late 19\textsuperscript{th} century, agriculture in Delta, and most of the Lower Fraser Valley, was slow to adopt mechanisation. Although there is no available data on the adoption of agricultural technology in Delta, provincial level data may be used as a means of gauging change prior to the Second World War. Table 5 offers a view of farm tractor use in British Columbia, the Prairies and Ontario for the years 1921 and 1941.

\textbf{Table 5: Farm Tractor Use, British Columbia, Ontario, Prairies, 1921 and 1941}

<table>
<thead>
<tr>
<th></th>
<th>Tractors per 1000ha</th>
<th>Tractors per farm</th>
<th>Average area under crops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
<td>1941</td>
<td>1921</td>
</tr>
<tr>
<td>British Columbia</td>
<td>2.65</td>
<td>10.03</td>
<td>.02</td>
</tr>
<tr>
<td>Ontario</td>
<td>1.78</td>
<td>9.14</td>
<td>.03</td>
</tr>
<tr>
<td>Prairies</td>
<td>2.18</td>
<td>4.52</td>
<td>.15</td>
</tr>
</tbody>
</table>

Data source: Urquhart (1965)

What this table suggests is that technological change in agriculture, as represented by the adoption of the tractor, was uneven among provinces. Although the march (or trundling) of technology across the agrarian landscape may have been inexorable, its progress was contingent upon the peculiarities of place. In this instance it was the type of agriculture encountered. Prairie agriculture was dominated by the cultivation of wheat on large farms – the average area under crops per farm in 1921 was 68.8ha compared to 8.9ha and 20.2ha for British Columbia and Ontario respectively. Large farms engaged in the cultivation of a single crop lend themselves more readily to mechanisation than smaller farms with a mix of crops. Compared to British Columbia and Ontario, there were, in the Prairies, more tractors per farm in both 1921 and 1941, although there was not as great an increase in the intervening 20 years. The large, and expensive, labour requirement at seeding and harvesting, relatively flat terrain, state subsidies, market pressures, and the short and critical window of opportunity at harvest were some of the factors influencing the decision to mechanise.\textsuperscript{74} The smaller farms of British Columbia on the other hand, and by extension Delta, were less compelled to mechanise as quickly.

\textsuperscript{73} These farmers often rented out their machines to defray costs.
\textsuperscript{74} See Ankli et. al. (1980) for a discussion on tractor usage in the Prairies.
Developments up to the Second World War

By the early 20th century Delta was a productive agricultural area. The establishment of road and railways offering better access to markets, and state regulation enabling agricultural production and processing, had resulted in the generalisation of commodity production. One impact of this transformation was the modification of the landscape. From the earliest settler period, farmers were intent on creating a landscape amenable to agricultural production. In addition to the dyking and draining discussed above, roads opened up the local economy to markets, and fences, in addition to marking the boundaries of private property, contained livestock. Even these rudimentary changes, this creation of a second nature, had profound ecological implications. The construction of dykes, for example, resulted in an alteration in hydrology. As Philips notes: ‘As part of the dyking project, Chilukthan Slough was cut by a flood-box at the Fraser, and over the next few years it began to silt up heavily. In time, the Strait of Georgia mouth of the slough disappeared completely’ (1988:39). This had an economic as well as an ecological impact: the sloughs, as previously mentioned, served as a means of access to those parts of the settlement removed from the shores of the Fraser River. By this time, however, in the mid to late 1890s, roads were beginning to replace boats and steamers as a means of transport.

Dyking and the establishment and cultivation of fields also had the effect of destroying habitat for waterfowl. Furthermore, as Terris notes: ‘The pioneers also changed the vegetation of the region as they dried out the land. The tall swamp grasses, bulrushes, cattails, and wild berries that had previously grown in profusion were replaced by improved pastures and cropland’ (1973:120). In particular, the variety of grasses on the alluvial plain were replaced by a monoculture to support livestock. The built environment had also changed. Delta had once been a settlement characterised by homesteads – a central farm house with a low-roofed barn or two to store hay and agricultural implements. The emergence of intense dairy production had resulted in the construction of large barns and towering silos for storing grain as well as the complex of buildings required by the collection of milk.

In contrast to the early settlement period, and in addition to the ascendancy of dairying, there was a diversification in terms of commodities being produced (Table 6). The original reliance on hay and oats, while still required for dairy stock, had yielded to the production of potatoes and eggs as marketable commodities. Eggs in particular made a pronounced appearance during the 1920s. While there was little commercial production of eggs in Delta in 1911, by 1927 eggs constituted 14 percent of the value of total farm products. Stimulated again by easier access to urban markets,
egg production represented an intensification of land use. Large farms were subdivided and leased and sold to poultry farmers. The privately owned Delta Land Company, in its efforts to sell the lots, built and operated a demonstration poultry farm on a 200 hectare farm formerly owned by Thomas Ladner (Szychter 1998). Dairy production, however, remained the dominant productive activity. Hay and grain were both produced to feed livestock for milk production, surplus was sold on the market.

Table 6: Agricultural Production, Delta, 1911, 1927, %

<table>
<thead>
<tr>
<th>Year</th>
<th>Hay</th>
<th>Grain</th>
<th>Milk</th>
<th>Root Crops</th>
<th>Livestock</th>
<th>Eggs</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1911</td>
<td>36</td>
<td>28</td>
<td>10</td>
<td>14</td>
<td>9</td>
<td>n/a</td>
<td>3</td>
</tr>
<tr>
<td>1927</td>
<td>13</td>
<td>24</td>
<td>18</td>
<td>9</td>
<td>11</td>
<td>14</td>
<td>9</td>
</tr>
</tbody>
</table>

Data source: Taylor (1958)

As dairy production assumed a greater economic role in Delta’s agriculture, land originally devoted to hay production was converted to pasture. This is illustrated by Table 7, which demonstrates the change in proportion of the cultivation of oats, hay and potatoes between 1911 and 1941. During that interval, the area of land under cultivation decreased by approximately 45%; this land had been converted to pasture to support the dairy stock. A decrease in the cultivation of hay was accompanied by an increase in the area devoted to oats which increased by 23.8% between 1911 and 1941. In a farming area characterised by fixed boundaries and high land values, the shift towards the cultivation of oats as opposed to hay represented a rational economic decision. As noted above, Delta, by the turn of the century, had begun a shift towards dairy farming. Between 1931 – the first year for which data is available at the census subdivision level – and 1941, the number of dairy cattle in the area increased by 122% from 2,712 in 1931 to 6,022 in 1941. Both hay and oats are fodder crops, but oats, being of higher value, both economically and nutritionally, was the more desired. For example, in 1913 the market value realised for every hectare of hay was $91, compared to $1304 for oats (British Columbia Department of Agriculture 1913:35).
Table 7: Major Field Crops in Delta, 1911 and 1941

<table>
<thead>
<tr>
<th></th>
<th>1911</th>
<th></th>
<th>1941</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area under</td>
<td>As % of</td>
<td>Area under</td>
<td>As % of</td>
</tr>
<tr>
<td></td>
<td>cultivation</td>
<td>total</td>
<td>cultivation</td>
<td>total</td>
</tr>
<tr>
<td></td>
<td>(hectares)</td>
<td>field crops</td>
<td>(hectares)</td>
<td>field crops</td>
</tr>
<tr>
<td>All field</td>
<td>11,657</td>
<td>6306</td>
<td>3,292</td>
<td>29</td>
</tr>
<tr>
<td>crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>3,292</td>
<td>29</td>
<td>3,326</td>
<td>52.8</td>
</tr>
<tr>
<td>Hay</td>
<td>6,760</td>
<td>59.8</td>
<td>1,860</td>
<td>29.5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>598</td>
<td>5.3</td>
<td>553</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Data source: Taylor (1958)

Between 1911 and 1941, the number of farms in Delta more than halved from 1,188 to 448. During the same interval the average size of farms increased from 16.6ha to 22.5ha. In British Columbia as a whole, the number of farms increased from 18,467 in 1911 to 26,394 in 1941, while the average size of farms increased from 10.4ha to 13.7ha. This divergence in trends can be accounted for by the fact that although the Lower Fraser Valley, southern Vancouver Island, and the Okanagan had been settled by the early 20th century, the Peace River district was in the embryonic stages of agrarian development. Furthermore, the farms in the Peace River, devoted to the cultivation of grains and wheat, were larger that the provincial average. In 1931, the average size of farms in the Peace River district was approximately 105 hectares, twice the average size of farms in the whole of the province (Fay 1923).

As Figure 1 illustrates, farms were fairly evenly distributed across the various farm-size classifications. Proportionally there were more small farms – less than 10 acres – in both 1911 and 1941. In 1911, small farms constituted 30.5% of the total and in 1941, although there were fewer small farms, 46.4%. In the 30-year period under scrutiny there was a gradual disappearance of medium-sized farms. There was, as well, a proportional increase in large farms – generally over 200 acres – from 3.6% of the total in 1911 to 6.5% in 1941. Changes in farm size were accompanied by changes in tenure. In 1911, 78% of farms were being operated by their owners. By 1941, the number of owner-operators had dropped to 62%. Despite these structural changes, there was relatively little alienation of farmland in Delta. For example, the amount of improved farmland in Delta decreased by only 15% between 1911 and 1941 from 17,397 ha to 14,737 ha. Much of the land made available for the construction of infrastructure such as roads, housing and buildings was through the transformation of unimproved land. In general, although the figures are

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75 1911 was the first year in which Census of Agriculture data was disaggregated to include Delta as a distinct geographical entity.
not directly comparable, the quantity of unimproved land – forest, marsh, natural pasture, etc. – dropped between 1911 and 1941: land covered in forest, for example, decreased by 97%.

Figure 1: Farm Size, as % of Total, Delta, 1911 and 1941

Data source: Statistics Canada. Census of Agriculture (1911; 1941)

Between 1911 and 1941, agriculture, with the exception of the emergence and consolidation of dairy production and the intensification of agriculture through poultry production, changed little. While the subsistence farming characteristic of the early settle period had yielded to commodity production, the political economy of production had not changed in any significant sense. Farms were still family-owned – the larger farms employing wage labour – and the structure of supply management, dictated by the state, was a cooperative enterprise under the control of producers. The concentration of farmland ownership – the increase in the number of large farms – reflected both demographic change as well the influence of British Columbia’s increased integration into the world economy. With respect to demography, the increased urbanisation and industrialisation of British Columbia acted as a magnet to farm family members who were unattracted to the rigours of farming. Employment in industry and services in the province provided such an opportunity, particularly for women (Belshaw and Mitchell 1996).

The Great Depression unleashed by the stock market crash of 1929 also arrested agricultural development. Markets – both domestic and export – shrunk, credit was inaccessible, land values plummeted, and unemployment soared. Due to the structure of its economy, British Columbia
was particularly affected. In the 1920s, the per-capita income of British Columbia was approximately 15% greater than the next most prosperous province, Ontario; from 1929 to 1933, British Columbia’s per-capita income fell by half (Belshaw and Mitchell 1996). Recovery up to the mid 1930s was slow. British Columbia’s dependence on export market made it particularly vulnerable to economic shocks rippling through the world economy. Demand for the province’s resources melted away and the United States, in its attempts to shore up its own economy during the Depression, imposed tariffs on such resources. While farmers were in the enviable position of being able to provide their own subsistence in such a context, the expansion of their activities was severely restricted. This was particularly due to the collapse of commodity prices and the inability to secure capital. The value of farm capital plunged; in British Columbia, between 1930 and 1941, the total value of farm land (expressed in current dollars), buildings, implements, machinery, livestock and poultry, dropped from $190,198,000 to $142,372,000, a 25% decrease. Levels of farm capitalisation extant in 1930 were not achieved again until 1943. British Columbia seems to have been hit particularly hard, given that its agricultural sector was not particularly export oriented. Farm capital in the Prairies, which had an export agriculture, decreased by approximate 30% during the same period. In British Columbia, the dependence of the whole economy on exports made it just as vulnerable to economic crises. As a consequence of these social and economic factors, agriculture in Delta and elsewhere in British Columbia stagnated. It took the stimulus of the Second World War and the emergent second food regime to reanimate Delta’s agrarian economy.

**Conclusion**

The primary focus of this chapter has been the process of agrarian change in Delta. This change cannot be divorced from broader social and economic changes within the province as a whole. In particular I have highlighted the role of the state in the transformation of the agricultural sector. Articulating a discourse of province-building, and inspired by a Jeffersonian agrarianism, the state sought to establish the conditions for the development of agriculture. Agrarian settlement became a specific object of state regulation. This was accomplished through regulation aimed at controlling nature – through the construction of dykes along the Fraser River – and through the establishment of a regime of private property rights. While the latter had the effect of the dispossession of First Nations peoples, it established a class of landed farmers. Given the goals of territory-building, however, these farmers had to be transformed into commodity producers to ameliorate the provincial trade deficit in food and to feed the growing urban population. The generalisation of commodity production was enabled by regulation for the creation of producer
associations and orderly marketing. While these forms of regulation served the interest of farmers confronted by consolidated capital in the processing sector, it also unleashed a process of technological change.

The clearest instance of this was the establishment of the Delta creamery. The creamery represented the appropriation of the gendered labour of butter production which had historically taken place on the farm. Butter and milk processing in general also represented the development of Fordist production techniques, albeit on a limited scale. There were discrete stages in the production of a standardised commodity. This is not to suggest, however, that milk production itself represented Fordist production. Dairy livestock raising was an extensive activity and did not resemble the intensive livestock production that consolidated into its current form during the post-Second-World-War food regime (Goodman et. al. 1987). As the final section of this chapter revealed, the specialisation of dairy farming in Delta led to land use change, particularly the conversion of arable land into pasture. The tendency towards specialisation is one of the hallmarks of the industrialisation of agriculture (Atkins and Bowler 2001). Technological change also occurred in the field through mechanisation. This represented the appropriation of the labour processes concomitant with ploughing, harvesting and threshing, which drew local farmers into the orbit of industrial capital.

The first food regime, as discussed in the previous chapter, identified the movement of agricultural staples from settler states to Europe as the defining characteristic of the international food economy up to the First World War. British Columbia, by any measure, was well outside the orbit of the first food regime. For much of its early history, agricultural production in British Columbia was oriented towards the amelioration, or elimination, of the provincial deficit in agricultural trade. Furthermore, unlike the Prairie provinces, British Columbia did not produce any staples. Although British Columbia’s agricultural sector played no part in the general tendencies identified with the first food regime, it was not insulated from global shocks. British Columbia’s economy as a whole, through its export-oriented resource sector, was fully integrated into the global economy. The fall in commodity prices attendant with the Great Depression affected the province’s economy as a whole and, given its structural dependence on internal markets, the further development of agriculture in the region was retarded. However, as Chapter 5 reveals, agriculture in Delta would be fully integrated into the prevailing food regimes.
CHAPTER 4: THE GREENHOUSE TOMATO INDUSTRY IN EUROPE AND NORTH AMERICA

Introduction

There has been, under the third food regime, a significant change in the structure and form of greenhouse tomato production worldwide. In particular, there has been a spatial concentration of technologically intensive greenhouse tomato production in such countries as the United States, Canada, Spain and Mexico. There is a multiplicity of factors responsible for this change, factors operative at all spatial scales from the global to the local. At the global scale, trade liberalisation – particularly the formation of trading blocs – the differentiation of consumer markets, and increased concentration within the retail sector have played a critical role in the restructuring of global greenhouse tomato production. At the national and regional scales, causal factors are particular and more varied in their determination of the sites of greenhouse tomato production, thus precluding generalisations.

The chapter begins with a description of greenhouse production ranging from the complex to the simple. This is followed by an account of the greenhouse tomato industry in the Netherlands. The significance of the Netherlands lies firstly in it having developed modern greenhouse production – techniques of which having been diffused throughout much of the globe –, and secondly in its role as the global centre of greenhouse tomato research and seed breeding.76 This is followed by an account of the development of the greenhouse tomato industry in Spain which represents, within Europe, the transformation of the sector. The rise of the Spanish greenhouse tomato industry is then linked to a discussion of transformations in both consumer preferences and the retail grocery sector under the third food regime. The focus then shifts to North America, sketching developments in Canada – the case of Delta in taken up in greater detail in following chapters – the United States and Mexico.

One of the main threads running through this chapter is the significance of geography and nature to the greenhouse tomato industry. In particular, the biophysical production process at the core of greenhouse production exerts its influence on the spatial locations of the industry. That is, nature remains important, even in the case of the technologically sophisticated greenhouses under

76 Examples of the links between the Dutch industry and the greenhouse sector in Delta are offered in Chapters 5 and 6.
consideration. This is not to argue for an environmental determinism. Rather that the intensification of biophysical production represented by greenhouses is a specific accumulation strategy, one that is distinct from soil-based cultivation. It is an accumulation strategy founded on making nature – greenhouse tomato plants – work harder in a relatively novel organisation of agricultural production.

The Changing Structure of the Global Greenhouse Industry

Greenhouse tomato production occurs on all continents and is characterised by a variety of technologies ranging from simple shade houses to controlled environment systems.77 Shade houses, used in tropical climates, use a rudimentary structure to protect the crop from the sun and wind and are, in essence, a simple extensions of field cultivation. Controlled environment systems, on the other hand, represent an unprecedented degree of control over the growing environment. Housed in permanent buildings sheathed in either glass or plastic, controlled environment systems use a soilless growing medium and every aspect of the conditions required for crop growth – light, heat, humidity, atmospheric composition, biocontrols, nutrition, hydration – is manipulated by computer controls. Protected cultivation includes numerous hybrid systems which may incorporate one or more of the components of controlled environment systems. The most common hybrid system, however, is characterised by a permanent structure, commonly sheathed in plastic, soil as a growing medium, and automated irrigation.

Historically, protected cultivation was used to extend the growing system, particularly in mid-latitude climates characteristic of much of Europe and North America. In these instances, permanent structures warded off crippling frosts and the use of raised beds elevated soil temperature, thus allowing for earlier planting. Although such systems had a negligible effect on yield per area, in certain climatic conditions an extra crop was possible (Jensen and Malter 1995). More sophisticated systems however, in addition to extending the growing season, also allow an increase in yield through control over the growing environment. The most sophisticated production systems – controlled environment systems – account for most of the production in such countries as Holland, Canada, and the United States. With the exception of the Netherlands, which has had an established greenhouse industry for decades, the aforementioned countries are relatively recent entrants rapidly expanding their production capacity by adopting the technology-

77 These types of agriculture are also broadly referred to as protected cultivation.
intensive model pioneered by the Dutch. Controlled environment systems are also being increasingly deployed in countries such as Mexico and Australia.

Netherlands

The Netherlands has had a commercial greenhouse sector since the early decades of the 20th century. This sector emerged in the province of Zuidholland (South Holland) located in the west of the country on the North Sea coast. Greenhouse production is still concentrated in this region. Here, the mild coastal climate and the characteristics of the soil, a mixture of peat and sand, made greenhouse cultivation feasible. Although sheathed in glass, these greenhouses were rudimentary structures exploited for their ability to extend the growing season. While climate played a role in shaping this regional concentration of greenhouses, the turn towards intensive agriculture – represented by greenhouse cultivation as well as by livestock raising, dairy production, poultry production, and swine production – was compelled by demographic pressures on land (Crone 1942). Such pressures had resulted in the fracturing of landholding into smaller units ‘…which made it essential to raise produce with a relatively high value’ (Crone 1942:240). The industry was fostered by the existence of large, relatively close markets both within the country and without. Crone (1942:240) notes that greenhouse commodities were being shipped to urban centres throughout Western Europe. However, the effects of the Great Depression of the 1930s, particularly the loss of export markets, resulted in the emergence of a regulatory regime designed to protect agricultural industries. Export sectors, including greenhouse production, were nursed through the crisis by ‘…subsidies, standardisation and grading of produce, and trading agreements’ (Crone 1942:243). The Dutch state also dictated the flow of imports, subsidised exports, determined the crops to be cultivated and maintained prices. While such measures were compelled by the importance of Dutch agricultural exports to the nation’s economy, they also allowed the greenhouse industry to embed itself firmly within the agrarian landscape.

The end of the Second World War ushered in a period of economic and social turbulence that fettered the further development of the Dutch greenhouse industry (Zanden:1998). But by the 1950s, the industry was in the process of being transformed, reflecting the restructuring of agriculture in general. Changes in the agricultural sector were themselves compelled by broader social and economic changes. In particular, and partly as a consequence of post-war reconstruction, increased industrialisation and urbanisation had resulted in a wage disparity between rural and urban work. The consequent depopulation of the countryside as agricultural labour migrated to urban centres prompted farmers aggressively to adopt labour-saving
technologies – tractors, milking machines, field machinery – as well as the restructuring of agricultural production. These technological adoptions represented the movement towards a productivist agriculture which was one of the features of the second food regime. The restructuring of agricultural production took a number of forms, including an increase in farm size, specialisation and intensification. In particular, there was a tendency towards a spatial intensification of agricultural production represented by the development of the livestock, poultry and greenhouse horticulture sectors. Prompted in part by land constraints – the Netherlands had, and still has, one of the highest population densities in the world – intensification allowed an increase in productivity with an attendant decrease in labour requirements. For example, between 1950 and 2000, inputs of capital and consumables in Dutch agriculture increased by a factor of six. This intensification was accompanied by a consolidation of farms into larger units: between 1950 and 2002, the number of farms in Holland declined from 410,000 to 90,000 (Kuhlman et. al. 2003:2). During the same period, productivity increased by a factor of 14.4, eclipsing the factor increase in capital (2.4) and the factor increase in inputs such as fertiliser and energy (5.0). There was also a significant decline in labour used on farms: between 1950 and 2000, the number of workers declined from 550,000 to 198,000 (Jongeneel and Ge 2005).

In essence, the structural form of Dutch agriculture – characterised by a tendency towards the consolidation of farms into fewer but larger units and intensification – was similar to that of the agricultural sectors of other advanced capitalist economies during the second food regime (Bowler and Atkinson 2001). While the processes of consolidation and intensification took root before the Second World War (Friedmann and McMichael 1989), it wasn’t until well into the second food regime that they reached their apogee. The structure and form of agricultural production in the Netherlands has changed little since onset of the third food regime although, as Kuhlman et. al. (2003) report, the trends towards consolidation and intensification have failed to maintain the growth rates characteristic of the early post-war period.

Within this context of agrarian development there was a significant and parallel development within the greenhouse horticulture sector. In essence, greenhouse horticulture underwent the same sort of transformation as other sectors of Dutch agriculture. Reconstruction, however, got off to a slow start for two main reasons. Firstly, industries ravaged by the war were incapable of supplying the materials necessary for building and equipping greenhouses, and secondly, as a

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78 Most of the following description of the developments within the Dutch greenhouse sector is drawn from Buurma (2001).
consequence of the general poverty of most Europeans following the war, there was little consumer demand for greenhouse vegetables. By the late 1950s, general welfare levels throughout Northern Europe had risen and the industrial infrastructure had been rebuilt. Both yield and labour productivity dominated research and practice, an improvement in one often leading to an improvement in the other. For example, one of the early innovations was the switch from hose watering to sprinkler irrigation. An irrigation system in greenhouses obviated the need for laborious hand-watering and improved yield through precise and even watering. Also significant at this time was the switch to soils produced off the farm, a labour saving strategy which initiated a gradual process of the appropriation of farm labour by non-farm capital (Goodman, Sorj and Wilkinson 1987).

The growth of Western European economies in the mid-1960s, with an attendant rise in wages, spurred further appropriation. For example, the period between 1965 and 1980 was characterised by increased mechanisation, particularly of climate control systems, through the introduction of electric motors, and of harvesting and grading. Further appropriation was achieved through the off-farm purchase of plants. As Buurma notes: ‘Traditional plant raising at the farm level could not compete with modern plant raising by specialised and mechanised nurseries. For that reason, most growers discontinued plant raising and started contracting out the activity to specialised nurseries’ (2001:28). Farm labour was also appropriated through the replacement of manual pollination of greenhouse plants by bumble bees. Pollination by bumble bees not only resulted in a significant decrease in labour, it was also more efficient than manual pollination, which led to higher yield and better fruit quality.

Following the reconstruction and mechanisation periods, there was a systematic attempt to increase the growing season, that is, to increase the number of turnovers of capital. The lengthening of the greenhouse growing season in the Netherlands, in some instances a shift towards year-round production, was compelled by competition from newly emergent greenhouse sectors, particularly in Spain. Greenhouse production in Spain, the development of which was one of the characteristics of the third food regime, was favoured by a climate which allowed year-round production. The extension of the growing season in the Netherlands, primarily through the introduction of artificial heating and lighting, was aided by the deployment of computers. The precise control of greenhouse climate variables – light, temperature, humidity, carbon dioxide

79 This process of appropriation is discussed in greater detail in a following chapter.
80 Discussed in greater detail below.
levels – was possible only through computerised controls that could maintain the conditions necessary for ideal plant growth outside the seasonal growing period.

The consolidation of the Dutch greenhouse sector occurred during the second food regime, one of the features of which was strong state support for national agriculture. The two principal aims of Dutch state policy during the second food regime were an increase in productivity – achieved through the adoption of intensive techniques of production – and the security of farmers’ incomes. A secondary aim was food security (Kalfagianni 2004). In the Dutch context, state support for agriculture was conducted within a corporatist framework. As Breeman (2003) notes: ‘In the period between 1945 and 1980 Dutch agricultural policies were produced in close cooperation between farmers, state-officials, agricultural spokesmen in parliament and representatives of farmer organisations. All policies were aimed at the continuous increase of the levels of agricultural production’ (2003:5). This productivist logic was harnessed to the requirements of an agricultural sector that was primarily export oriented (Oosten 1998).

The national regulation of agriculture during the second food regime occurred in the context of international regulation represented by the Common Agricultural Policy (CAP), the guiding principles of which were established in 1962. The productivism of national agricultural regulation was reflected in the CAP, which attempted to promote national food security as well as a rise in farmers’ incomes, the latter through the implementation of price support schemes (Le Heron 1993:115). The supranational regulation represented by the CAP was the erosion of trade barriers for agricultural commodities between member nations, coupled with the erection of barriers to such commodities with origins outside the European Community. Given the export orientation of the Dutch agricultural sector, the implementation of the CAP only served to stimulate the development of that sector.

The restructuring of Dutch agriculture during this period was facilitated by state policies fostering agricultural research, improving farmer’s/grower’s access to capital, and constructing an infrastructure conducive to an internationally competitive agricultural sector. For example, in 1963 a programme was instituted which promoted the enlargement and specialisation of farms. Specialisation, the production of a relatively few agricultural commodities, requires both capital

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81 The CAP emerged out of the Treaty of Rome (1957) which created the European Economic Community or ‘common market’. See Le Heron (1993:114-141) for an account of the CAP.
82 Price support, however, applied only to a few commodities, namely milk, beef, cereals, and sugar (Kalfagianni 2004).
intensity and a large land base – for arable crops and livestock – in order to be efficient and consequently profitable. The Dutch state accelerated this process by subsidising both the retirement of older farmers, whose land was consolidated into larger units, and the purchase of these larger farms by new farmers (Breeman 2003:12). An example of early state support for greenhouse production was the provision of suitable irrigation water, since salt water from the North Sea and the Rhine had contaminated the surface water in South Holland, the location of most greenhouses (Buurma 2001:23).

State intervention in the agricultural sector in the Netherlands led to the creation of an extensive research network, one which was to be significant to the development of national greenhouse industries elsewhere in Europe and in North America. In the 1950s and 1960s numerous new agricultural research institutes and experimental stations were rapidly established throughout the country (Roseboom and Rutten 1998). However, this somewhat haphazard process resulted in a patchwork of research agencies with overlapping mandates (Roseboom and Rutten 1998:1118). As a consequence, in the 1960s, there was an attempt to rationalise the research system through consolidation. For example, the creation of the Directorate of Agricultural Research in 1962 resulted in the centralisation of research which, in the context of the corporatism characterising the Dutch agricultural policy regime, led to a relatively efficient knowledge production system. The close relationship between research, agricultural extension services, and education was epitomised by the fact that each of these functions had the same director and that there was close collaboration between the agents of the three sets of institutions and farmers. With respect to greenhouse development, Buurma notes: '(K)nowledge development flourished quite well in an open atmosphere of researchers, extensionists and grower’s study groups. The three stakeholder groups cooperated as real colleagues, resulting in a high level of team spirit. The team spirit was strongly supported by organisational linkages (same director, common meetings) between the three groups’ (Buurma 2001:25). The efficacy of the Dutch greenhouse research complex is suggested by the increase in yields of tomatoes. In 1954, yields of tomatoes were 8 kilograms per square meter (kg/m²), through 10 kg/m² in 1963, 15 kg/m² in 1975, 24 kg/m² in 1980, 38 kg/m² in 1988 to 47 kg/m² in 1996 (Buurma 2001:19). The current yield of greenhouse tomatoes is approximate 60 kg/m².

As a consequence of the productivist imperative governing Dutch greenhouse production and the corporatist agricultural research complex, the Netherlands emerged as the pre-eminent site of greenhouse tomato research and development. And despite the structural changes ushered in by
the third food regime – primarily the retrenchment of the state and the emergence of greenhouse sectors elsewhere – the Netherlands continues to be the source of innovation in greenhouse technologies. The process of rationalisation of agricultural research begun in the 1960s was accelerated in the 1980s and the 1990s. The most significant development was the centralisation of agricultural research within a single institution, the Knowledge Centre Wageningen (KCW) at the Wageningen Agricultural University. As Roseboom and Rutten note, the KCW is ‘…one of the worlds largest agricultural science conglomerates’ (1998:1119) and is responsible for all aspects of agricultural research in the country. Research into every aspect of horticulture, from seed breeding to marketing, is conducted at Wageningen. For example, the Plant Research International Institute conducts research into plant genetics, reproduction, plant physiology, agricultural systems, soil fertility, crop protection, crop ecology, plant health and production quality while the Institute for Agricultural and Environmental Engineering focuses its efforts on finding the optimal greenhouse climate. The practical issues of horticulture are the mandate of the Practical Plant Research Institute (PPRI) which tests and develops the findings of the research institutes under conditions that mimic commercial production. The PPRI has at its disposal a number of greenhouses scattered throughout the country which, in addition to conducting practical trials, allows it to assess a number of ecological zones for their commercial greenhouse potential.

While parts of the Dutch research complex were privatised during the 1990s, funding for institutions such as experimental farms were cut. Funding for research is currently awarded through contracts with specific targets and outputs, rather than open grants, and the state awards such contracts to a relatively small number of institutions such as the KCW (Roseboom and Rutten 1998). As part of the restructuring of the research system, growers play a critical role in funding and directing research. Furthermore, the restructuring of the agricultural research complex in the Netherlands occurred in the context of a shift in state agricultural policy. The original emphasis on productivity, food security and farmers’ welfare yielded to an emphasis on international competitiveness. As Oosten notes, the state ‘…started a thorough reorganisation of agricultural research with the ultimate goal to develop strong specialisations in order to claim international top-level position’ (1998:10). Greenhouse horticulture was one such specialisation and, despite competition from Spain, the cultivated area under glass has changed little since the end of the second food regime (Berkhout and Brukhem 2006). Thus, the Netherlands remains the pre-eminent site of greenhouse research and, as demonstrated in the next chapter, the fruits of that research provided the foundation of the greenhouse industry in Delta and elsewhere.
Table 8: Evolution Of The Greenhouse Industry In The Netherlands

<table>
<thead>
<tr>
<th>Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-1965</td>
<td>Reconstruction after World War II</td>
</tr>
<tr>
<td>1965-1980</td>
<td>Mechanisation; Cutting labour costs</td>
</tr>
<tr>
<td>1980-1993</td>
<td>Application of computer technology</td>
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<tr>
<td>1993-present</td>
<td>Change to demand-driven economy</td>
</tr>
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Spain

The province of Almeria in Andalusian Spain currently possesses the largest concentration of greenhouses in the world. Figure 2 illustrates the scale of this spatial concentration. Approximately 48,000 hectares in the region are covered by either plastic or glass and are devoted to the cultivation of tomatoes, cucumbers, peppers, and melons (Heuvelink 2005). Although protected cultivation had been established in the region in the early 1960s, rapid expansion of the industry only began in the mid-1970s, in the early phase of the third food regime, when Spanish exports of greenhouse tomatoes began threatening the Dutch monopoly.

Figure 2: Concentration Of Greenhouses In Almeria, Spain

Figure has been removed due to copyright restrictions. The information removed is an aerial photo of Almeria, Spain illustrating the spatial concentration of greenhouses in 2004.

Source: United Nations Environmental Programme
http://na.unep.net/digital_atlas2/imagery/site_172_image2-lg.jpg

83 The greenhouses depicted, in the Campo de Dalias, cover approximately 300 square kilometres. There are two further concentrations of greenhouses: one just east of Almeria and another, again to the east, in the Campo de Nijar. El Ejido, the new town built when the greenhouse industry was being established, lies in the north west of the Campo de Dalias and has a population of approximately 70,000, most of whom are migrant or immigrant labour.
Once considered the most economically depressed province in Spain (Tout 1990), Almeria became, in the late 1950s, the focus of an agrarian renewal strategy initiated by the Spanish state.\textsuperscript{84} The National Institute of Agricultural Reform and Development initiated hydrogeological surveys that established the presence of significant groundwater reserves and conducted experiments in a variety of arid-area cultivation techniques, including protected agriculture (Tout 1990). The first greenhouse – \textit{invernadero} – was erected in 1962 and consisted of a metal structure supporting a plastic sheathing. Just as crucial was the spatial organisation – that is, concentration – of production through the creation of new towns. Peasant families from Almerian mountain villages and the more undeveloped coastal villages of Granada were given 2.5 hectares of land, which was to be paid for over 20 years. Despite the developments in dry-farming techniques, the cultivation of 2.5 hectares yielded little more than subsistence but, as Tout notes ‘…the introduction of the greenhouses proved to be the farmer’s salvation’ (308:1990). The proven success of greenhouse cultivation led to a surge in population of the area: between 1950 and 1981, the population increased from 44,197 to 92,815. In addition to access to land, peasants who settled in the region were offered preferential interest rates on credit, typically 2 to 5 percent below normal commercial rates, and the state developed the infrastructure necessary for intensive cultivation by building, for example, pumps to supply water and a desalination plant. Unlike the Netherlands, where the greenhouse industry developed in an organic fashion, the industry in Almeria was a direct result of the intervention of the state resulting as it did in a characteristic social organisation of production. As Tout notes, the industry was developed by ‘…poor, often illiterate peasants, not by large corporations…’ (1990:310).

Nature conferred an advantage to Almeria’s greenhouse industry. An average temperature of 20°C and 3000 hours of annual sunshine – both of which are double that of the Netherlands – accord it a certain competitive advantage. One particular aspect of this advantage is the ability of Almeria’s greenhouses to supply commodities to Northern European markets ‘out of season’. The seasonality of Northern producers is dictated by the (high) cost of energy of heating greenhouses in the winter: such costs erode the profit margin to the point where winter production becomes economically unviable. While northern European production occurs between February and November, Almeria’s greenhouses produce tomatoes throughout the winter months. As well, the growing season in Almeria during the winter is longer than the growing season in the Netherlands.

\textsuperscript{84} Given the technical obstacles posed by farming in an arid climate, peasant livelihood at the time was derived from the collection of \textit{esparto} grass which was used in the manufacture of paper.
during the summer. Counter-seasonality, coupled with the low cost of production relative to such
countries as the Netherlands, has allowed Spanish greenhouses to appropriate a significant
proportion of the European market.

The structural form of Spanish greenhouse production, its social organisation, stands in sharp
distinction to that of the Netherlands and confers it a certain advantage. In the Netherlands
vegetable greenhouses, which are family-owned, have an average size of approximately 2.5
hectares (Silvis and de Bont 2005). The top five greenhouse firms, which account for about 4% of
the total acreage of greenhouse vegetables, cover an average of 34 hectares. The top ten (0.5% of
all greenhouse vegetable firms) account for almost 10% of the total acreage, and cover an average
of 28 hectares of glass. The largest greenhouse vegetable firm encompasses 51 hectares
(Berkhout and Bruchem 2006:199-221). In Spain, the average size of a vegetable greenhouse is
approximately 1.2 hectares, approximately half that of the Dutch average, and there are
approximately 25,000 farmers in Almeria. The range of greenhouse sizes, however, is much
narrower; greenhouses range in size from 1 to 1.4 hectares (Cantliffe and Vansickle 2003:4).
Thus in Spain, in contrast to the Netherlands, there is a fragmentation of the production landscape
into a multiplicity of small producers as opposed to the consolidation of production within fewer
but larger greenhouses.

A further contrast is the technological intensity of the relative greenhouses. Dutch greenhouses,
as previously noted, are characterised by their technological sophistication through the use of
hydroponics and climate control systems. Spanish greenhouses, on the other hand, are relatively
crude. As Castilla and Hernandez note: ‘In most cases, the use of simple structures, a generally
low level of technology, and a lack of equipment for climate control create a very strong
dependence of the greenhouse microclimate on external condition’ (2005:15). Greenhouses are
almost all unheated and covered with polyethylene on a small roof slope. Cultivation mostly
occurs in an artificial sandy soil with a drip irrigation system. As a consequence of the
technological disparity, yields of greenhouse tomatoes in Spain are approximately a third of those
realised in the Netherlands (Cantliffe and Vansickle 2003:4). While the advantages conferred by
climate enhance the competitiveness of Spanish greenhouses, low productivity and the
fragmentation of production would suggest a disadvantage. Yet Spanish greenhouse tomatoes
have eroded the market share once held by Dutch producers. While low energy costs are often
touted as the reason for Spanish greenhouse tomatoes’ cost competitiveness, there are other forces
at play.
In his study of the greenhouse industry in Almeria, Tout observed that growers subject themselves to ‘…a routine of up to 16 hours a day, seven days a week…’ (1990:311). Furthermore, ‘As the greenhouses are largely family affairs there is pressure on the children to leave school early to work in them’ (Tout 1990:311). Cantliffe and Vansickle note; ‘The family companies generally retain low labour costs and have a strong motivation for work’ (2003:4). As both Chayanov (1986) and Kautsky (1988) have noted, there is a marked propensity among small-holders for self-exploitation. Chayanov demonstrated that family farmers could survive under market conditions through the exploitation of their own labour and of their family. Kautsky argued, in a different formulation, that self-exploitation intensified once small-holders start producing for the market as opposed to simply producing for their own consumption. The level of technological development compounds the tendency towards self-exploitation:

Competing through lengthening working time always goes hand in hand with technical backwardness. The latter generates the former – and vice versa. An enterprise which cannot fight off the competition through technical innovation is forced to resort to the imposition of even greater demands on its workers (Kautsky 1988:111).

Kautsky further argues that the ability to exploit labour, whether self, family or wage, retards technological change. In Almeria, wage labour, in greenhouses large enough to require it, is provided primarily by immigrants or migrants from North Africa, primarily Morocco.85 Approximately 90% of the greenhouse workforce are immigrant workers, half of whom are ‘illegal’ (Higginbottom 2000).86 Workers rarely have permanent contracts – even workers who have been employed by a single firm for years rarely labour under a condition of permanent employment – and many are employed on a seasonal basis (Hoggart and Mendoza 1999). Wages for migrant workers in the sector are approximately half the average rural wage (Nash 2000), reflecting the cost of the reproduction of that labour. In general, the greenhouse workers in Almeria live in sub-standard housing without electricity and running water (Higginbottom 2000). The proximity of Morocco, the willingness of people to make the hazardous crossing through the

85 There are, as well, migrant workers from West Africa, Latin America and from Eastern Europe.
86 Arango and Martin (2005:263) offer the following explanation for the need to resort to immigrant labour: ‘The most common explanation for the immigration and persisting high unemployment paradox is that rigid labor laws allow many Spanish workers to collect unemployment insurance benefits while working for cash wages. Labor force participation rates among Spanish women, youths, and older males are low, and many Spanish workers have reportedly become accustomed to accepting short-term work contracts, collecting Unemployment Insurance (UI) benefits when the job ends, and then accepting another short-term work contract that is followed by UI benefits.'
Strait of Gibraltar, and the compulsion to seek work in Spain, all contribute to the existence of an army of labour to be exploited by the greenhouse industry. As a consequence, Almeria’s greenhouse industry is characterised by the ‘…maintenance of competitiveness through a low-wage, anti-investment strategy’ (Hoggart and Mendoza 1999:557).

The greenhouse growers of Almeria, despite their nominal independence as small holders, are nevertheless drawn into the orbit of national and international agro-industrial capital. In the case of Spain this is accomplished primarily through the need of small-holders to consume industrialised inputs, particularly seeds and agro-chemicals. For example, the seeds used by Spanish greenhouses are developed by Dutch breeders, most of whom have research stations in the Almeria region (Cantliffe and Vansickle 2003). The necessity of using proprietary hybrid seeds is dictated by the expectations of the Northern European consumers of Spanish greenhouse tomatoes. These expectations are primarily related to attributes of quality such as taste and appearance. Given that the project of developing and marketing seeds is capital intensive, only large firms with the necessary resources are able to undertake breeding. While there are a number of mechanisms through which surplus is extracted from small-holders (Deere and de Janvry 1979), in this instance the oligopolistic structure of the breeding industry allows the capture of high profit margins.

While the establishment and early development of the Spanish greenhouse tomato industry was the result of the influence of particular local and regional forces, its ascendancy must be situated in the structural changes ushered in by the third food regime in particular and the post-Fordist regime of accumulation in general. Although the relatively low cost of production made Spanish tomatoes competitive in Europe, the real fillip arrived with the devaluation of the Spanish peseta. Spain joined the European Exchange Rate Mechanism (ERM) of fixed exchange rates in 1989. Until the fall of 1992, the Spanish peseta was kept within a 6% fluctuation around its central rate and its volatility significantly reduced relative to previous years. Between September 1992 and May 1993 the peseta underwent a devaluation within the ERM by a total of 20% relative to other major European currencies. In 1995 the peseta underwent a new realignment within the ERM, stabilizing at a new depreciated level. Prior to the devaluation of the peseta, Spain’s admission to the European Union in 1986 had given the country freer access to the markets of Europe, which raised consumer awareness of Spanish greenhouse tomatoes. Fortuitously, Spanish greenhouse tomatoes appeared in European markets, Germany in particular, when Dutch greenhouse tomatoes had come into disrepute. The Dutch emphasis on productivity, on yield, had resulted in
tasteless tomatoes which German consumers had derisively named *Wasserbomben* – ‘water bombs’. As a consequence, German consumers switched to Spanish tomatoes (Terhorst 2006). Membership in the European Union meant Spain’s agricultural sector was eligible for support through the Common Agricultural Policy. However, such subsidies have historically only been available to, among others, the food processing sector – processed tomatoes, for example –, the livestock and dairy industry, and cereal production. Support for vegetable production through the CAP exists in the form of subsidies for marketing in both domestic and foreign markets (European Commission. Directorate-General for Agriculture 2003).

As discussed in Chapter 1, one of the characteristics of the third food regime has been the transformation of the relationship between agricultural commodity producer and food retailer. This relationship, the supply chain, has been profoundly transformed in the last few decades. Historically, most agricultural commodities had reached consumers either through short distribution channels – direct sales and farmer’s markets – or traditional distribution channels – the commodities physically appear on wholesale markets. Contemporary supply chains, or integrated distribution channels, are now characterised by the elimination of wholesale markets and the forging of direct links between retailers and individual growers, if they are large enough to supply commodities in the requisite volume. In the instance of a collection of small growers, commodities are consolidated for sale and distribution through grower-owned co-operatives or private enterprises, also referred to as Producer Organisations (PO). The emergence of integrated distribution channels is a result of changes in the political economy of retailing, namely the appearance of large centralised retail chains whose outlets are hypermarkets and supermarkets. These chains have a system of centralised warehouses that distribute commodities to outlets. Requirements as far as commodities are concerned include establishing firm prices, guarantees of certain attributes of quality such as appearance, confirmation of adherence to particular production practices, and above all, a guarantee of volume.

Greenhouses in Spain, due to their spatial concentration and their volume of production are able to meet these criteria. Thus, the political economy of contemporary food retailing in Europe has well served Spanish greenhouse growers, a point emphasised by Castilla and Hernandez: ‘(N)ew marketing structure appeared …and the growers groups started selling their produce directly to

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87 The Dutch response was to abandon their Fordist approach to greenhouse tomato production – that is, the emphasis on yield and on relatively undifferentiated commodities. The attempt to regain market share was characterised by an emphasis on quality – taste and texture in particular – as well as the production of new, differentiated varieties such as cherry and truss tomatoes.
the supermarket chains... These new marketing channels were effectively used by the associated Spanish growers to supply the European markets with greenhouse vegetables’ (2005:18).

Traditionally, greenhouse tomatoes had been released into the marketing chain exclusively through auctions, essentially growers’ co-operatives, attended either by individual growers or representatives of groups of growers. From the early 1990s, these auctions started yielding to integrated distribution channels, between retailer and grower-owned co-operatives, as mechanisms for the export of greenhouse tomatoes. By 2000, all tomato producers in Spain were being represented by POs (Briz, De Felipe and Garcia 2007:8). The realignment of regulation with the contemporary political economy of retailing in Europe has resulted in the explicit support for the formation of POs under the Common Agricultural Policy: ‘The European Union provides financial assistance to recognised producer organisations to set up operational funds, encouraging them to become a major means to market fruit and vegetables’ (European Commission. Directorate-General for Agriculture 2003:5). Fifty percent of the operational budget of POs is subsidised by the European Union. Thus, despite Spain’s greenhouse industry being characterised by the existence of numerous small producers, who individually would have little market power despite their collective production, the formation of POs to mirror the structure of contemporary European retailing under a particular regulatory regime has, among other factors, enabled Spanish greenhouse tomatoes to capture market share.

In summary, the establishment of the Spanish greenhouse industry in Almeria was the result of the Fordist/ Keynesian strategy of regional economic development. Greenhouses were established as a means of alleviating rural poverty. But the industry only flourished under a new regime of accumulation that witnessed the erosion of barriers to trade between European nations. The movement of Spanish tomatoes across national borders was further propelled by the devaluation of Spanish peseta. Greenhouse production in Almeria, as a form of nature-based production, was one of the few forms of agriculture feasible in an arid region. This conferred an advantage to Spanish producers in an increasingly competitive regional capitalist economy.

**North American Greenhouse Tomato Production**

While the production of greenhouse tomatoes has been a feature of the agrarian landscape in North America – Canada, United States, Mexico – since the early 20th century, it was only in the

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88 Under this regime, POs are expected to perform certain functions, including improving production and marketing methods, ensuring food safety, and mitigating environmental harm.
last two decades of that century that the industry underwent a profound transformation. For much of the 20th century, greenhouse tomato production had been scattered throughout the continent, serving local markets. Greenhouses were relatively small and technologically unsophisticated, production volume was low, and they served a niche market. By the mid-1980s, the greenhouse industry was in the process of being transformed. North America’s largest greenhouse had just been built in Delta, Dutch greenhouse horticultural technology was being adopted wholesale, and the volume of production was increasing exponentially. There was a spatial change as well: greenhouses were being increasingly concentrated in particular localities and regions, much as they had, or were in the process of doing, in Holland and Almeria.

**Figure 3: Concentration of Greenhouses, North America**

| Figure has been removed due to copyright restrictions. The information removed is a map of North America illustrating the spatial concentration of greenhouses.  |  |

| Source: Cook and Calvin, United States Department of Agriculture (2005:4) |  |

The purpose of the following section is to sketch some of the developments in North America as a prelude to the discussion, in the following chapter, on the emergence of a greenhouse industry in Delta. Furthermore, I attempt, in general, to outline some of the causal factors influencing the transformation of the greenhouse tomato industry on the continent. I establish some of the main features of North American greenhouse tomato production by identifying, for example trade patterns and markets. The developments sketched below are critical for understanding the greenhouse tomato sector in Delta.

**Ontario**

Greenhouse tomato production in Canada is concentrated in southern Ontario and in Delta. In Ontario, greenhouses are concentrated in the Leamington area in Essex County and in the Niagara
Region: in Essex, 87% of the greenhouses are dedicated to vegetable production, and in Niagara, 84% are dedicated to flowers. Historically, floriculture had dominated greenhouse production in Ontario but the current trend is towards vegetable production. In 1986, vegetables accounted for 39% of greenhouse area, in 2001 this had increased to 43%. The average size of a vegetable greenhouse in Essex County in 2001 was approximately 2.1 hectares – the average for the province as a whole was approximately .65 hectares – and the largest vegetable greenhouse in 2005 covered an area of 20.8 hectares (Planscape 2006:iii). Although Ontario has had greenhouses since the early 20th century, immigrants who arrived from Europe after the Second World War, primarily from Holland as well as from Italy, laid the foundations for the contemporary industry. The majority of the vegetable greenhouses in Ontario are owned and controlled by family groups. While the structure of ownership of greenhouses – and of farms in general – in Ontario is reflective of the North American pattern, the structure of production is anomalous. Compared to the rest of North America, the concentration of greenhouses producing tomatoes in Leamington is characterised by the presence of numerous smaller holdings. In 2005, there were 79 greenhouses producing tomatoes, 59 of which occupied an area of less than 5 hectares (Planscape 2006:26). Delta, in contrast, has 13 greenhouses with an average size of 10 hectares. The annual production of these 13 greenhouses is a little less than half of the production of Ontario’s tomato greenhouses. The structure of greenhouse production in Leamington reflects the relatively long history of greenhouse spatial concentration, sustained during the second food regime by the markets offered by the relatively populous southern Ontario region. These greenhouses responded to increased demand later in the third food regime (see below) by expanding and/or intensifying their production to meet that demand. The 1990s also witnessed the construction of newer, larger greenhouses and part of that intensification of production.

While greenhouse tomatoes are produced in all provinces, production in Ontario and British Columbia accounts for most of the country’s output. In 2005, Ontario and British Columbia produced, respectively, 64% and 27% of the national total (Figure 4) (Statistics Canada, Cansim Database 2006). Alberta and Quebec accounted for much of the rest of national production. As Figure 5 illustrates, there has been an increase in production in Canada, British Columbia and Ontario.

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89 This shift can be attributed to the increase in imported floricultural commodities, primarily from Central America. Growers have responded by shifting either to vegetable production or to the production of flowers unable to withstand the rigours of international air transportation (Planscape 2006:26).

90 All tables and figures incorporate the latest data available.
Figure 4: Greenhouse Tomato Production, by Province, 2005

<table>
<thead>
<tr>
<th>Province</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>64%</td>
</tr>
<tr>
<td>British Columbia</td>
<td>27%</td>
</tr>
<tr>
<td>Alberta</td>
<td>2%</td>
</tr>
<tr>
<td>Quebec</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
</tr>
</tbody>
</table>

Data source: Statistics Canada, CANSIM Database

Figure 5: Greenhouse Tomato Production, Canada, British Columbia and Ontario, 1955-2000, Tonnes

Data source: Statistics Canada. CANSIM Database
Historically, there had been little change in greenhouse production in Canada between 1955 and the early 1990s. But between 1995 and 2004 there was an exponential growth in greenhouse production in both Ontario and British Columbia: an increase of 576% and 564%, respectively. Total growth in greenhouse tomato area in Canada increased from 158 hectares in 1995 to 445 hectares in 2004 (Infohort, Statistics Canada 2005). As demonstrated below, this increase in production was a result of structural changes which occurred under the third food regime.

Canada is now the largest greenhouse tomato producer in North America, accounting for approximately 42% of continental production. (Table 9) While the production efficiency of Canada and the United States is similar – a function of the adoption of large scale, technology intensive production facilities – Mexico’s greenhouse tomatoes are produced in a variety of facilities ranging from simple shade houses which perform the rudimentary task of shielding tomato plants from the sun, to highly automated greenhouses characterised by hydroponics and climate control. Thus, despite Mexico’s vast greenhouse area, relative to both Canada and the United States, yield per hectare is less than half the continental average due to the use in that country of both high and low technologies.

Table 9: North American Greenhouse Tomato Production, 2003

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Canada</th>
<th>Mexico</th>
<th>North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (tonnes)</td>
<td>159,664</td>
<td>220,114</td>
<td>148,300</td>
<td>528,078</td>
</tr>
<tr>
<td>Greenhouse area (hectares)</td>
<td>330</td>
<td>446</td>
<td>950</td>
<td>1,726</td>
</tr>
<tr>
<td>Yield (tonnes/hectare)</td>
<td>484</td>
<td>494</td>
<td>156</td>
<td>1134</td>
</tr>
</tbody>
</table>

Data source: Cook and Calvin, United States Department of Agriculture (2005:4)

United States

Structurally, the United States greenhouse tomato industry is characterised by a concentration of production. Four firms – Eurofresh, Village Farms, SunBlest and Houweling – with a total

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91 The United States has not, historically, collected data on the greenhouse industry. The data provided here are derived from Cook and Calvin (2005), in a report written for the United States Department of Agriculture, whose statistics are based on estimates, interviews with the industry and, interestingly, on data collected by the United States International Trade Commission (ITC). In the process of examining a petition filed by American greenhouse tomato growers claiming that Canadian greenhouses were dumping their commodities in the United States, the ITC conducted interviews and sent out surveys in order to determine the structure of the American industry. Incidentally, the ITC ruled against the petitioners. See U.S. International Trade Commission (ITC) 2002.
production area of approximately 203 hectares in 2003, produced 67% of the country’s tomatoes. The production landscape included 7 medium sized firms – defined as possessing a production area of between 3 and 16 hectares – which produced a further 11% of the total (Cook and Calvin 2005:33). Cook and Calvin (2005) estimated that there were approximately 500 small greenhouse producers in the country operating facilities of less than 3 hectares but with an average size of .07 hectares. This group produced the remaining 22% of the total greenhouse tomato production.

Unlike the Netherlands, Spain or Canada, the United States greenhouse tomato industry is not spatially concentrated. American greenhouses had traditionally been located in the northeast of the country, producing only in the summer months for local markets. In the late 1980s and early 1990s, the greenhouse industry began a structural and spatial transformation which reflected the pursuit of accumulation strategies. The new greenhouses that were being built, first by Village Farms in 1991 and Eurofresh in 1992, were much larger than the ones in existence. The spatial transformation occurred when these greenhouses were built in Colorado (SunBlest), Arizona (Eurofresh), Texas (Village Farms), and California (Houweling). This move to the southwest was motivated by a number of factors, the most important of which was the need to increase production in order to meet the demands of a concentrated retail sector (see below). A further compulsion was the desire to produce in the winter when prices for tomatoes are highest given the absence of field grown tomatoes on the market. The Western locations offer high light levels – one of the most critical factors in the greenhouse production of tomatoes –, low humidity, good water and, in the high altitude locations such as Colorado and Arizona, the warm days and cool nights that optimise tomato production. A further incentive to relocation was the relative absence of local regulation. Unlike the densely populated Northeast, or even southern Ontario, southern British Columbia or the Netherlands, situating a greenhouse in the relatively remote portions of the Southwest avoids the conflicts attendant with urban pressures. For example, Eurofresh, SunBlest and Village Farms greenhouses are located on sites far from major urban centres yet close enough to the amenities of small, usually agricultural, towns. Furthermore, the economic vulnerability of these rural areas results in local and state governments providing incentives to new industries such as greenhouses. As one Delta greenhouse owner commented, in the context of a debate on the pressures on the local industry: ‘Yet if you go to Texas, the mayor

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92 Eurofresh has increased its production area, which stood at 67 hectares in 2003, to 89.4. hectares. In 2003, Village Farms operated 52 hectares, SunBlest 49 hectares, and Houweling 34 hectares.
93 While Arizona allows winter production, summer production is only possible with the installation of a cooling system.
will meet you as you get off the plane and ask you, “Can we pave a road to your greenhouse?” or maybe “Can we pull a new gas line to your place?’ (Artemis Agri-Strategy Group 2001:23).

**Mexico**

Mexico is an emergent greenhouse tomato producer, one that is making incursions into markets traditionally dominated by U.S. and Canadian producers. Unlike Spain however, Mexico is characterised by a heterogeneous production landscape populated by both small and large greenhouses distinguished by technological intensity. Again unlike Spain or Canada, where much of the greenhouse tomato production is spatially concentrated, Mexican greenhouse tomatoes are produced throughout the country. While the more important producing areas are the Baja peninsula, Sinaloa in the north-central Mexico, and Jalisco in central Mexico, greenhouse tomato production occurs in all Mexican states. This spatial diversity and the concomitant differences in climate initially engendered the adoption of technologies specific to local conditions (Cook and Calvin 2005). For example, Sinaloa’s warm and humid coastal climate – one which precludes summer production due to the cost of cooling – resulted in the use of simple shade houses, along with a number of more substantial plastic-covered greenhouses, for production during the winter.94 The low level of technological intensity, characterised above all by the use of soil as a growing medium, results in both reduced quality and yields compared to those tomatoes issuing from technologically complex greenhouses. As a consequence, greenhouse tomatoes from Sinaloa tend to command a lower price in the market thus discouraging exogenous capital investment and technological modernisation.95 The uniqueness of greenhouse tomato production in Sinaloa is signalled by the fact that greenhouse are primarily an expansion of field production. Field tomato growers, who were highly organised and who had an established export-oriented marketing structure, sought an expansion of production counter-seasonal to their field production in order to exploit the growing winter market in the United States and to a certain extent, Canada.96

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94 Sinaloa’s climatic conditions are similar to those of the Baja peninsula where, again, low technology, protected agriculture predominates.

95 Despite the underdevelopment of the greenhouse sector in Sinaloa, the state is the largest exporter of tomatoes to the United States. These are primarily field-grown tomatoes produced by large, capital intensive farms integrated with shipping units and with sales units located in the United States. As Cook and Calvin note: ‘These growers are some of the best capitalized in the Mexican horticultural sector’ (2005:21).

96 Sinaloa’s growers have also invested in a cluster of glass-sheathed, technologically intensive greenhouses in the northern Sonora desert near the Arizona border (Cook and Calvin 2003). While high summer temperatures stand as a barrier to year-round production, these sophisticated greenhouses produce high quality tomatoes with the ability to command high prices. Furthermore, these greenhouses are situated near Nogales, Arizona, the point of entry to the United States for the export commodities produced in Sinaloa. Sinaloan growers are thus able to exploit existing, and familiar, networks and institutions.
On the other hand, in central Mexico – Jalisco for example – a more moderate climate allows the year-round production of tomatoes in plastic-covered greenhouses. Good light conditions and a dry, mild climate result in the potential for multiple crops in the course of a year, thus increasing the number of turnovers of capital. These production circumstances have attracted capital to the region, much of it exogenous. The largest greenhouse tomato operation in North America, for example, is situated in Jalisco and is owned and operated by an American company. Despite the use of low technology, and a concomitant reduction in yield, the ability to produce year-round and the proximity to the large U.S. export market have resulted in the growth of the greenhouse sector in the region (Cook and Calvin 2003). The attraction of greenhouse capital to the Jalisco region, as opposed to coastal areas such as Sinaloa and the Baja peninsula, ceteris paribus, can be attributed to the reduced turnover time of capital resultant of continuous cropping throughout the year. In Sinaloa and other coastal region this was accomplished through the expansion into greenhouse production.

Although greenhouse production has been a feature of Mexico’s horticultural landscape since the 1950s, it wasn’t until the 1990s that larger and more modern greenhouses began to appear with the re-regulation of international trade under the post-Fordist regime of accumulation (Cantliiffe and Vansickle 2003b; Steta 2004). Thus, greenhouse development in Mexico was spurred by the North American Free trade Agreement (NAFTA) of 1994 which increased access to the large and growing American markets and which increased the flow of foreign capital into the sector. Dutch, Spanish, Israeli, American and Canadian greenhouse interests are represented in Mexico in the form of direct investment, technology transfer, or joint production and marketing agreements (Steta 2004). In the case of the latter, Canadian or American growers who only produce seasonally but with agreements to supply retailers with greenhouse tomatoes year-round, will enter into contracts whereby Mexican producers supply the retailer in the off-season. Houweling and Windset of Delta, for example, have such an agreement with Mexican growers. The movement of capital into Mexico – usually deployed by firms with existing interests in greenhouse production in Europe and the rest of North America – has resulted in a concentration in ownership. The most recent estimates suggest that in 2003, 56% of greenhouse tomato production was consolidated in the hands of just three firms, each of which had operations of a minimum of 60 hectares. A further 18% was controlled by five firms with operations extending over 40 hectares. Thus a full 74% of Mexico’s greenhouse tomato production area – 703 of 950
hectares – was controlled by eight firms. (Cook and Calvin 2003). The remaining area consists of small enterprises of an average of 5 hectares.

In essence, these three producer nations compete for the North American, primarily United States, fresh tomato market. Dominance of the market by any one producer, or combination of producers, is a function of the comparative seasonal advantage primarily conferred by climate. The relatively mild summers of southern Ontario and coastal British Columbia means that summer production volume, 80% of which is exported to the United States, captures market dominance in both countries. As a United States Department of Agriculture (USDA) study notes, ‘…Canada’s volume of summer tomatoes is so great that it is hard for growers in the United States and Mexico to compete profitably in that season’ (Cook and Calvin 2005:iv). In the winter, when Canadian production ceases due to prohibitive energy costs, American and Mexican production meets market demand. Both the U.S. and Mexico are blessed, in this respect, by their geographies. The defining continental trading pattern is the movement of greenhouse tomatoes from Canada and Mexico into the United States. Between 2001 and 2005, United States imports of greenhouse tomatoes from Canada and Mexico increased from 91,922 to 286,518 tonnes.97 Canada’s and Mexico’s share of imports were 47% and 51% respectively. In 2005, imported greenhouse tomatoes represented approximately 10% of the total United States consumption of fresh tomatoes, in 2001 imports were 2.1% of total consumption (U.S. International Trade Commission (ITC) 2006). In winter, the absence of Canadian production and exports is compensated for by increased Mexican production as well as domestic production in the United States Southwest. Canada is the dominant exporter to the United States in the summer. Both American and Mexican tomatoes are imported into Canada in the winter.98 Intra-continental trade is facilitated by trade liberalisation in the form of the North American Free Trade Agreement

97 In 2005, approximately 6,400 tonnes of greenhouse tomatoes had been imported from the European Union, primarily the Netherlands. Extra-continental imports of greenhouse tomatoes have been declining significantly since, particularly, the emergence of the Mexican industry. In 2001 such imports constituted 18.5% of total imports, by 2005 they were just 2% of the total (U.S. International Trade Commission (ITC) 2006).

98 Canada does not publish detailed statistics on greenhouse tomato imports. Based on estimates, the United States Department of Agriculture reports the following for 2003: ‘Canada imports greenhouse tomatoes mostly during the midwinter. In 2003, Mexico was the largest supplier with 6,152 metric tons, followed by Europe, Israel, and Morocco with 4,176 metric tons, and the United States with 3,836 metric tons (fig. 7). Imports from non-NAFTA countries have decreased with the growth of the U.S. and Mexican industries. Actual greenhouse imports from the United States and Mexico may be higher if Canadian import statistics, like U.S. statistics, do not always correctly classify greenhouse shipments (Cook and Calvin 2005:16).
(NAFTA)\textsuperscript{99}. The trade in tomatoes in North America is currently free of tariffs and quotas although, as an anti-dumping case brought against Canadian greenhouse tomatoes illustrates, there are mechanisms for resolving trade disputes.\textsuperscript{100} The absence of tariffs on greenhouse tomatoes is complimented by the absence of production support or price stabilisation programmes in the three countries (Patterson and Josling 2005).

With respect to tomato consumption in the largest market, the United States, Error! Reference source not found. Figure 6 illustrates the change between 1979 and 2006. In essence, per capita tomato consumption has almost doubled in this period, from 5.6 to 9.3 kilograms. In terms of the total volume of tomatoes consumed in the American market, greenhouse tomatoes have dramatically increased their share. For example, between 1999 and 2005, greenhouse tomatoes increased their share of the market from 31\% to 41\% (Cook 2006). This increase in market share occurred at the expense of field grown round tomatoes which, due to their volume of production and low price, have traditionally been the Fordist tomato.

\textsuperscript{99} NAFTA is structured as three bilateral agreements, one between Canada and the United States, a second between Mexico and the United States, and a third between Canada and Mexico. The first accord was the Canada Free Trade Agreement, which took effect on January 1, 1989, and is subsumed by NAFTA. The second and third agreements are found in NAFTA itself, which took effect on January 1, 1994.

\textsuperscript{100} Prior to 1995, the general United States\hspace{1pt} tariff on imported tomatoes equaled 3.3 cents or 4.6 cents per kilogram, depending on the tariff season. In accordance with the Uruguay Round Agreement on Agriculture (URAA), the United States gradually lowered these rates to 2.8 cents and 3.9 cents per kilogram, respectively. These reductions were phased in over the 6-year period that ended on January 1, 2001. Under the Canada-U.S. Free Trade Agreement (CFTA), which was subsumed into NAFTA, the United States phased out its tariff for fresh tomatoes from Canada over the 9-year period that ended on January 1, 1998. Under NAFTA, the United States gradually eliminated its tariff for Mexican tomatoes imported during the periods of July 15 to August 31 and September 1 to November 14. These reductions occurred over the 4-year period that ended on January 1, 1998 (Zaniser and Link 2002).
The increased consumption of tomatoes is linked to a general increase in vegetable consumption in the United States. This increase in consumption is a function of availability, rising incomes, increased immigration and of changes in consumer taste and preference. The recent robustness of the United States economy has led to a general rise in incomes and, as fresh vegetables are classified as a normal good – that is, consumption increases with income – there has been a correspondent increase in vegetable consumption (Lucier, Pollack, Ali, and Perez. 2006). Demographic changes, immigration in particular, have also led to an increase in consumption. The United States Department of Agriculture (USDA) notes that Hispanic consumers were the strongest consumers of fresh market tomatoes, accounting for nearly 11 percent of the population, and were reportedly consuming 13 percent of fresh tomatoes. Hispanics of Mexican descent represented 5 percent of the U.S. population but consumed 7 percent of fresh tomatoes (Lucier et. al. 2000). Between 1990 and 2004, the Hispanic population of the United States increase from 22.4 million to 41.3 million. The rootedness of Hispanic diets in fresh produce, tomatoes in particular, contributes to the increase in consumption, aided by the increasing purchase power of Hispanic consumers (Abate 2006).
There has also been a shift in consumption pattern more directly related to the physical attributes of tomatoes and thus of particular relevance to greenhouse tomatoes. In particular, consumers seek blemish-free commodities which, in the case of tomatoes, implies fruit of perfect shape, colour and consistency. Greenhouse tomatoes profit from this consumption requirement through the fact that greenhouse production, as opposed to field production, tends to result in the formation of physically ‘perfect’ fruit. The production process, in which the growing environment is precisely controlled, means that the contingencies which often characterise field cultivation – pests, excessive or insufficient moisture, extremes of temperature, wind damage – and which affect the commodity, have been eliminated. The result is tomatoes of consistent quality without the variability in attributes which characterise field tomatoes.

**North American Greenhouse Tomato Production and the Third Food Regime**

There are a number of ways in which greenhouse tomatoes meet, or are made to meet, changing food consumption patterns under the third food regime in order to stimulate consumption. The emergence of niche markets has been identified as one of the characteristics of the post-Fordist regime of accumulation (Harvey 1989). The emergence of niche markets, as opposed to Fordist markets defined by the presence of standardised commodities, was concomitant with an increase in product differentiation. In the context of food consumption and the third food regime, the emergence of niche markets has been linked to the early development of organic food production (Guthman 2004) and, more recently, to alternate food networks such as ‘embedded’ foods production (Murdoch, Marsden and Banks 2000). I have noted above that greenhouse tomatoes originally occupied a niche position, catering to local counter-seasonal markets, their sole differentiating attribute being, at that time, their availability. As production and supply increased, and as new distribution networks emerged, greenhouse tomatoes became ‘mass’ commodities competing with field-grown tomatoes. A crisis of accumulation within the industry, however, precipitated by the increase in production in Mexico which had the effect of depressing prices, has led growers towards an increased differentiation of their tomatoes (Cook and Calvin 2005).101 In addition to the production of the mainstay of the American market, the beefsteak tomato, growers now produce TOV (tomato-on-the-vine), cherry tomatoes, Campari (cocktail) tomatoes, and roma and mini-roma tomatoes. As Abate notes: ‘Growers are aggressively pursuing and experimenting with specialty varieties…to increase sales of greenhouse tomatoes’ (Abate 2006).

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101 A similar crisis occurred in the Netherlands when Spanish tomatoes began to appear on European markets. The response by Dutch growers was a partial shift towards the production of more varieties to tomatoes differentiated by size, shape, colour and taste (Terhorst 2006).
Greenhouse tomatoes are further differentiated through stickers on the fruit which identify the grower.

Although occupying a mainstream position in the market, suggested by their possession of some of the more Fordist attributes such as appearance, greenhouse tomatoes trade on the ‘quality turn’ identified with the third food regime (Murdoch, Marsden and Banks 2000). In particular, growers are anxious to emphasise the fact that greenhouse tomatoes are grown in an essentially pesticide-free environment. Although not technically organic, since hydroponically produced tomatoes use agro-chemicals as fertilisers, the distinction, amplified through marketing campaigns, is sufficient to further differentiate greenhouse tomatoes from field tomatoes. In the context of the food scares which periodically grip the world of food consumption, the absence of pesticide use is a powerful marketing tool, one which exploits the growing tendency towards the consumption of organic produce. One way in which greenhouse growers and retailers attempt to differentiate greenhouse tomatoes in terms of the ‘ecological’ conditions of their production, is to present the tomato, at the retail level, still attached to part of the vine (Figure 7). Doing so re-establishes the link between the agri-commodity and nature: the calyx, that part of the plant which connects the fruit to the vine, imparts the scent of the tomato plant, and, since the shelf-life of the tomatoes increases the longer they are left connected to the vine, the act of harvesting is mimicked by the consumer as the tomatoes are used (Hochmuth 1998).

Figure 7: Tomatoes Attached To Vine

Source: Photograph by author
The Consolidation of Retail Capital

The emergence of greenhouses in North America, and their tendency towards spatial concentration in certain instances, was compelled in part by the restructuring of the retail sector in the United States. The increased concentration of the retail sector is a tendency that has been identified as one of the features of the third food regime.

This process began in earnest in the late 1990s with acquisitions and mergers. Between 1997 and 2000, more than 4,100 stores were acquired, amounting to almost a 20% of all United States supermarkets. Mergers and acquisitions by large grocery retailers, including Kroger, Albertson’s, Ahold USA, and Safeway, produced a significant increase in the share of grocery store sales by the largest firms. By 2005, the 20 largest retailers accounted for 61.6 percent of total U.S. grocery store sales, up from 40.6 percent in 1995 (Kaufman 2007). In certain metropolitan areas of the United States, the market concentration of the top 4 retailers is estimated to be approximately 70% (Hendrickson et. al. 2001:717). The contemporary landscape of food retailing is distinguished from the pre-consolidation period by the presence of so-called ‘mass merchandisers’ such as Wal-Mart and Costco. Such corporations, which sell a variety of food and non-food commodities, have, since late the 1990s, encroached upon the retail food scene by appropriating market share from traditional food retailers such as A & P and Winn-Dixie (Wrigley 2001).

The consolidation of the retail food sector in the United States and the ascendancy of retail capital were caused primarily by the deregulation of the retail sector and of financial markets. With respect to the regulation of the retail sector, Wrigley notes that: ‘For almost 50 years – from the 1930s to the 1980s – U.S. antitrust regulation was hostile to the development of ‘big’ retail capital and to market share being concentrated into the hands of a small number of major chains, operating multiregionally and enjoying considerable purchasing leverage’ (2001:496). By the late 1980s, most of the antitrust regulatory constraints on the retail sector had either been eliminated or eased, paving the way for consolidation. This process, however, was retarded for another decade by, ironically, the deregulation of financial markets. The relaxation of investment regulation and the creation of new financial instruments and markets, such as the ‘junk’ bond market, created ‘…immensely strong countervailing tendencies of deconglomeration and deconcentration within the U.S. economy’ (Wrigley 2001:497, emphasis in original). In essence, financial deregulation had acted as a fetter to capital expenditure and hence to consolidation through acquisitions and mergers.
The consolidation of retail capital had, as one of its consequences, a transformation of the relationship between retailer and producer or farmer. Prior to the 1990s and the consolidation of the retail sector, fresh fruit and vegetable markets were fragmented spatially and structurally, and the relationship between grower and retailer was usually mediated by a wholesaler. The transactions between grower and wholesaler was usually negotiated daily, the terms of the agreement being dictated by prevailing price and supply. Contemporary agreements, however, are characterised by a direct relationship between producers or their representatives, and retailers. The size of modern food retailers, combined with the logistics of centralised distribution systems, compels retailers towards growers or grower’s associations able to deliver the requisite volume. For retailers, such arrangements reduce transactions costs, increase profits through the elimination of intermediaries, and create a situation where, in the context of a tendency towards oligopsony, retailers are able to dictate terms concerning, for example, volume, delivery and packaging. The shortening of the supply chain, however, represents a partial triumph over the obstacle represented by the perishability of the agricultural commodity. As both Marx and the Mann-Dickinson thesis have noted, the perishability of agricultural commodities poses certain risks to capitalist agriculture by spoiling before their value can be realised in the market. In the case of greenhouse tomatoes, the reconfiguration of the supply chains results in ripe greenhouse tomatoes ending up in stores the day after they are harvested.

**Conclusion**

In this chapter I have outlined the main features of the greenhouse tomato industry in Europe and North America. The Netherlands, which has the oldest and most developed greenhouse tomato industry in the world, remains important for developments occurring elsewhere. In particular, the technologies issuing from the Dutch research complex continue to be fundamental to various national greenhouse sectors. Despite the relative maturity of, for example the Canadian and American greenhouse industries, Dutch developments, innovations and practices, a function of the concentration of greenhouse research activities in that country, are continually being adopted by firms in a highly competitive industry. The particulars of that relationship are discussed in the following chapter. The greenhouse tomato industry in the Netherlands is also unique in that it matured as a technologically innovative sector during the second food regime. This was due to

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102 This has been noted with respect to the Spanish case, where retail consolidation was met with the formation of Producer Organisations to represent grower’s/farmer’s interests.
the productivist logic of the Fordist regime of accumulation which resulted in the adoption of technologies that would increase yield.

The Spanish industry, which had been established in the 1960s as the result of a Fordist strategy of national development, assumed its current form under the third food regime. As a result of the re-regulation of international trade and the consolidation of European retail capital, greenhouse production became an accumulation strategy. This resulted in an intensification of production, although the subordination of nature, while real, was not as forceful as in Dutch greenhouse. Spanish greenhouse were constrained by the structure of ownership – many small producers – and a lack of capital. They were not technologically sophisticated and an increase in yields was achieved through the gross use of agro-chemicals.

There are two key observations to be made about the North American greenhouse tomato industry. First, the re-regulation of the financial sector in the United States in the 1990s led to a concentration of retail capital which, in turn, led to the transformation of the retail landscape. This concentration of retail capital, along with the concentration of agro-industrial capital, has been identified as one of the characteristics of the third food regime (Bowler and Atkins 2001). The emergence of large retail outlets was accompanied by centralised warehouse and distribution systems, which resulted in the reconfiguration of the supply chain. In essence, retailers required large volumes of commodities delivered to centralised warehouses. Furthermore, as discussed in greater detail in the next chapter, direct contact between producer and retailer began to define the supply chain. As a consequence of the demand by retailers for large and consistent supplies of commodities, the greenhouse tomato industry was compelled to restructure. This restructuring took the form of the construction of larger greenhouse, as well as their relocation. Furthermore, the regulation of continental trade which, significantly, witnessed the entry of Mexican greenhouse producers into the North American market, created a climate of strong competition. In light of these developments, greenhouse tomato growers pursued particular accumulation strategies, one of the elements of which was relocation. EuroFresh’ establishment of a greenhouse complex in Arizona – and, as discussed in the next chapter, the greenhouse tomato industry in Delta – is a case in point.

In the context of a highly competitive market, relocation represented a means of intensifying the biophysical productivity of the greenhouse production system. Capitalist greenhouse growers seek out the best location for this intensification, a necessity in a highly competitive sector.
Although still constrained by nature, greenhouse production is relatively mobile in comparison with field cultivation. Thus greenhouse producers have an extra degree of freedom and are not wholly restricted to increasing biophysical productivity through the use of improved seeds or superior fertilisers. They can move, and have done so. Along with the adoption of technological innovations which increase biophysical productivity – extra degrees of control over the growing environment for example (see Chapter 6) – greenhouse producers can exploit the advantages conferred by climate – increased light levels, for example. EuroFresh’ relocation to the high Arizona desert was a result of the fact that the biophysical productivity of greenhouse tomatoes increases in proportion to available light.
CHAPTER 5: THE GREENHOUSE TOMATO INDUSTRY IN DELTA

Introduction

The purpose of this chapter is to explain the presence in Delta of the concentration of greenhouse tomato production. Emergent well into the third food regime, Delta’s industry – which produces 90% of British Columbia’s greenhouse tomatoes, representing approximately 30% of national production – is characterised by spatial concentration. One of the question which this chapter seeks to address is ‘Why Delta?’ Why not elsewhere in the Fraser Valley – Langley, Abbotsford, or Chilliwack – or the province? When greenhouse growers have been asked why they built in Delta, the first, immediate response is ‘climate’. Is there something particular then about the greenhouse tomato industry that compels the concentration in Delta? Why are other emergent forms of intensive agriculture, blueberry cultivation for example, dispersed throughout the Fraser Valley but not greenhouse tomato production?

The chapter begins with a discussion of the individual tomato greenhouses in Delta, the purpose of which is to understand the motivations of individual greenhouse growers, and to situate those motivations within a structural context. In particular, I try to delineate the forces which have led to a concentration of greenhouse tomato production in Delta, particularly as they have occurred under the third food regime. This section also tries to demonstrate that the tomatoes have a unique ecology of production – one which distinguished them from cucumbers and peppers – which becomes critical in a context characterised by strong competition.103

The third food regime, as discussed in earlier chapters, includes as one of its characteristics the transformation of the food retail sector, particularly its consolidation. Large retailers prefer short supply chains characterised by direct contact with producers. In the second section of this chapter, I focus on the supply chain of greenhouse tomatoes having its origins in Delta. In particular, I argue that regulation instituted in the 1930s to protect a nascent capitalist agricultural sector, regulation still extant, acts as a fetter to accumulation by greenhouse growers within a context characterised by the porosity of borders – the free continental movement of tomatoes – and by the consolidation of retail capital. In effect, there has been a partial deregulation of greenhouse

103 Storper and Walker (1989) define weak competition as occurring within sphere of circulation (under pricing competitors, securing lower supply costs) and strong competition as technological and locational changes.
vegetable supply and management which allows greenhouse growers to adapt to changes induced by global deregulation.

In the next section, I consider labour supply and the labour market in the Fraser Valley and their relationship to the greenhouse industry. Again this is considered through a Regulationist lens. Agricultural labour in the Lower Fraser valley has historically been supplied by Indo-Canadians whose presence in the country was the result of an immigration programme aimed at family reunification. However, demographic changes in the community of Indo-Canadian agricultural labour have resulted in a crisis of labour supply. The re-regulation of the labour market has resulted in a new supply of labour, Mexican migrants.

The final section focuses on the space within which greenhouse tomato production in British Columbia occurs. My argument is that the regulation of land use in the province in the 1970s, which resulted in the creation of the Agricultural Land Reserve (ALR) Act, was serendipitous to the greenhouse tomato industry over two decades later. The ALR is regulation which protects designated agricultural land from being used for purposes other than farming. Thus much of Delta’s land has been protected from the pressures resulting from its proximity to Vancouver. The relocation of greenhouse tomato production to Delta, from elsewhere in the Lower Fraser Valley, has to be situated within the context of capitalist competition, at the continental level, discussed in the previous chapter. Within this competitive context, capturing the advantages of Delta microclimate constituted an element of the accumulation strategy pursued by regional greenhouse tomato producers.

The Greenhouse Industry in Delta

In this section I present an overview of the greenhouse tomato industry in Delta. This is accomplished through a history of the five greenhouses in the locality which produce tomatoes – Houweling, Gipaanda, Windset, Millenium Pacific, Village Farms – their attributes such as size and labour force, and the strategies pursued by individual greenhouse as a response to increased competition. Through these accounts, the nuances of greenhouse tomato production in Delta and in general are revealed, often by greenhouse growers themselves. But these accounts also illustrate the structural forces acting on greenhouse tomato growers, forces they had to respond to in order to become and remain competitive.
My primary argument in this section is that competition between greenhouse tomato growers – both regional and continental –, and the restructuring of the retail sector under the third food regime, resulted in the concentration of greenhouse tomato production in Delta. That Delta became the site of this concentration was due to the intensification of biophysical productivity made possible by Delta’s micro-climate. In essence, and in the context of greenhouse tomatoes, a one percent increase in light levels results in a proportional increase in yield. Capturing this advantage, this increase in productivity, was a key component of the accumulation strategies pursued by greenhouse growers in a climate forged by strong competition.

**Houweling Nurseries**

The first large technologically sophisticated vegetable greenhouse in Delta was by built by Casey Houweling in 1985. Greenhouse production in Delta, prior to Houweling’s arrival, consisted of a small number of floral operations using soil as a growing medium. Houweling greenhouse which, from the outset, utilised hydroponic production techniques in use in the Netherlands, was one of the first technologically sophisticated greenhouses on the continent. Houweling is of Dutch descent and his father, Cornelius, was a horticulture research scientist working for the Dutch state. Upon emigration to Canada in the 1970s, the elder Houweling started farming in Langley; initially growing field vegetables. The first greenhouse built by Cornelius Houweling, in Langley, was a 1.2 hectare floriculture greenhouse in 1974. In 1976, his sons Paul and Casey joined their father in the business. In 1980, when Cornelius Houweling had decided to retire, Casey and Paul Houweling purchased their father’s interest in the business and expanded the greenhouse floriculture facility to 6.5 hectares. In 1985, Houweling and his brother bought 37 hectares of farmland in south Delta, bordering on Boundary Bay, and built a 2.4 hectare greenhouse which, at the time, was the largest in Canada. This greenhouse was devoted exclusively to tomatoes. By 1989, a further 3.6 hectares had been added for the cultivation of cucumber and peppers. Between 1990 and 1993, the greenhouse had been increased by another 2.4 hectares to accommodate a greenhouse plant propagation operation. The final phase of construction saw the addition of a further 10 hectares that was used for the production of tomatoes. By 1995, the Houwelings had an 18.6 hectare greenhouse, its current size, growing vegetables such as cucumbers, peppers and, primarily, tomatoes. In Delta, Houweling employees 22 people full time, including 8 senior managers in finance, marketing, distribution, and operations. At the height of production during the harvesting period, they employ approximate 150 contract workers. Casey Houweling, the sole proprietor of the firm – he had acquired his brother’s share in the business in 1997 – directs the
overall operations of the Delta greenhouse as well as his facility in Oxnard, California (see below).

While the initial phase of building was financed by commercial banks – ‘it was easy to get money in those days’ – within two years the Houwelings had accumulated enough capital to build the next phase without resort to external financing. Through their relocation to Delta, the Houwelings had garnered an advantage over other greenhouse vegetable growers in the region. This was particularly true of tomatoes, Delta being ‘one of the best places in the world’ for their cultivation. Due to light and climatic conditions, tomatoes yields, per unit of greenhouse acreage, are greater in Delta than, for example, in Langley or Surrey. As a consequence of this locational advantage, the Houwelings were privilege to surplus profits. As Harvey explains: ‘(P)roducers…in superior locations receive excess profits relative to production costs…in the worst locations’ (1989:93). In 2000, Houweling had expanded into plant propagation during the winters, that is, growing plants from seed for use in their own greenhouse but also for sale to other greenhouses. While there were specialised propagation firms in the region – the largest on the continent is BevoAgro in Langley – propagation allowed an increase in the number of turnovers by exploiting an underutilised facility, the greenhouse in winter.

Aware of the growth in consumer demand for greenhouse vegetables, tomatoes in particular, and the need for year-round production to meet the demand articulated by the retail sector, in 1995 the Houwelings built a 34 hectare greenhouse – one of the four largest greenhouse in the United States – on 65 hectares of land they had bought in California’s Oxnard Valley. The warmer climate and ample light of the Oxnard Valley allowed winter production which, in turn, satisfied the demand by retailers for continuous tomato supply. 104 Given its coastal location, Oxnard has moderate temperatures during the summer which promotes greenhouse tomato production and, unlike EuroFresh Arizona greenhouses, obviates the need for auxiliary cooling. Furthermore, the Oxnard Valley, which has a concentration of farms, is well served by firms supplying the inputs necessary for production. Although land prices in the Valley are high, Oxnard was attractive as a greenhouse location due to the size of the markets, Los Angeles and San Francisco in particular, offered by densely populated Southern California. Houweling’s Oxnard location remains the only greenhouse-tomato-producing facility in California. Houweling’s decision to establish a greenhouse in California in the mid-1990s was a response to both an increase in competition with

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104 As discussed below, producing greenhouse tomatoes in Delta remains competitive in spite of increased competition
respect to greenhouse tomato production – that is, it represented a particular accumulation strategy – as well as the restructuring of the retail sector.

Raised in an agrarian, scientific and Dutch context, Casey Houweling was intimately familiar with greenhouse horticulture and its possibilities. He says that, with greenhouse production in the Lower Mainland, ‘I could see it happening’. Trips to the Netherlands had also exposed him to the vibrant Dutch greenhouse horticultural sector. Houweling comments that in the Netherlands he saw ‘thousands of acres of greenhouses. I didn’t see a reason why we couldn’t do it here.’

Critically, he recognised the climatic similarity between the area in which the Dutch greenhouses were clustered, Zuid Holland, and Delta. Both have maritime climates characterised by adequate sunlight, mild winters which, in the case of greenhouse vegetables allows the extension of the growing season, and moderate temperatures in the summer. The latter is of particular importance in the cultivation of greenhouse tomatoes since excessive temperatures retard growth and compromise yield. Why move to Delta and grow greenhouse vegetable? The Canada-United States Free Trade Agreement of 1988, which eventually reduced tariffs between the two nations, had yet to be struck and the consolidation of the United States retail sector, which was to have a determinate effect on greenhouse tomato production, would not occur until the late 1990s. The decision to undertake greenhouse horticulture, however, occurred during a period of rapid growth in British Columbia in greenhouse floriculture production. As Houweling notes, ‘there were many new producers and profit margins were being reduced’. In essence, competition had increased in the sector – represented by an annual increase of production of over 10% during the 1980s – due to increased consumer demand. Capitalists, in such a context, have a number of choices, including the adoption of new technologies and relocation (Harvey 1999).

The Houwelings’ greenhouse had a significant effect on greenhouse tomato production in the province. Between 1986, once Houweling had begun production, and 1994, just before the wave of greenhouse tomato expansion in Delta, greenhouse tomato production in the province had increased by 56%. That much of this increase is the result of the Houwelings’ greenhouse is suggested by the fact that between 1985 – before the Houwelings had begun production – and 1986, greenhouse tomato production in the province had increased by 61% from 2490 to 4019 tonnes.

Between 1985 and the mid-1990s, there were no new greenhouses built in Delta other than the Houwelings’ expansion through the decade. This can be attributed to a number of factors. Greenhouse tomatoes, in the mid- to late-1980s were a niche commodity (David Ryall, personal
communication). The volume of production was low, there was little competition from either United States or Mexican producers, and the market was either local or regional. Greenhouse tomatoes at this time appealed to consumers through their appearance – particularly shape and colour – which, when compared to field grown tomatoes, was superior. As a consequence, these early greenhouse tomatoes commanded a price higher than the combination of their cost of production and the average rate of profit, thus yielding surplus profits. Thus greenhouse growers elsewhere in the region could grow tomatoes even though their rate of profit was lower than that of the Houwelings, who reaped the benefits of both a locational advantage as well as a niche commodity.105

Gipaanda

David Ryall, of Gipaanda Greenhouse, is one of the senior members of the local greenhouse industry. As he puts it:

I started working for one of the bigger growers in Surrey in 1967. The greenhouse was two acres [.8 hectares], which was big at the time. The owner knew that I was just coming to learn and I would eventually be starting on my own business. At that time there was no Kwantlen College offering a horticulture diploma, so I took the route of learning on the job.

For Ryall, the attraction of greenhouses is the control over plants and their growth which, in contemporary greenhouse cultivation means ‘making a change on the computer [atmospheric control parameters or the formula of the nutrient solution] and seeing the results in three days.’ After three years working for the grower, Ryall and his father, who had a degree in agriculture from the University of British Columbia, built a greenhouse in Surrey. By 1981, the greenhouse covered approximately 2 hectares, employed 25 people, and produced beefsteak tomatoes, cucumbers and peppers. In 1996, Ryall and his partner Sarah Ryall built a new greenhouse for growing tomatoes in Delta. Initially a 3.6 hectare structure, the greenhouse was expanded the next

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105 It would be inaccurate to claim that greenhouse tomatoes at this time occupied a niche position as a result of a strategy of product differentiation. The contemporary differentiation of greenhouse tomatoes – between beefsteak, cherry, cocktail, vine, etc. – had yet to occur. The only variety being cultivated at the time was the beefsteak – a large, round, red tomato – which was essentially a Fordist commodity. Although appearance was the attribute that growers traded on in the market – given that the primary competition for the greenhouse grown beefsteak tomato was the field grown beefsteak variety – the priority with respect to production was yield and the size of the fruit. While export opportunities were limited – the United States’ tariffs on greenhouse tomatoes were only reduced incrementally following the Free Trade Agreement of 1989 – there was sufficient domestic demand for greenhouse tomatoes. This demand, coupled with the relative absence of competition – floriculture was the dominant greenhouse activity – and the surplus profits yielded by a niche market, allowed greenhouse tomato growers in the region to function.
year by another 3.6 hectares to its present size of 7.2 hectares. Given its relatively small size – Millenium Pacific at 11.4 hectares is the next larger size – only tomatoes are grown at Gipaanda. This represents a maximisation of the potential of the greenhouse since, of all the greenhouse crops, tomatoes, as a consequence of their price, yield the highest return. Ryall states that if he were just entering the industry he would not build anywhere but in Delta, again because of the extra yield possible.

Gipaanda employs approximately 90 to 100 full time and part time employees. David Ryall is responsible for the overall management of the greenhouse while Sarah Ryall is responsible for administration and finance. The technical operation of the greenhouse – that is, fostering the ideal conditions for plant growth – is delegated to a head grower and two technical assistants.

The move from Surrey was compelled by a number of factors, the most significant of which was the encroachment upon farmland by residential development. The Ryall’s greenhouse in Surrey sat on land zoned by the municipality as agricultural, and not on land protected by the ALR. They were surrounded by dairy, strawberry and raspberry farms. When the zoning of the land around them was changed in the early 1990s to allow development – schools and houses were built next to them – acts of vandalism compelled them to move. Development also meant the destruction of the agrarian ecumene. As Ryall pointedly puts it with respect to the ALR:

> The reason we came down here was the ALR. We were going to choose to be in the ALR because we don’t want houses bothering us. We want to farm, that’s it.

A further attraction of Delta was the flatness of the land which Ryall says is very critical to the industry:

> If you have a slope, even a very slight slope, you get the chimney effect…so therefore the climate in the greenhouse in not similar…we like to be within 1 degree Celsius anywhere within the greenhouse. The idea is that we are fine tuning our growing techniques and we want all our plants to be at the same temperature because otherwise you’re going to get different yields…All we think about is getting production all the time, yield.

Ryall also cites the importance of climate for the production of greenhouse tomatoes, a condition well served by Delta. In contrast to Surrey, Delta has 10 to 15% more light – each percentage increase in light results in a directly proportional increase in yield – as well as more moderate summer and winter temperatures. While the light increases yield, the moderate summer temperatures of Delta’s climate improves fruit quality. Fruit quality is of particular significance–
yield of course is always important – in the context of a market characterised by differentiation. Thus the greenhouse tomatoes produced in Delta must distinguish themselves within the market from field tomatoes, in the case of beefsteak tomatoes, and from more specialised tomatoes grown in less ideal conditions with less sophisticated technology, Mexico for example. The criticality of climate is signalled by Ryall’s assiduous search for a suitable location. Concerned about land rents in Delta as well its proximity to Vancouver, he first directed his attention to the Hazlemere Valley in Cloverdale. The micro-climate of this area mirrored that of Delta, in terms of available light and summer temperatures. The critical difference was in winter temperatures in the Hazlemere Valley which are 2 to 3 degrees Celsius cooler than Delta. Tomatoes are first planted in greenhouses in December and thus need supplemental heating, commonly provided by natural gas furnaces. The extra heating costs required by a greenhouse in the Hazlemere Valley as opposed to Delta was sufficient to dissuade Ryall from relocating to the former.

**Windset**

Windset, owned and managed by the Newell brothers, who, like the Houwelings and the Ryalls, are migrants to Delta from further reaches of the Lower Mainland, is also a family enterprise. The Newells, who had been farming in Abbotsford since 1981, built their first greenhouse there in 1996. According to John Newell:

> We started a greenhouse in Abbotsford with 4 acres [1.6 hectares], that was our first facility on our home farm. We are also in the chicken business…we have a background in [intensive] agriculture. We started with growing peppers in Abbotsford and we could see the demand [for greenhouse vegetables] was increasing and so we decided to take a look at expanding and decided that the best place to expand the business would be in Delta for a variety of reasons…number one, the climate here is one of the best for growing spring, summer, and fall tomatoes. When we started down here we grew tomatoes, our first three phases were tomatoes… tomatoes were our focus for the last 7 years…we decided to do vine tomatoes, some beefsteak tomatoes as well…and also specialty tomatoes, vine-type tomatoes.

In 1998, the Newells constructed a 6-hectare greenhouse in Delta. By 2001, the Newells had tripled their operation to 18 hectares. A further expansion in 2005 resulted in an addition of 9 hectares, making Windset Farms, at 27 hectares, the second largest greenhouse, after Village Farms, in Delta. While Windset had historically concentrated on tomatoes, they also grow cucumbers and peppers in the extension built in 2005. Windset is co-managed by John Newell.

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106 The following information was garnered during an interview with John Newell of Windset Farms on March 18, 2006.
and Steven Newell, sharing responsibilities with respect to finance, establishing relationships with retailers, and the management of their marketing and distribution agency (see below). The greenhouse employs approximately 370 full and part time workers. The technical management of Windset’s greenhouse crops is delegated to four growers and assistant growers.

Newell notes that the massive growth spurt in late 1990s of the greenhouse industry in Delta is over and that a more modest – 5 to 10 percent – growth rate is to be expected. He also expects that the greenhouse industry will expand in other areas of the Lower Mainland rather than in Delta due to the expansion of pepper and cucumber production. While localities such as Langley, Surrey and Abbotsford are more productive in terms of the cultivation of peppers and cucumbers – due to warmer summer temperatures – Delta ‘…is still a better place to grow tomatoes, much better.’ Newell elaborates: ‘The general industry consensus for greenhouses is that one percent more light equals one percent more yield, it tends to happen that way…right away, our size goes up…the size of tomatoes will be larger, quality is better.’ The more moderate climate, particular in the summer, is also an advantage. Tomatoes plants stop growing if the temperature is greater that 26 or 27 degrees Celsius, the result being smaller fruit.

While temperatures of this magnitude are rare in Delta, they are the norm in localities such as Abbotsford or Surrey. Newell puts the climatic advantage into context:

If our yield is up by 10 kilos more per square metre…10 kilos for vine crops is 2 boxes of tomatoes…2 boxes of tomatoes at an average price of 10 Canadian dollars per case is 20 dollars per square metre….over 100,000 square metres, that’s 2 million dollars…so right away you’re ahead of the guy in Abbotsford…if you’re that much ahead that would pay for most of your labour…we can afford to be more competitive price-wise than somebody in the valley….that’s a huge consideration for the United States [market] …the more we grow, the more profit … we have an easier time of it…I’m not saying that these greenhouses in Delta are profitable right now…it’s very, very, difficult…we’re fighting competitive companies from Mexico… their costs are lower.

The competitive climate, induced by the expansion of production throughout North America, has compelled Windset to venture into winter production in a fairly restricted form. In approximately 5 hectares of greenhouse space, Windset grows a specialty vine tomato – Campari – for Costco. Newell expects these tomatoes to be profitable over time despite the extra energy costs, particularly for lighting. Winter production is also feasible due to the particular ecology of

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107 Newell also argues that the difference in land rent between Delta and other localities in the region are, currently, insignificant given the capital intensity of greenhouses; it costs approximately a $ 1,000,000 per hectare to construct a facility.
Campari production: ‘…a tomato of 2.5 inches in diameter and high value…the crop is such that it doesn’t have as high a fruit load as a beefsteak or tomato on the vine crop so it is possible to do that crop successfully under lights.’ This experiment in winter production is also compelled by the mechanics of the third food regime, particularly the necessity of maintaining a year round supply of commodities to retailers. As Newell notes with respect to Costco, ‘…it allows us to keep them happy through the winter with that product at a very consistent and high quality level.’ Year-round supply to retailers, critical for maintaining accounts, is also accomplished through importing tomatoes from Mexico, repackaging them with Windset labelling, and shipping them out. While Newell argues that it is still possible for a new greenhouse to be established in Delta, it would have to be on a scale sufficient to meet the demand of retailers.

**Millenium Pacific**

One anomaly in this pattern of family ownership and control of greenhouses in Delta is Millenium Pacific. Unlike Houweling, the Newells or the Ryalls, Millenium Pacific is not the result of an agricultural past or the practice of an agricultural vocation. Shirvan Bakhtiyari, the owner of Millenium Pacific, is by training a structural engineer, by profession a property developer, and by inclination a land speculator. In the late 1990s, Bakhtiyari bought 66 hectares of land protected under the ALR. Given the land pressures engendered by Vancouver’s rapid growth, he expected, and continues to expect, that much of the land in Delta would be released for development. In the interim, part of the land was leased to a grower who built a greenhouse for the production of tomatoes. Financing for the greenhouse was secured by Bakhtiyari through a mortgage taken out on part of his land holdings. A combination of factors, including high energy prices, the cost of a lawsuit aimed at eliminating a 30% tariff on greenhouse tomatoes exported to the United States, and the production of tomatoes varieties with little market appeal, led to the bankruptcy of the greenhouse. As a consequence of his ownership of the debt, Bakhtiyari was compelled to assume control of the greenhouse and presides over the daily operations. Despite his ‘accidental’ role as greenhouse grower, less a farmer than a businessman, two of Bakhtiyari’s sons work in the greenhouse in managerial capacities. Millenium Pacific covers approximately 11.5 hectares and employs 120 full- and part-time workers.

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108 Bakhtiyari was interviewed on March 13, 2006. At his request the conversation was not taped. The following is drawn from notes taken during the interview.
In an earlier chapter I discussed the centrality of the Dutch research and education system to greenhouse developments, most of which have been diffused through to the principal greenhouse sectors in Europe and North America. At Millenium Pacific, the grower, the person responsible for establishing and monitoring the conditions of growth, is Dutch.109 Gary Van Stolen was educated at Wageningen University, the centre of greenhouse research and education, and acquired a degree in greenhouse horticulture equivalent to a Bachelor of Science. Van Stolen was required to do a practicum and fulfilled that requirement at Houweling in 1997. Two years later he returned to British Columbia to work at Millenium Pacific (Gary Van Stolen, personal communication).

**Hot House Growers/Village Farms**

The first greenhouse to be built in Delta after the Houwelings’ was by Hot House Growers which was acquired by Village Farms in October 2006. HHG began by first constructing a 4.8 hectare greenhouse and, in 1997, expanded that facility to 10 hectares. In the same year, a new 10.5 hectare greenhouse, adjacent to but separate from the existent greenhouse, was built. Two years later this newer greenhouse was expanded by a further 13 hectares. Village Farms currently has approximately 35 hectares of greenhouse area in Delta devoted to the production of tomatoes. It also has greenhouses in Abbotsford, a 7.5 hectare facility growing peppers, and in Pitt Meadows, where beefsteak tomatoes are grown in a 2.5 hectare operation. As a measure of the size of the enterprise, there are 49 full time employees, 15 of whom are growers and assistant growers. Approximately 600 contract workers, in all locations, tend to plants as they grow, and harvest, grade, pack, and ship. The complex of greenhouses in Delta founded by HHG is currently the largest in Canada.

The structure of ownership of HHG differed markedly from the rest of the greenhouses in Delta because it was not owned or managed by a family unit. HHG was established as an income trust trading on the Toronto Stock Exchange. All of the Class A shares and 30% of the common shares were held by the three directors of the company. The rest of the common shares are owned, through the income trust, by shareholders. The acquisition of HHG by Village Farms has resulted in the retention of the income trust structure but a change in the ownership of the Class A and 30% of the common shares. In effect, the senior management of Village Farms has assumed both

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109 Houweling also has a Dutch grower, Simon Kruitof, who has 40 years experience in growing vegetables and cut flowers in a variety of roles, including growing, harvesting, packing and overall greenhouse Management. Kruitof, who has worked in greenhouses in the Middle East, China, Mexico, Canada, U.S., South Korea and Eastern Europe, was educated at the Vocational Horticultural School, Holland.
the majority ownership and control of HHG. Village Farms in the United States emerged out of a corporation called EcoScience, a classic example of agro-industrial capital as Goodman et. al. (1987) define it. EcoScience’s initial activities were the manufacture of hydroponic equipment, including computerised management systems, the production of biological and chemical pest control for use in greenhouses, and the post-harvest protection technologies (coatings to ward off damage, rot, and pests) for fruits and vegetables. In 1998, EcoScience acquired Agro Power Development (APD, founded in 1990), the parent company of which owned Village Farm greenhouses in Texas, Pennsylvania, New York and Delaware. EcoScience’s acquisition of APD resulted in the rare instance of a fully vertically integrated company in the agricultural sector. With the exception of seed production, EcoScience, which changed its corporate name to Village Farms after the acquisition of APD, had direct control over the chain leading from production in greenhouses through to marketing.

Jonathan Bos, a former grower for HHG and now the Director of Operations for Village Farms in Delta, offers the following rationale for the appearance of a new greenhouse in Delta:

What has happened in the history of the greenhouse industry in the Fraser Valley (is that) most of the greenhouses started in the Chilliwack, Abbotsford, Langley area. That would have been in the early 80s, late 70s. There were two large institutions at that time, United Farm Growers, which covered plants and tropica[floriculture] and British Columbia Hot House Foods. As these companies grew, they outgrew their ability to sell their products locally and so an export market was searched out, and of course the US market was by far the closest. As relationships with customers [large retailers] grew, the ability to grow that business developed.

In addition, in the last 10 to 15 years there may have been 20 large produce handling companies in North America, there are maybe five left. All these people [retailers] consolidated so your ability to do business with them depended on your critical mass. So as you become more and more marginal [small greenhouse] you are in fact incapable of doing business with those people. One of the prerequisites [of the retailers] is a certain amount of volume, or a certain kind of ability to do a different kind of packaging or subscribe to certain standards or very cost and labour intensive procedures [e.g. grading, packaging]. These would be grocery chains, or club stores, some wholesalers.

With vegetables, more light means more production, and it became obvious to the growers in the Fraser Valley that the Delta area had between 10% to 15% more light than a place like Abbotsford. It also has a marine climate which is more moderate in the winter and in the summer. (It is a) very effective and efficient use of space. It costs more to live here (and) it costs more to purchase land here, but the benefits far outweigh the negatives. So in short, that is why in the mid 90s, soon as the industry
(reached) a certain point of saying ‘we have to get critical mass to be able to retain the Wal-Marts, the Costcos as customers’, decisions were made by companies to expand, and to expand in Delta (Personal communication, February 6, 2005).

In summary, the concentration of greenhouse tomato production in Delta was a result of a number of interrelated factors. Under the third food regime there has been a concentration of retail capital, resulting in the emergence of large retail outlets and centralised warehouses. For retailers there is an operational need for the regular delivery of large quantities of commodities. In the context of greenhouse tomato production, for Delta’s producers this need could only be served by increasing the sizes of greenhouses and of adopting strategies for delivering a year-round supply to their customers. The strategy adopted by Houweling was the construction of a greenhouse in California for winter production while other growers forged relationships with Mexican producers to serve the same end. The spatial concentration of greenhouse tomato in Delta is a result of the competitive pressures between capitalist growers who were forced to pursue new accumulation strategies. Regional competition initially conditioned the move to Delta which proved to be propitious as competition intensified on a continental level. In this context then, the biophysical productivity possible for greenhouse tomato production in Delta was, and currently remains, an advantage. As Harvey notes with respect to soil-based agriculture: ‘Relative surplus value (excess profits) can accrue to capitalists with access to use values of superior quality’ (1999:335).

**The Restructuring of the Retail Sector and Greenhouse Tomato Production**

Between 1985 and 1995, there was a profound shift in the regulatory regime which had a decisive impact on the greenhouse vegetable industry in the Lower Mainland. Before the mid-1990s, as David Ryall of Gipaanda confirms, there wasn’t enough demand to compel greenhouse owners to follow Houweling’s lead to relocate to Delta. The most notable shift in the regulatory regime was the demand for greater volumes of production made by an increasingly consolidated retail sector. While the deregulation of the financial sector in the United States only occurred towards the end of the 1990s, the retail landscape had already begun to change. For example, between 1991 and 1996, the number of supercentres – large retail outlets selling a mix of food and general merchandise – in the United States had increased from 225 to 730. Wal-Mart alone increased its number of these large stores during the same period from 10 to 344 (Wrigley 2001:5000). In Canada, Costco, a membership-based discount retail outlet, and one of the earlier customers for greenhouse tomatoes in volume, opened its first outlet in Canada in 1986 – there are now 59 in
the country. Between 1990 and 1996, the number of retail food outlets in Canada had decreased from approximately 33,000 to 27,000 (Agriculture and Agri-Food Canada 2006).

As this process of consolidation continued, and as retail outlets such as Costco began dotting the landscape, greenhouse producers in the Lower Fraser Valley, before the concentration of tomato production in Delta, were able to find large and stable buyers for their commodities. However, as retail consolidation gathered momentum in the United States, the need to produce even greater volumes of greenhouse vegetables, tomatoes in particular, became pressing. In general, the mid-1990s was a propitious moment for greenhouse growers. In the first place, and as planned under the United States-Canada Free Trade Agreement (FTA), the tariff regime for imported vegetables was nearing its end. Perhaps a more important factor was the Canadian dollar’s precipitous decline relative to the American dollar. In 1991, the Canadian dollar was valued at US $ 0.89, the highest it had been since the late 1970s, just before another prolonged decline in relative value. By 1996 it had dropped to US $ 0.73 and in 2002 it reached an all-time low of US $ 0.61. While greenhouse growers had not made their decisions to expand production in Delta based on the exchange rate, it did give them a competitive advantage vis-à-vis American producers and helped establish accounts with large retailers (Jonathan Bos, personal communication). The move to Delta in the mid-1990s then was to meet the demand of an increasingly consolidated retail sector. As Gary Van Stolen forcefully puts it: ‘If you didn’t expand, didn’t get big, you couldn’t compete’. At the centre of the process resulting in the concentration of the industry in Delta is the tomato. Competition between capitalist farmers, as represented by the greenhouse owners, and induced by the increased demand of retailers, necessitated a move to Delta. Compared to the rest of the Lower Fraser Valley, the tomato’s yield is greater in Delta. Thus growers who wanted to produce tomatoes and be competitive, in terms of both volume and price, had to relocate. As Storper and Walker state:

(C)ompetition drives capitalists to revolutionise production in order to gain an edge on competitors...Firms do not merely adjust to market conditions and keep to competitive standards; they struggle with one another with a fierce sort of economic warfare. A firm that gains competitive advantage over its rivals can earn surplus profits and increase its rate of accumulation...Capitalists, therefore, actively search for ways to transform business practices, to do what has never been done before [e.g. Houweling] (1989:48)

110 The passage of the North American Free Trade Agreement of 1994 did not alter the tariff regime established by the FTA.
**Marketing and Regulation**

In this section I consider some of the regulatory practices which have shaped, and continue to influence, the form of greenhouse tomato production in Delta. The section begins with the regulation of supply management and marketing in British Columbia – as embodied in the Natural Products Marketing Act – its impact on greenhouse tomato production, and its transformation under the third food regime.

The Natural Products Marketing Act (referred to hereafter as the Act), which passed into legislation in 1936, was a response to the crisis within the province’s agriculture in the early 20th century. A political economy of agriculture characterised by numerous small producers but a small number of large processors and distributors was threatening the viability of agriculture in the province. The Act, in this context, regulated that only certain designated agencies could sell to upstream agents. All agricultural commodities were consolidated and funnelled through these agencies in order to bolster the market power of farmers. This regulation, however, has proved to be a hindrance to greenhouse tomato producers in light of the transformation of the structural conditions of the market.

Unlike any other jurisdiction in North America, greenhouse vegetable production in British Columbia is subjected to both supply management and orderly marketing. The primary instrument of regulation of supply management and orderly marketing in the province is the British Columbia Vegetable Marketing Commission (BCVMC), administered under the Act. As discussed in Chapter 2, the Act emerged out of a political economic context characterised by province building, and by a production landscape populated, on the one hand, by numerous small farmers and, on the other, by a relatively small number of distributors. With respect to territory building, the early state had, as one of its objectives, the province’s self sufficiency in food production. During the first two decades of the 20th century, much of the food consumed in British Columbia was imported. The promotion of an export-oriented capitalist agricultural sector, through favourable settlement policies, was viewed as a means of addressing the trade imbalance in food. However, the production landscape was populated by numerous small producers who individually, with respect to the market, had little economic power. Competing imports, particularly from the United States, and price instability posed a threat to these small farmers. Furthermore, the relatively small number of distributors and food processors, representing a monopsony, could dictate the market price of commodities to producers. This imbalance of power, which represented a threat to the nascent agricultural sector, resulted in state
intervention in the form of the Act.\textsuperscript{111} The Act, passed in 1936, remains the overarching legislation for regulated marketing.\textsuperscript{112}

In 1980, the BCVMC was established to regulate all vegetables grown in the province.\textsuperscript{113} The two major functions of the BCVMC with respect to greenhouse vegetables are supply management and orderly marketing. Supply management is the control over the production of commodities through either restrictions on production area or on the volume/weight of commodities produced. In the instance of greenhouse vegetables, the BCVMC issues to each greenhouse a production area quota. In other words, greenhouse growers are allocated a specific area for the production of a particular commodity. While these area quotas are calculated on average yield per unit of production area, they allow some scope for growers to increase production volume through technological refinement. The BCVMC also dictated the production areas of the distinct varieties within crops. In the case of tomatoes, the allocation of quotas for varieties has reflected the change in the marketplace towards greater differentiation. In general, there has been a decrease in the area devoted to beefsteak tomatoes accompanied by an increase in the allocation of area quotas for more differentiated tomatoes such as vine tomatoes, cherry tomatoes, and Campari tomatoes. Historically, the purpose of supply management was to prevent overproduction, one of the consequences of which is the depression of market prices. The institution of supply management for greenhouse vegetables occurred during a period when the industry was characterised by numerous small producers, markets were local or regional, and the retail sector was fragmented. As discussed below, supply management is proving to be an anachronism in the context of the massive changes which have occurred under the third food regime. There has been a consolidation of production – fewer but much larger producers –, a consolidation within the retail sector, and the market is characterised by intense international competition.

In 2005, the BCVMC canvassed all registered greenhouse growers in the province on the issue of the deregulation of the industry. In essence, growers voted to retain the current regulatory structure subject to certain modifications. Some of the changes included the right to choose

\textsuperscript{111} For a brief account of the role of marketing boards in Canada, see Tamilia and Charlebois (2007).
\textsuperscript{112} The primary objectives of the Act were to improve and stabilize producer incomes; improve the stability and predictability of commodity prices by ‘dampening’ volatile price swings; ensure stable, predictable and adequate supplies; and promote and encourage the economic viability of small closely held (family) farm businesses (Martin, Grier and Mayer 2002:4).
\textsuperscript{113} The commodities first regulated by the Act included tree fruit, fluid milk and dairy products.
agencies, the ability to switch varieties within crops without prior authorisation from the BCVMC, and the creation of new agencies to foster a more streamlined supply chain (BCVMC 2006). However, and to the chagrin of Delta’s large greenhouse growers, production quotas were retained. As David Ryall notes, the regulatory system best served the interest of small growers, as it did in its inception in the 1930s, but hindered the ability of large greenhouses to fully exploit their production capabilities as well as the large retailers and growing markets of the United States. Ryall comments that the regulatory systems was

…great in the 50s…helped the farmers establish, the trucks weren’t going as far so it made some sense. Stuff flows all around the world …globalisation has changed things…I was happy to have it until about 15 years ago but now’s the time to get rid of it.

The retention of the quota system was, according to Ryall, a function of the distribution of voting rights: each grower, regardless of the size of the facility, was accorded a vote. As a consequence, the numerous small and medium sized producers, whose numbers overwhelm those of the large producers, voted in their own best economic interests. Of the growers eligible to vote, 60% wanted to retain the existing system, yet they represented only 20% of total greenhouse area. Ryall argues that had votes been proportional to the size of the greenhouse, the outcome would have been different. Prior to the concentration of tomato greenhouses in Delta – when the Ryalls grew in Surrey, and the Newells in Abbotsford – and when the market was domestic as opposed to continental, and when there was little competition from American and Mexican growers targeting the same market, primarily the United States, the regulatory structure allowed the industry to thrive.114

The second major function of the BCVMC is orderly marketing which, in essence, means that producers are required to sell their commodities through a designated agency. That is, producers are restricted from conducting private arrangements with either intermediaries such as wholesalers, or with final users such as processors and retailers. The purpose of the agency is to consolidate the commodities produced by farmers which, historically, was developed as a measure to meet the monopsonic structure of wholesaling and processing in British Columbia during the early 20th century. Contemporary agencies have expanded their functions to include the grading, packing, and marketing of commodities. The regulation of marketing, like supply

114 There are no quota or market restriction on growers from Ontario, Mexico, or the United States.
management, is proving to be a contentious issue within the greenhouse sector in the Lower Fraser Valley. Again, regulation of a historical nature, the Act, grates against the structural changes induced by the third food regime.

Greenhouse vegetables in the Lower Fraser valley had historically been marketed through a single agency, BC Hot House Foods (BCHHF). In 1973, before the regulation of the sector, a group of 44 greenhouse growers in Lower Fraser Valley formed the Western Greenhouse Growers Cooperative Association (Association) which mimicked the structure and function of most producer associations in the province. The Association, shares of which were owned by member producers, pooled commodities as a measure to bolster the market power of greenhouse growers, and graded and packed greenhouse vegetables. In 1997, in the heat of the expansion of the greenhouse industry in Delta, the Association was reorganised from a co-operative to a private company, with ownership still resting with producers, and renamed BC Hot House Foods. While the Association had limited itself to commodity pooling, grading and packaging, with marketing and distribution contracted out to third parties, the creation of BCHHF resulted in a partial vertical integration of the supply chain. That is, BCHHF assumed the responsibility for the marketing and distribution all of the greenhouse vegetables produced in the region. Also in 1997, the BCVMC formally appointed BCHHF as the sole agency for the pooling of greenhouse vegetable commodities produced in the region. In anticipation of its role, BCHHF built a 18,000 square meter facility in Surrey for vegetable storage, grading, packing and shipping. Through formal contracts established with each growers, BCHHF purchased commodities which were then shipped to the BCHHF storage, grading and packaging facility. Greenhouse vegetables subsequently lost their identity, as a product of a particular greenhouse, as they were all branded as Hot House vegetables. Up until 2001, BCHHF retained its monopoly on greenhouse vegetable marketing and represented, within the structure of orderly marketing, the principle of single-desk marketing.

In 2001, an application was made to the BCVMC for the establishment of a new marketing agency, Greenhouse Grown Foods (GGF). The application, which was approved in 2002, was made by Windset Greenhouse, the owners of GGF. Together, Windset and GGF represented the first instance of the vertical integration of the supply chain in British Columbia’s greenhouse sector. Greenhouse vegetables produced at Windset are graded and packed on site and shipped by Windset/GGF to customers. All marketing for Windset’s products is conducted by GGF.

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115 Other than acting as its agency, BC Hot House Foods is an entity distinct from Hot House Growers.
Newell of Windset cites a number of reasons for assuming control of the marketing function previously handled by BCHHF. In the first place, through its own marketing agency, Windset is able to establish and maintain a unique relationship with its customers. Through the line of communication established by such relationships, and its relative efficiency, the needs of individual customers could be accommodated by the greenhouse. Examples are the demand for a particular variety of tomato or a particular form of packaging. With its own agency, Windset was also able to extend its marketing reach by exploiting markets that BCHHF had hitherto neglected. While the traditional focus of BCHHF had been the western United States, Windset cultivated customers, and markets, in other reaches of the country. Direct control over marketing also allows growers to carve out niche markets for themselves through product differentiation; Windset’s production of Campari tomatoes, discussed above, is an example of that control. A further advantage of an agency owned and controlled by a single grower is the capture of value through the supply chain. Although BCHHF did not make a profit on the commodities it sold on behalf of growers – cost recovery by BCHHF is achieved through the imposition of fees for its marketing and distribution – through their own agencies, growers have greater control over any costs incurred. As Steve Newell puts it: ‘We have control over our own marketing, our own distribution, our own sale, everything.’

Windset’s acquisition of the right to market and distribute its own commodities signalled the gradual deregulation of orderly marketing in British Columbia. There are currently four agencies marketing greenhouse vegetables in the Fraser Valley: BCHHF, Greenhouse Grown Foods, Country Fresh Produce, and Village Farms. Country Fresh, designated an agency in 2005, is owned by a group of three greenhouse firms which includes Houweling. Houweling’s decision to end its relationship with BCHHF was predicated on the latter’s shortcomings with respect to marketing and costs. In the marketing of greenhouse tomatoes, BCHHF was limited by its summer supply from Delta’s greenhouses. As a consequence, relationships with retailers, who

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116 The BCVMC made the following recommendations with respect to the deregulation of marketing: lift the moratorium on new agency applications; examine more streamlined and business-supportive processes for approving agency applications; re-classify producers currently exempt from shipping through an agency as “Producer-Shippers”; provide greater freedom for producers to move between agencies based on commercial contract obligations; retain the authority to direct product but only use these powers in exceptional circumstances; provide that crop changes within a commodity (e.g. tomatoes) only require reporting not Commission approval; retain the requirement to obtain Commission approval to change between commodities (e.g. tomatoes to cucumbers) but remove time constraints and establish effective criteria to assess applications; remove timing restrictions and change the criteria for issuing new or additional production allocations (quota) to the ability to demonstrate a business plan; and; remove the requirement for agency sponsorship of crop mix changes and new production area.
prefer and increasingly demand a year-round supply of tomatoes, had to be re-established every year due to the winter interruption in supply. This implied a measure of insecurity for Houweling who could not establish a desired direct relationship with retailers which, as I have demonstrated, is one of the characteristics of the third food regime. Furthermore, because BCHHF had relied on third parties for distribution, it had little contact with retailers and was thus not at the ‘…forefront of consumer trends, market volume and pricing information, and retailer demands’ (Peter Cummins, the Chief Financial Officer of Houweling, personal communication). These relative inefficiencies increase costs to growers who, in a climate of strong competition, are compelled to seek a reduction in these costs wherever they can. In 2006, Millenium Pacific abandoned BCHHF in favour of Country Fresh Produce. As John Savage of the BCVMC puts it: ‘If growers can reduce their marketing costs by 4 to 5 cents per kilogramme, they’ll do it’ (Personal communication).

The deregulation of marketing, the erosion of BCHHF’s monopoly, has had a significant impact on the agency. The management of BCHHF had not anticipated that it would face such competition and this was reflected in its construction of the new facility in Surrey. The situation for BCHHF is dire, as Brian Beggs, the organisation’s president explains:

We have almost no tomato members [growers] right now. There are no tomatoes being shipped through United States. We’re having to go out and cobble together tomato supply in order to market a suite of products. BCHHF at this moment in time, it’s a little problematic. Merging with this Mexican outfit [a recent arrangement that Beggs had just effected with a Mexican greenhouse] is going to help, there’s a lot of tomato supply but it’s not during the summer months… Some of the shareholders no longer ship to United States. This whole building [18,000 square meters] was at one time BCHHF. We had three enormous grading operations for tomatoes, peppers and cucumbers… there’s a big shift going on for United States …we’ve already tried to attack our cost structure by subletting part of our building but ultimately we sold our building and are now leasing back a part of it. And it’s still not enough… The challenge for BCHHF that started when deregulation reared its head is that you’ve got this legacy cost structure that’s based on a different paradigm (Brian Beggs, BCHHF, personal communication)

For two years after GGF foods had been given the license to act as an agency, an attempt was made to preserve some the monopolistic advantages that BCHHF had enjoyed. There was, first of all, a moratorium on the granting of licenses to further agencies. Secondly, there were restrictions on the geography of marketing. Historically, BCHHF had concentrated its marketing efforts in the western states of the United States. As a consequence, GGF, established by Windset, was immediately restricted in its ability to exercise its new found reach. Although there was a gradual
easing on marketing restrictions, the ability of the BCVMC, in an emergency, to direct where commodities can be sold is still a point of contention. As John Newell of Windset states:

The BCVMC can control where our product goes…whether it’s in BC or whether it’s outside BC…they basically have a *carte blanche* control over our product grown in BC… (Personal communication)

In summary, the contemporary political economy of continental greenhouse production and of retailing has forced changes upon the supply chain of greenhouse tomatoes with their origins in Delta. The regulation of marketing that emerged during the 1930s has proven to be a fetter to large growers in the region. The long supply chain represented by single-desk marketing – that is, the movement of commodities though BCHHF – exists as an anachronism under the third food regime, particularly for large growers. Such growers, who produce enough greenhouse vegetables to satisfy the demands of large retailers, are able to command the prices necessary for further accumulation. Thus the pooling of commodities represented by the historical function of the BCHFF, in order to bolster the bargaining power of small producers, had become an irrelevance. Furthermore, single-desk marketing hampered the ability of large growers to differentiate their commodities from other producers and to cultivate markets for niche products, the latter further restricted by quotas which had specified which varieties of a particular crop could be grown.

Through the establishment of their own agencies, either individually or in concert with other growers, large greenhouses growers could streamline the supply chain and establish enduring relationships with retailers. The partial deregulation of orderly marketing in British Columbia, in which the agencies attached to Delta’s large growers appear to be a mere formality, is an example of the way modes of social regulation which emerged during an earlier regime of accumulation act as a fetter to accumulation under a newer regime. For example, the Natural Products Marketing Act was created during a period characterised by territory building and the accumulation of capital by indigenous capitalist agricultural producing for regional markets. The deregulation of trade, the increased porosity of borders, the consolidation of the retail sector, and the agglomeration of greenhouse production which characterises the contemporary regime of accumulation is ill-served by the Act. The Act is also an example of the ways in which more local/regional modes of social regulation yield to the forces unleashed by global re-regulation.
Labour and Regulation

In this section I consider labour in the context of greenhouse tomato production in Delta. The focus is on the re-regulation of the labour market as a response to the contraction of the supply of agricultural labour in the Lower Fraser Valley.

As the following illustration suggests, and despite the tendencies towards automation discussed elsewhere, labour is critical to the accumulation process represented by greenhouse production. In the Spring of 2006, the interior of Gipaanda’s greenhouse was a sea of brown instead of the expected green. Dead tomatoes vines were hanging limply from their trestles and the greenhouse was empty of workers. Gipaanda’s greenhouse workers – the only unionised greenhouse workforce in the Lower Mainland – has been locked out due to wage demands and concessions. Without labour to tend the plants, Gipaanda’s spring and summer crops had to be abandoned. While the concentration of labour in greenhouses mimics that of industry – yet differs from modern, mechanised field agriculture – the biophysical process at the core of greenhouse production must be maintained through the constant attention of labour. In the case of tomato plants, labour performs such necessary tasks as propagating, planting, crop management, harvesting, grading, packing and shipping. In most instances, the withdrawal of labour in industrial production results in a pause in production and a resumption once labour is reintroduced. In the case of industry, the durability of the raw materials and the partially finished commodity guarantees that, under most conditions, production can be resumed. For Ryall, the absence of labour resulted in the loss of a complete crop and the reduction in the number of turnovers of his capital.

Despite the high degree of automation – particularly climate control systems and hydroponic systems – greenhouse operations are highly labour-intensive. Thus, despite the capital intensity of modern greenhouse production, there is a relatively low organic composition of capital. Lower than, for example, the highly mechanised cereal farms of the Prairies. Every hectare of greenhouse requires tending by, on average, 13 people. (British Columbia Greenhouse Growers’ Association 2004.) In Delta alone, this constitutes a labour requirement of approximately 1690 workers. Three crops of tomatoes are grown during the production period in Delta, each crop taking 90 days to mature. During the growth period, certain tasks must be performed in order for maximum yield to be realised. The most important of these is the pruning of the leaves of tomato

117 Gipaanda’s workers are members of the United Steelworkers.
vines, which directs the flow of nutrients towards the fruit rather than the vegetation. Given the rate of growth, this is a continual task. Tomato vines, which lack any rigidity, must be suspended, typically on a series of trestles traversing the greenhouse. As the vines grow they must be lowered and rearranged to prevent damage to the plant and to enable the unimpeded development of fruit. This, again, is a continual task during production periods. Such tasks are performed by teams of experienced workers who cycle through the greenhouse, starting over once a section has been completed.

The number and the rate of growth of plants dictates the quantity and pace of labour throughout the greenhouse. The packaging process, which includes grading and crating, is also a significant consumer of labour. But the seasonality of production results in periods of peak demand for labour, from spring to fall. The harvest period places the greatest demand on labour, requiring a flexible supply. The availability of a flexible supply of labour is currently one of the constraints on production in Delta’s greenhouses. The extension of the growing season and, in the case of a number of greenhouse, the year-round production of surplus value, and the continuous application of labour during the growing season, have resulted in a reduction of the discrepancy between labour time and production. However, the nature of biological production in agriculture, characterised by peak labour demands during harvest, still results in the lost potential for the extraction of further surplus value throughout much of the production time.

As a conversation with any grower will confirm, there is a shortage of agricultural workers in the Fraser Valley. As David Ryall notes, ‘labour is generally getting tighter…we’ve been able to get by but we know it’s getting tighter…we do need more workers.’ Peter Cummins, the Chief Financial Officer of Houweling and a five-year veteran of BC Hot House Foods, states that ‘…labour started to get tight about three years ago and it’s been critical for the last two years.’ The problem is one of demand and supply. Within the agricultural sector, the growth in other forms of intensive cultivation such as cranberry and blueberry farms has created intense competition for agricultural labour. Such farms, according to Cummins, ‘…suck up a lot of farm labour in the summer time when we need it most…we’ve gotten into quite a bit of competition for Indo-Canadians who have been the principle source of farm labour.’ Given the seasonality of most agrarian enterprises, this shortage can be critical. Seasonality also dictates a flexible labour force resigned to the reality of periods of peak labour demands followed by either unemployment or under employment. The recent emergence of intensive agricultural practices such as greenhouses and mushroom farms in the Lower Fraser Valley, and their forcing of the growing
season, have tended to ameliorate the impacts of seasonality on agricultural labour. However, and particularly in the case of greenhouse vegetables, the absence of year-round production still dictates the need for a flexible labour force. In Delta, with the exception of Gipaanda, most workers are hired through contract. The contracts are secured through intermediaries, labour contractors, who are responsible for paying workers. Labour contractors are paid a fee by the greenhouse for securing workers. Historically, greenhouses in Delta, and agriculture in general in the Fraser Valley, have employed recent immigrants from India, the Punjab in particular.\textsuperscript{118}

A recasting of Canadian immigration policies in 1967 resulted in a gradually increasing flow of labour from the Indian subcontinent, particularly from the Punjab (Walton-Roberts 2003). Most Indo-Canadian farm workers in the region are a product of the family unification programme (family class) which sought to unite parents and spouses with the original immigrant.\textsuperscript{119} As a consequence, Indo-Canadian agricultural workers in the region tend to be middle-aged or older and almost half, 45\%, are women (Runston et al. 2000). While some workers live on the farms where they work, most live in the suburbs and are ferried to their workplaces by their employers, labour contractors who are also Indo-Canadian. However, an ageing workforce and competition from other agricultural concerns, as well as industries such as construction, have resulted in a general critical shortage of the labour typically supplied by Indo-Canadians. Peter Cummin’s experience is that ‘…typically the first generation of immigrants will work in agriculture but the second generation, Canadianised, will go into other industries.’ Cummins also adds that ‘…18 months ago we realised that we had a significant problem and we started looking at Mexicans.’

The new source of labour is the Seasonal Agricultural Workers Program (SAWP) administered by the federal government in cooperation with the Mexican state.\textsuperscript{120} While Mexican migrants have been working on Ontario’s farms and in greenhouses since 1974, 2004 was the first year of the program’s operation in British Columbia\textsuperscript{121}. In its first year of operation in British Columbia, SAWP saw 11 employers bringing 47 Mexican workers into the province. In 2005, 67 employers

\textsuperscript{118} Almost all agricultural labour contractors are also Indo-Canadian.
\textsuperscript{119} As Walton-Roberts (2003) notes, India represents the largest source of immigrants of this class and was central to the formation of Indian immigrant communities in Canada, particularly in Toronto and the Lower Mainland.
\textsuperscript{120} Jamaican workers started to migrate to Canada in 1966 under the SAWP. In 1974 the program was extended to Mexican workers. Trinidad and Tobago, Barbados and the Organization of the Eastern Caribbean States (OECS) (Antigua and Barbuda; Commonwealth of Dominica; Grenada; Montserrat; St. Kitts-Nevis; Saint Lucia; St. Vincent and The Grenadines) also joined thereafter. In addition to British Columbia, the SAWP operates in Alberta, Quebec, Manitoba, Nova Scotia, New Brunswick, Prince Edward Island and Ontario, which receives 90\% of workers.
\textsuperscript{121} For a critical discussion of the Mexican migrant experience in Ontario, see Basok (2002).
brought 690 workers into B.C and in 2006 119 employers brought in 1,278 workers. In addition to Ontario and British Columbia, Mexican workers, both migrant and resident, labour in the greenhouses of California and the American Southwest. Unlike the immigrant labour from India, Mexican workers are all male, relatively young, work on the farms and greenhouses for approximately half of the year, and are housed in accommodation paid for by the workers and arranged by the employing farm. Houweling for example, which employed Mexican workers for the first time in 2005, houses them in a 60-unit short-term rental building on South West Marine Drive. The company rented all units, each of which houses three workers. Houweling also provides transportation to and from the greenhouse. Because Mexican workers are divorced from their primary social network – that of family and kin – they constitute a more flexible workforce compared to the Indo-Canadians. Cummins notes that Mexican workers are ‘easier to schedule’ precisely because of the absence of a social network. This is particularly important in an agrarian enterprise characterised by periods of varying labour needs. For example, Houweling has a permanent labour force of 80 to 100 Indo-Canadian workers. Part of this labour force at Houweling services their propagation business – that is, planting and tending new greenhouse plants for their own use as well as for other greenhouses – which occurs during the off-season between December and February. The flexible component of labour is supplied by Mexican workers. Typically 20 to 30 Mexican are employed by Houweling early in the season with the number rising to 80 to 100 as harvesting begins.

Ironically, migrant workers find themselves in fairly rigid circumstances with respect to mobility – in essence unfree labour, unlike Indo-Canadians who were free, theoretically, to sell their labour to anyone. Contracts, agreed to between an employer and a worker before the journey to Canada, stipulate that the worker is obliged to labour for only that particular employer and must return to Mexico upon completion of the contract term. Basok notes with respect to the Mexican migrant workers in Ontario that that they were attractive to growers because, among other things, they were ‘…docile (and) disciplined…’ (Basok 2002:143). It remains to be seen whether this will be the case in British Columbia, but it does stand in stark contrast to the history of Indo-Canadian labour in Delta’s greenhouses. To paraphrase one Delta grower: ‘Indo-Canadians are too militant. Mexicans are much better in that respect’. Indo-Canadian workers have been unionised in certain greenhouses at various periods, currently only at Gipaanda, and

122 Under exceptional circumstances, workers are allowed to change employers, but only within the agricultural sector, and only if the employer has breached the contract. The transfer of workers from one employer to another must be approved by the Department of Human Resources and Skills Development. For the full contract see: http://www.hrsdc.gc.ca/en/epb/lmd/fw/BCSAWP2005contract.pdf
have demonstrated a capacity to articulate their demands and to back those demands with concrete actions (Keeton 1999).

Uneven development has yielded a large pool of labour to which Delta’s greenhouses, along with other agricultural enterprises in the Lower Mainland, are availing themselves. In one respect, the cluster of greenhouses in Delta, although place-bound, is assuming the characteristics of a globalised industry. As noted above, the global greenhouse tomato industry is undergoing a spatial restructuring through its search for both sun and labour. The emergence and development of the greenhouse tomato industry in southern Spain is a case in point. While the climate offers year-round production capabilities, migrant workers from North Africa supply the labour. For Delta’s greenhouses, Mexico offers the potential of a flexible and reliable source of inexpensive labour.123

For decades, agriculture in the Fraser Valley, and more recently greenhouses in Delta, have employed Indo-Canadians as labour. This has allowed accumulation to proceed in the sector. The demographics of Indo-Canadian agricultural workers in the Fraser Valley coupled with increased competition for their services, particularly from intensive forms of agriculture, is a threat to this accumulation. One of the options that firms have is relocation. The capital represented by the greenhouses in Delta, however, is relatively immobile. Being place bound – particularly for tomato production in Delta which, despite increased continental competition, yields at least average rates of profit – means that greenhouses must secure a new source of labour. The re-regulation of labour and the labour market by the state, which resulted in the institution of the SAWP programme, is a means of re-establishing one of the conditions for accumulation and is part of the global trend towards the increased mobility of migrant labour in the post-Fordist era.

The Agricultural Land Reserve (ALR) Act and the Greenhouse Industry

As I have argued earlier in this thesis, and in this chapter, greenhouse tomato production has been characterised by strong competition. Increased production in the United States and Mexico, and the increased movement of Mexican tomatoes in the United States market, have created a competitive environment within which Delta’s greenhouse growers must compete. I have also argued that greenhouse tomatoes, in such a competitive context, must be grown in climates that

123 A contrasting example of the use of a racially or ethnically demarcated labour force is the complex of greenhouses built by Jewish settlers in the Gaza Strip. Palestinians, with little or no transnational mobility, serviced these greenhouses. The Israeli withdrawal in 2005 has resulted in Palestinian control over greenhouses.
maximise both yield and quality. Delta is one such place, one of the best in the world as growers are wont to note. In particular, the light conditions and the relatively moderate climatic conditions in the summer offer Delta’s greenhouse tomato producers a competitive advantage compared to growers elsewhere in the Lower Fraser Valley. That almost all greenhouse tomatoes produced in the province issue from Delta is testament to that fact. This is further reinforced by the observation that certain greenhouse growers – Ryall and the Newells in particular – migrated to Delta in order to exploit its unique nature vis-à-vis greenhouse tomato production. Furthermore there is an absence of greenhouse tomato production in, for example, Abbotsford, Surrey or Langley, despite the existence of large greenhouses in those locales.

Part of the rationale for the establishment of greenhouses growing tomatoes in Delta is, of course, capital’s necessity, governed by competition, of seeking the best production circumstances. Within industry, such locational change may be determined by a number of factors including access to lower cost labour, resources and markets. Greenhouse production, however, is resolutely nature-based, despite the mastery acquired over growing conditions. But in the case of greenhouse tomato production, within the current competitive context, this dependency is heightened. In other words, given the absence of competition, or a situation characterised by weak competition, a greenhouse could be established under a minimal set of production conditions. But if Delta’s greenhouse growers are, first, to compete with American and Mexican producers and, secondly, to meet the requirements of a consolidated retail sector, then given the current level of technology, the maximisation of yield, enabled by Delta’s climate, becomes critical.

In this section I argue that the ALR created the space for the concentration of greenhouse production in Delta. Thus, despite its location on the urban fringe, and the attendant upward pressures on land prices, the regulation of agricultural land use in the province created a space, within a specific historical juncture, ripe for the consolidation of the industry. I begin by outlining the creation of the ALR by the provincial New Democratic Party in the early 1970s. This is followed by a discussion of the ALR’s impacts on agriculture in Delta and the way farmers have responded. For Delta’s greenhouse tomato growers, the ALR represents serendipitous regulation, one which emerged under an earlier regime.

124 A case in point is Alberta’s greenhouse tomato sector. With a total acreage of 6 hectares, and in a climate characterised by extremes of temperature, Alberta’s greenhouse tomato producers supply only supply local markets.
Delta has a land area of just over 18,000 hectares, of which 10,000 hectares are in the Agricultural Land Reserve. Approximately 2000 hectares of ALR land in Delta is consumed by uses such as railroads, canals, Boundary Bay Airport, parks and golf courses, leaving 8000 hectares for agricultural uses. ALR lands account for 56% of Delta’s total land area (Figure 8). Much of this land has prime agricultural capabilities (Class 1 - 3), making it some of the most fertile in Canada. An estimated 7,500 to 7,600 hectares are being actively farmed. There are three distinct urban communities, Tsawwassen, Ladner and North Delta, which cover 2,500 hectares. An additional 1,300 hectares are designated for industrial use, bringing to 3,800 hectares the total amount of land used for housing, commercial and industrial activities. Greenhouse complexes in Delta currently occupy 2.3% of available ALR land. Taking into account the lots on which these complexes sit, the coverage is 5.4% of available ALR land (Marcy Sangret, Corporation of Delta, personal communication). The following section argues that the existence of the ALR created the space in Delta for greenhouse production and other forms of intensive agriculture. Pressures induced by urbanisation led to the establishment of the ALR. However, Delta’s location in the urban fringe and its mixed land use have exerted upward pressures on the value of agricultural land. This has led to a turn towards intensive farming in the area.

125 An additional 310 hectares outside the ALR are zoned for agricultural use.
126 Corporation of Delta: Agriculture Overview, published by the BC Ministry of Agriculture and Food, 2000
Regional Planning and the Emergence of the ALR

The establishment of the Lower Mainland Regional Planning Board in 1949 represented the first comprehensive approach to regional land use in British Columbia.127 The post-war boom in the province had been accompanied by a higher than average population growth – compared to the rest of Canada – and a consequent suburbanisation within the Lower Mainland. While the Lower Mainland Regional Planning Board was primarily concerned with urban sprawl, its publication in 1962 of a tract entitled Land for Farming signalled the need for a co-ordinated attempt to deal with the perceived threat posed by urban sprawl to farmland. The report takes an unequivocal stance on sprawl, characterising it as ‘the municipal locust, the great devourer of money and land, and producer only of grief…’ (Lower Mainland Regional Planning Board 1962:22). Without romanticising farming – the farmer as rational economic actor as opposed to a bearer of tradition – the report claims that the consequences of the demise of agriculture in the region range from the economic (loss of jobs) through the erosion of regional self-sufficiency in food to the social and

127 For a brief historical discussion of land use planning in British Columbia, see Garrish (2002).
aesthetic (recreation and ‘green space’). In a specific reference to Delta, the Board’s report notes that,

On fair soils (Land Capability Class IV) urban growth took place almost entirely at the expense of agricultural uses. On poor soils (Land Capability Class V), the amount of vacant land actually increased between 1949-58 as farm lands were abandoned in anticipation of urban development (Lower Mainland Regional Planning Board 1962:42).  

The Board made the recommendation that, at the regional level, almost half of the useable land in the Lower Mainland should be reserved for agriculture. This encompassed an area of 121,000 hectares. Land ultimately intended for urban development was to remain in agricultural use, or remain rural, until the appropriate stage in regional growth had been attained (Baxter 1974). The intention of the latter recommendation was to prevent the continuation of the existing pattern of haphazard development, one which had resulted in the spatial fracturing of the landscape into a multiplicity of uses. Through a coherent, planned approach to regional growth, minimum lot sizes were to be preserved in order not to compromise the viability of particular agrarian enterprises.  

Unfortunately, the recommendations were just that. Despite being accepted and approved by the provincial government in 1966, the expropriation of 1,600 hectares of land in Delta for the Roberts Bank Superport – land designated by the Board as agricultural – revealed the frailty of the existing system of regional land-use planning and agricultural land preservation. As Baxter puts it, the failure of the province to uphold the spirit of the recommendations concretized the fear of planners who were concerned with

…the change in farmland ownership patterns which followed the provincial expropriation. Within the municipalities of Richmond and Delta, a great number of farms had been purchased by development companies and then leased back to farmers…The provincial expropriation, therefore, was seen as the precipitator of

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128 A soil classification system installed by the provincial Ministry of Agriculture in 1955 rated soil according to its ability to support agriculture. Ratings of arability – from 1 (very good) to V (poor) – were based on such factors as soil texture, topography, salinity, stoniness, erosion, drainage, and fertility level. It was more land classification than pure soil classification. Class IV, for example, while having fair soil, could be compromised in its productivity by the need for irrigation or an absence of drainage. (Lower Mainland Regional Planning Board 1962)

129 The Board recommended, for example, that any of the agricultural activities in the Lower Mainland could only be supported on farms with a minimum size of 16 hectares, orchards could be supported on farms larger that 8 hectares, and smaller lots, 2 hectares or more, could only support intensive activities such as poultry and pigs. (Lower Mainland Regional Planning Board 1962)

130 In 1969 there was a further alienation of 28 hectares of agricultural land in Delta that was converted to residential use. An attempt in 1971 to convert a further 242 hectares was met by public opposition and the application was withdrawn. (Baxter 1974)
In essence, the goals of the provincial government, oriented towards ‘growth’ and ‘development’, consistent with a Fordist regime of accumulation, were antithetical to the goals of the Lower Mainland Regional Planning Board and, in 1969, the Board was dissolved. In its stead was a decentralised process where planning was devolved to four regional districts – one of which was the Greater Vancouver Regional District – each with its own spatial responsibility. The consequence was an uncoordinated planning process, shorn of any legal support, which witnessed municipalities succumbing to the lure of the economic benefits – primarily tax revenues – attendant with residential and industrial development (Pierce and Fusureth 1982).

The inability of the fragmented and mostly ineffectual planning process in the region, coupled with popular discontent with the conversion of farmland to other uses, created a space for the articulation of land-use policies by the political parties campaigning for the 1972 provincial election. Of all the parties seeking governance of the province – the incumbent Social Credit Party, the New Democratic Party, the Liberals, and the Progressive Conservatives – it was the New Democratic Party which had the most comprehensive agricultural land protection program. The New Democratic Party had proposed a ‘… land-zoning programme to set aside areas for agricultural production and prevent such land being subdivided for industrial and residential purposes… (and) …establish a land bank to purchase existing and re-zoned agricultural land for lease to farmers on a long term basis’ (Baxter 1974:8). The fact that land use was an element of all the parties’ platforms was a result of continued public concern over the gradual destruction of the region’s agrarian landscape (Garrish 2002).

The New Democratic Party’s election on August 31st of 1972 meant that the proposal articulated during the campaign could be concretised through legislation, particularly as the party had won a majority. On April 16th, 1973, Bill 42 – legislation allowing the establishment of a Provincial Land Commission – was passed. The Land Commission Act had a number of discrete

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131 The only comparable – that is, centralising legislation – in North America at that time was in Hawaii and California. The Land Use Law (1961) in Hawaii divided land into four categories based on use: conservation, agricultural, rural and urban. While the pattern of urban land use was dictated by local government, the use to which the other three categories could be subjected to was at the discretion of the State. The Williamson Act in California, enacted in 1965, enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In return, landowners receive property tax assessments which are much lower than normal because they are based upon farming and open-space uses, as opposed to full-market value. The Open Space Subvention Act of 1971 compensated local governments for the tax revenues lost as a
objectives such as the preservation of agricultural land for farm use; an emphasis on the preservation of family farms; and the preservation of green space in and around cities\textsuperscript{132} (Furuseth 1981). Central to the NDP’s land policy was the Agricultural Land Reserve (ALR) which, at the time, was a unique act of centralised agricultural zoning. Land was assigned to the ALR according to its classification by the federal Canada Land Inventory. As a consequence, approximately 1.8 million hectares of the province’s area – 4.9% of total area – was reserved due to its physical ability to support food production. In Delta, approximately 10,000 hectares are currently in the Agricultural Land Reserve.

Despite the ALR, Delta’s location on the urban fringe has resulted in an increase in the value of farmland posing a threat to traditional forms of agriculture. Farm values in Delta per hectare, based on sales during the last 24 months, have ranged from $49,000 to $395,000, with an average of $110,000 (Farm Credit Canada, Farmland Values Database). Competition for farmland comes not only from within the agrarian sector, but from a multiplicity of interests including the state, conservationists, and ex-urbanites seeking an emulation of ‘country life’.\textsuperscript{133} The net effect of this increased competition has been the intensification of agriculture in the region. Not only greenhouse vegetables in Delta but, throughout the region, cranberries, blueberries, poultry, dairy, and mushrooms. As one farmer noted, the competition for land ‘…forces you into intensive agriculture…’ (Artemis Agri-Strategy Group 2001:24) Jack Bates, who has a farm on Westham Island in Delta that traditionally grew potatoes and other field crops, has converted part of his holdings to blueberry cultivation as a consequence of increased competition in the market for such crops. When asked why he decided to focus on blueberries rather than build a greenhouse, Bates replied that ‘I don’t know anything about greenhouse growing’ (Jack Bates, personal communication).

\textsuperscript{132} Initial reaction to the ALR on the part of farmers was one of hostility (Furuseth 1981). John Savage, who has farmed in Delta for fifty years growing processing crops such as peas and beans, and who was Minister of Agriculture in the Social Credit Government of Bill Vander Zalm, supported the ALR but he notes that when the Act was passed, ‘…there were lots of farmers at the Minister’s office protesting against the ALR.’ (Personal communication).

\textsuperscript{133} Conservationist organisations, for example, have been instrumental in inflating the price of agricultural land. These so-called ‘land trusts’, such as Ducks Unlimited and the Nature Trust, have been buying farmland in Delta since the establishment of the Reifel Bird Sanctuary in 1962. Given its landscape – characterised by a mix of wetlands, fields and woodlands – and its proximity to estuarine waters such as the Fraser River, Delta provides significant ecological services to wildlife. Boundary Bay and the adjacent uplands are the most significant migratory waterfowl and shorebird habitat on the Canadian Pacific coast (Butler and Campbell 1987). Among the sources of nutrition required by these birds are Delta’s agricultural fields, particularly those planted with potatoes, corn and hay. With both state and public support, these land trusts purchase agricultural land in the interest of habitat conservation.
Earlier in this chapter I discussed the causal factors which resulted in the concentration of greenhouse tomato production in Delta. These include the competitive pressures on local producers, which resulted in an accumulation strategy centered on getting the most out of nature, of maximising the photosynthetic ability of greenhouse tomato plants. In the regional context, this could only be achieved in Delta given the attributes of its micro-climate and the effect of those attributes on increasing yield. That regional greenhouse growers could relocate to Delta was the happy result of a mode of social regulation which emerged under an earlier regime of accumulation. But, unlike the Natural Products Marketing Act, the ALR has not proved to be a fetter to greenhouse tomato production in Delta, quite the opposite.

**Conclusion**

In the previous chapter, I presented evidence that the deregulation of the financial sector in the United States had resulted in the consolidation of retail capital which resulted in the dominance of the market by large retailers. The particular demands of large retailers includes production in volumes large enough to meet their market demands. Greenhouse growers, located throughout the Fraser Valley in Langley, Surrey and Abbotsford, in order to meet the expectations of larger retailers and to keep their custom, were forced to expand their production. There was also increased demand for greenhouse tomatoes which, compared to peppers and tomatoes, yield more profit. Thus, in order to meet these conditions, greenhouse growers sought the most appropriate location for the production of tomatoes, Delta. The exception was, of course Houweling, who escaped the competitive pressures of the greenhouse floral industry. Each greenhouse growers had to relocate not just to meet the demands of retailers, but because, as capitalists, they were in competition with each other. Growing tomatoes in Delta, from a regional or provincial perspective, yields the highest profit. On a continental level, Delta’s growers remain profitable due to the advantages offered by the micro-climate to biophysical production within tomato greenhouses. A grower located outside Delta would not be able to compete in the greenhouse tomato market.

Deregulation at the national level of the financial sector in the United States compelled the restructuring of greenhouse tomato production in the Lower Fraser valley. Re-regulation at the continental level, which resulted in the entry of Mexico into the trading bloc, also necessitated this relocation. In British Columbia however, regional regulation in the form of the Natural Products Marketing Act, administered by the British Columbia Vegetable Marketing
Commission, acted as an impediment to the greenhouse vegetable industry. The Act’s enactment under an earlier regime of accumulation characterised by territory-building acted as a dead weight in the context of a regime founded on the porosity of borders. The long supply chain, in which BCCCF acted as the intermediary, was inadequate to the task of servicing the consolidated retail sector. Thus, a partial deregulation was initiated, eroding the monopoly of BCCF, which awarded growers greater control over the supply chain. There was, furthermore, a re-regulation of the labour market. The particular, agricultural, nature of greenhouse production requires a flexible labour force. While this requirement had previously been met by Indo-Canadians, competition from other forms of intensive agriculture in the region, coupled with the demographic characteristics of the Indo-Canadian workforce, has resulted in a labour supply problem. The re-regulation of the labour market, thorough the introduction of the SAWP programme, is a step towards the construction of a new structured coherence. Finally, the space within which greenhouses operate was artificially created by the Agricultural Land Reserve Act. Pressures on land rent induced by competition over use values and the decreased profitability of traditional field cultivation, had created an opening for intensive forms of agriculture such as greenhouses and blueberry cultivation.

In this chapter I have demonstrated the ways in which regulation, at all spatial scales, has shaped the greenhouse industry in Delta. In particular I have illustrated the ways in which regional regulation has acted either as an obstacle to greenhouse tomato production – the Natural Products Marketing Act – or enabled it – the Agricultural Land Reserve Act. Furthermore, there is the legacy of past regulation. The deregulation of the finance sector which led to the concentration of retail capital, and which occurred during the third food regime, created a set of competitive requirements which Delta’s growers found increasingly difficult to meet. This resulted in the partial deregulation of the supply chain which enhanced the competitiveness of Delta’s greenhouse growers. Regional regulation was pressured into adapting to the changes unleashed by regulatory change at greater spatial scales.
CHAPTER 6: THE “NATURE” OF THE CONTEMPORARY TOMATO AND OF GREENHOUSE PRODUCTION

Introduction

In this chapter I discuss both the transformation of the tomato and the particular ecology of greenhouse production. One of the central themes in this chapter is the process of appropriation as it relates both to the tomato and to greenhouse production.

With respect to the tomato, I begin with its incorporation into industrial production processes, particularly canning. This I view as instance of appropriation. However, as one of the first foods to be processed and packaged as a food of ‘convenience’, the tomato had to be modified for the task. Breeding programmes by both capital and state created a tomato that could withstand the rigours of a production line yet maintain some semblance of ‘tomato-ness’. In Canada, a public breeding programme, established at the end of the 19th century, created its own tomatoes, ones suited to the history and geography of a new nation and, in the process, sidelined that faction of capital represented by the seed industry. This is contrasted with the process of breeding in the United States, which was characterised by a particular relationship between capital and public breeding institutions. The final sections of the chapter discuss breeding technologies. I argue that the deployment of molecular technologies in the breeding process represent an instance of the real subsumption of nature.

Greenhouse production, in its technologically sophisticated variant, is a system of cultivation which professes complete mastery over the growing environment. Thus nature, at the core of this and any other agricultural system, is subjected to an unprecedented control. As David Ryall of Gipaanda Greenhouses in Delta observes, the attractions of greenhouse growing include ‘making a change on the computer and seeing the results in three days.’ The purpose of this chapter is to unpack this observation by focussing on two separate yet interdependent processes within the context of greenhouse production.

The first process, signalled by the use of the computer, and approached through the work of Goodman et. al. (1987) and Boyd et al. (2001), is the off-farm appropriation of the rural production process and the resultant real subsumption of nature. That is, processes once accomplished on the farm by living labour itself – tilling, fertilising, weeding, pest control, seed production, harvesting – have been appropriated by machines, chemical fertilisers and pesticides,
hybrid seeds, irrigation systems, and so on, that are produced by agro-industrial capital represented, for example, by Massey-Ferguson, International Harvester, Monsanto, Dow AgroSciences and DuPont. The products of these off-farm processes are then reintroduced onto the farm and these industrialised inputs thus characterise industrial agriculture. Nature at this point is subjected to a logic that represents its real subsumption. In this chapter, deploying both concepts, I discuss the various aspects of greenhouse production – in particular the growing medium, pest control, the greenhouse aerial environment, and the seed –, the form they assume, and their appropriation. With respect to pest control, there is a regulatory dimension within Canada that forces greenhouse growers to adopt a particular method. This also will be discussed.

The second process is that of the nature-based character of agricultural production. The Mann-Dickinson thesis argues that capital has eschewed direct control over the agricultural production process, or farming, due to the particular character of nature-based production (Mann and Dickinson 1978). Nature-based production, for Mann and Dickinson, presents certain obstacles to capital’s penetration of farming, obstacles that include the disunity of production time and working time, the limited number of capital turnovers, the problem posed by agricultural land as part of the means of production, and the risk inherent in biological production. The greenhouses in Delta, and elsewhere in the world, are capitalist enterprises due to the presence of wage labour. Is this penetration then complete? Does nature still present obstacles within greenhouse production? In this chapter I try to demonstrate, with reference to the case study, that nature within greenhouse production remains irksome.

The Transformation of the Tomato

In the latter half of the 19th century the tomato was transformed from a garden crop into a significant commercial crop. This was also the moment of an evolution in plant breeding techniques whereby a more systematic process of plant selection displaced the process that

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134 As early as 1847, tomatoes were being processed in Pennsylvania (Gould 1983). Up to 1890, canning was an artisanal process, accomplished by hand in small facilities. Between 1890 and 1900, the process was automated, to a degree. Scalders, cyclones and peeling tables were deployed and there was a gradual consolidation of production. Developments in processing were mirrored in the manufacture of cans. Machines that could produce 40,000 cans in a day replaced a labour-intensive process requiring the manual construction and sealing of a can (Alberts 1973:167). The tomatoes being processed ended up as soups, chutneys, sauces and ketchup and represented a proto-Fordism within the food industry. Processing also stimulated an expansion of tomato production, particularly in California, although Fordism, in the form of the mechanical tomato harvester, did not make an appearance in the field until the 1960s. The embryonic processing industry was soon to be consolidated in the form of Campbell and Heinz, those pioneers of Fordist food production.
preceded it. Whereas growers had been primarily concerned with security and predictability, selecting plants that were low in yield but were consistent in their production (McCouch 2004), the breeding of plants for the market resulted in a shifting of emphasis. With respect to the tomato, the catalyst for this transition was Alexander Livingston, a farmer and seed producer from Ohio.

Prior to Livingston’s pioneering selective breeding, tomatoes had hard ribbing on the skins, hard cores and hollow seed cavities. While these tomatoes might have met the needs of households and small local markets, the tomatoes that Livingston eventually bred had all the qualities requisite of a modern, fresh, agricultural commodity – smooth skinned, uniform in size and shape, succulent, and flavourful. The key to Livingston’s success was to select the best plant for breeding rather than the best fruit, as was the practice of the day. The best plant, in the sense of the robustness of its characteristics, if bred consistently, produces better fruit. By adhering to the principle of single plant selection – that is, the breeding of plants with desirable characteristics by repeated self-pollination of offspring all derived from a single parent plant – to meet the clearly defined demands arising in the tomato trade, Livingston developed and introduced 13 varieties between 1870 and 1893 (Gould 1983:5).135

Tomatoes bred for the canning industry at the time had to meet slightly different criteria. Appearance was not that important, but the tomato bred and grown for processing had to be ‘…moderately large, smooth, so that it would peel readily, ripened evenly to the stem, of a clear, red colour, and have a large proportion of solid meat of good flavour’ (Gould 1983:7). The amount of manual labour required for the preparation of processing tomatoes, peeling in particular, dictated a shape and firmness conducive to handling. The canning industry of the 19th century, while not completely Fordist as it would be a few decades later, still required an easily manipulable object. A deep red colour indicates the desirable quantity of solids and sugars. The apparent incommensurability of the two types of tomatoes, fresh market and processing, is illustrated by the reaction to an attempt in 1910 by the Canadian state to export tomatoes to Britain, tomatoes which had been grown for the processing sector. The Chief Cargo Inspector for Liverpool, for example, noted that ‘Canadian tomatoes, as supplied to canning factories, are not wanted here at any price. The tomato for this market must be of medium size, smooth and of

135 Single plant selection is based on the pure-line theory of inheritance developed by the Danish biologist W. Johannsen. (Walton 1988:255) A characteristic of this breeding method, other than the narrowing of the genetic base, is that further generations within the pure line do not produce increases in the desired traits, e.g. fruit size. Variability must be introduced through hybridisation.
cherry red colour’ (Canada. Department of Agriculture 1910:1). In addition to the fact that Canadian tomatoes were considered too large, they were faced with competition from local sources and from countries closer to Britain – France, Belgium, Portugal, Denmark, Spain, and the Canary Islands. Despite this setback in international trade, the processing tomato industry in Canada, Ontario in particular, was thriving in the early decades of the 20th century. For example, between 1891 and 1908, the area of processing tomatoes under cultivation increased ten-fold136 (Turney 1912:2). In 1908, Heinz established a processing plant in the Leamington area of Essex County in Southwest Ontario. It shipped its first bottle of ketchup in 1910, followed later by a diversity of industrial foods including soups, which began production in 1917. A further early instance of the concentration of production was represented by Canadian Canners Limited. Overproduction and crippling American duties on Canadian canned production had resulted in a crisis of accumulation, one of the consequence of which was a decimation of the ranks of small canners. The remaining canners, in an attempt to stabilise production, merged in 1903 to form Canadian Canners based in Hamilton. Given the state of plant breeding at the time, Canadian Canners attempted in 1905 to control the quality of their canned goods by forming a subsidiary, Canners’ Seeds Limited, to develop and test seeds. By 1910, Canadian Canners produced 80% of the country’s canned fruit and vegetables137 (Winson 1993). In 1930, Campbell’s Soups opened a processing plant just north of Lake Ontario, adding to the further concentration of tomato processing in Canada.

The growth in the processing tomato industry was a function of both demand and supply. Increasing urbanisation had resulted in a shift in consumer demand towards ‘convenience’ foods such as canned products. In fact most canneries in Ontario were built close to urban centres. For growers, the cultivation of tomatoes for processing was a profitable activity, compelling many farmers to shift cultivation away from more traditional crops such as cereals and potatoes. Turney notes that ‘…a number of farmers have expressed their firm belief that the tomato is the best paying and surest crop’ (1912:10). The nascent state of the industry, however, was signalled by the fact that most of the seed used by growers was imported. The bulk of the seed was imported from the U.S and, in a reflection of the level of development of tomato-breeding practices of the day, ‘…a number of growers select their own seed in a more or less indifferent way’ (Turney 1912:13). The seed procured by growers was a result of minimal breeding. Once a desired selection had been obtained and its purity was maintained, little attempt was made by seed firms

136 The first tomato canning factory in Ontario was established in 1881.
137 What was once Canadian Canners is now part of Nabisco.
to improve the characteristics of their tomato plants. Unlike Livingston, growers who tried to breed their own plants yielded to the practice of selecting seed from the best fruit rather than from the best plant, a fact lamented by Turney: ‘But not one grower have I met who has reserved a piece of ground exclusively for seed breeding and attempted to conduct rigid straight seed selection. The best seed selected one year is lost track of the next’ (1912:15).

Processors such as Heinz and Campbell, however, imposed a discipline on tomato cultivation. For instance, the development of cultivars was conducted within corporate research facilities and through the state. Heinz, for example, developed the Rutgers, an ideal processing tomato, with the New Jersey Agriculture Station during the 1910s (Collins 1994:112) while Campbell had led the U.S. Department of Agriculture and the Pennsylvania State Board of Agriculture to develop suitable plant varieties in the late 19th century (Alberts 1973:47). The resultant seeds, along with cultivation methods, were distributed to growers who were under contract to produce crops for processing, the price having being determined in advance (Pritchard and Burch 2003). New seeds developed by Heinz and Campbell were imported into Canada to be used by local growers, a characteristic practice within the seed industry in the early 20th century (Kuyek 2004).138 The Canadian state only began developing new varieties of processing tomatoes in 1942, at the federal experimental farm in Harrow near Leamington, Ontario. The goal of the research programme at the time was to producing disease-resistant varieties more suitable to southern Ontario (Ward 1978). Despite the concentration of capital within the tomato-processing industry, there were independent producers and processors who benefited from public breeding programs.

As noted above, Livingston’s work with tomatoes signalled the modernisation of plant science. Prior to the 19th century, individual agriculturalists and cultivators were concerned with the prevention of the destruction of existing crops and with ensuring a continual supply of seed. The reproducibility of existing crops and their yield for subsistence purposes were the main concerns. The modernisation of plant science, that is, the systematic, institutional attempt to improve the characteristics of plants, was signalled by a methodological shift. As Jensen notes:

By 1850 one could find references to procedures that were soon to become common in usage, such as attempts at hybridization in the early part of the 19th century, mass and individual plant selection being practised as cultivated species were being developed, individual crops being improved; e.g., the increase in sugar content of sugar beets around 1800 and the rapid growth of open-pollinated varieties of corn. The reproduction features of different plant species were

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138 Canadian public breeding is discussed in greater detail below.
recognized; e.g., such things as type of pollination and sexual or asexual patterns (1994:182-183).

Darwin’s thesis on natural selection and Mendel’s work on heredity, both of which appeared in the 19th century, had a determinate influence on the evolution of the life sciences during this period. So did the ‘institutionalisation’ of plant science research through the establishment of private and public laboratories and experimental farms, and through the establishment of a system of science education.139 (Bowler 1992). While wealthy land owners and individual farmers continued to experiment with simple breeding techniques, the 19th century professionalisation of plant science would ‘…catalyze the transformation of plant breeding and establish the hegemony of the scientist, rather than the farmer, as the principle producer of new crop varieties’ (Kloppenburg 1988:66).

The methodology that defined this ‘new’ science was, with the rediscovery of Mendel’s work at the end of the century, artificial hybridisation, that is, the intentional manipulation of the internal code of a plant (genotype) through the selection of a particular set of parents.140 Mendel’s work provided insight into the relationship between genotype and phenotype. For Jensen, artificial hybridisation represented a paradigm shift:

> When artificial hybridization came into general use around 1900, it really represented a new level of thinking …At one stroke, plant breeding, which may be thought of as controlled evolution, moved from Darwin’s open-ended time scale to a manageable human-generation scale (1994:185).

A hybrid is the result of the cross between two plants of different species, varieties or cultivars. Founded principally on Mendel’s discovery of the inherited and inheritable traits of organisms, hybridisation exploits this knowledge in order to breed plants exhibiting the best characteristics of each parent. Although hybridisation had been practised in a haphazard fashion for millennia, once the genetic basis and mechanism of heredity was understood, plant breeders could embark on a systematic programme to tailor the characteristics of plants to meet certain criteria. Hybridisation, however, did not displace the practice of selective breeding which preceded it. Once the desired outcome has been achieved through hybridisation, and is evident in the progeny, the characteristics of the hybrid are often maintained through practices such as pure-line breeding. One of the advantages of hybridisation is that the progeny – otherwise known as an F₁ (filial, first

139 See below for a discussion of the experimental farm system in Canada.
140 Although, as Jensen notes: ‘Artificial hybridisation was known but thought to be of minor importance in view of the vast reserve of variation existing in natural populations; its role changed with the rediscovery of Mendel’s law of inheritance’ (Jensen 1994:183).
(generation) hybrid – possesses the characteristic of hybrid vigour or heterosis. Heterosis refers to the superiority of the hybrid over the parents in some measurable quality such as rate of growth, yield and disease resistance.\textsuperscript{141} A further advantage is that hybrids may be better adapted to certain, especially new, environments and tend to be successful colonisers and invaders.\textsuperscript{142} However, the heterosis effect disappears after the F\textsubscript{1} generation, thus growers must purchase new seeds or plants from breeders if they want to reap the benefits of hybrid vigour.

These changes in the structure and form of plant biology inquiry, however, appear to have had little effect on the tomato at the time. Prior to the 1920s, tomato improvement depended largely upon selection of chance variants that originated from mutation, spontaneous outcrossing or assortment of pre-existing genetic variation (Rick 1976:453).

In the first two decades of the 20\textsuperscript{th} century, scientists and plant breeders explored the implications of Mendel’s discoveries.\textsuperscript{143} In general, research took place in the laboratory, primarily at academic institutions, thus reinforcing the division between the practical and research aspects of breeding. The transformation in the 1920s was a result not of advances in classical genetic inquiries – although progress was been made yearly – but of the institution of breeding programmes that combined the theoretical and practical.\textsuperscript{144} The essence of such a programme at,  

\begin{itemize}
  \item For a discussion of the impact of heterosis on the U.S. corn industry, see Kloppenberg (1988).
  \item Mendel’s findings conferred a new discipline on the life science of classical genetics.
  \item Even before 1900, the year in which Mendel's work were rediscovered, William Saunders, Director of the Central Experimental Farm, recognised that new varieties resulted from crossing two plants within the same species, the progeny of which might combine some of the desirable characteristics of each parent. By 1894 he was the first in the world to make an interspecific (between two or more species) cross of apples to develop a hardier variety. Saunders also pioneered the hybridisation of wheat in Canada in 1888 and, by 1901, had produced 58 cultivars. A brief exposition of his hybridisation experiments can be found in Saunders (1894). For a history of field crop breeding in Canada, cereals in particular, see the collection edited by Slinkard and Knott (1995). For a typically institutional history of the Research Branch of Canada’s Department of Agriculture, see Anstey (1986). For accounts of pre-Mendelian hybridisation, and notions of character inheritance, see Zirkle (1935) and Roberts (1965). Bowler (1992) provides an historical account of the development of the life sciences including Mendelism.
  \item Breeding programmes involving hybridisation resulted in a number of achievements such as increased yield in the form of larger fruit size and increased fruit number; improved fruit quality (taste, texture, colour, etc.); modification of the plant and the fruit to facilitate cultivation and harvesting, particularly by machines; and pest resistance (Rick 1976:271). Despite the promises of hybridisation, there were mixed results in the early decades of research. While Driver (1937) reported a 95% increase in yields from hybrids over both parents, Larson and Currance (1944) obtained an increase of 30% over the mean of both parents. Williams and Gilbert (1960) however, found that the best selection from a cross of greenhouse tomatoes were as productive as the F\textsubscript{1} hybrid.
\end{itemize}
for example, the Central Experimental Farm in Ottawa, combined the theoretical insights of Mendelian genetics, the principles of scientific inquiry, and traditional breeding methods.\textsuperscript{145}

Modern breeding methods also resulted in the production of tomatoes for specialised environments such as greenhouses. The tomato plant is hermaphroditic; that is, both reproductive organs – the male stamen and the female pistil, consisting of a style and ovary – exist on the same plant. It is also self-pollinating. Pollination occurs when pollen is shaken off the anthers of the stamen and onto the stigma, thus inducing fertilisation. Incomplete pollination results in diminished fruit production. In the wild, pollination is effected through either insect activity – bees in particular – or the wind, and is facilitated by the extended style as illustrated in Figure 9. In contemporary greenhouses, and as discussed below, pollination is accomplished through the introduction of bumblebees which, in concert with the recession of the style in the flower, has resulted in high rates of fruit set (Casey Houweling, Personal communication). By the middle of the 20\textsuperscript{th} century this style recession, essentially an alteration of the tomato plant’s phenotype through the manipulation of the genotype, had been accomplished through hybridisation and selection.\textsuperscript{146}

\textsuperscript{145} These techniques included the use of plant introductions, i.e., varieties introduced into a new environment; a planned hybridisation programme; the rigid selection of plant material using the best discriminatory means available; preliminary and final evaluation of all characteristics in replicated trials; and testing varieties for local and national use (Adapted from Morrison 1960).

\textsuperscript{146} In some large contemporary greenhouses, and in an ironic mimicking of ‘first nature’, nature services capitalist nature through the agency of the bumble bee as pollinator. See below for a fuller discussion.
Probably the most celebrated example of specialised breeding was the development of a cultivar amenable to mechanical harvesting in California. Tomatoes, whether fresh-market or processing, are thin-skinned, bruise easily, and grow low to the ground, and the individual plants tend to ripen unevenly. These factors did not hinder manual picking. However, the cancellation of the Bracero programme in California in 1965 saw the end of the supply of migrant workers from Mexico, who, under the terms of the programme, were allowed into the U.S. specifically for fruit and vegetable harvesting. There was thus a strong economic impetus on the part of growers to adopt mechanisation. This required a new tomato cultivar that allows the efficient deployment of a mechanical harvester. Developed at the University of California at Davis, plants of the new cultivar had thick skins, all ripened at the same time – only one pass with the harvester was required – and were pear-shaped to aid plucking\(^{147}\) (Rasmussen 1968).

\(^{147}\) For a discussion of the host of new problems generated by the introduction of the mechanical harvester, see Busch et. al. (1991).
A further example of the use of plant breeding to meet the needs of capital, in this instance seed producers, is the inducement of male sterility. As noted above, the value of hybridisation is the generation of the heterosis effect (superiority of the hybrid), encapsulated in the seed of the hybrid plant which is sold to growers. This seed has exchange value only if the potential of the heterosis effect is retained. In a self-fertilising plant such as the tomato, and in a hybrid plant, pollination and fertilisation would result in the dilution of the purity of the hybrid and, consequently, loss of the heterosis effect. Fertilisation must be induced only through pollen from one of the crossed pair of plants. As a consequence, the plant must be emasculated manually, a highly labour-intensive process – approximately 40% of the total labour costs of tomato hybrid seed production is consumed by manual emasculation. In the attempt to prevent both the erosion of the exchange value of the hybrid seed and the reduction of labour needs, plants that display the characteristic of male sterility were bred. Male sterility means that those plants do not produce pollen, but can produce seeds with pollen from other plants. During the 1950s and 1960s, there was continuous research at Experimental Farm Stations in Ottawa to breed hybrids that were male sterile; it was one of the main research areas of their breeding programme (Canada. Department of Agriculture. Horticulture Division 1954). In the attempt to induce male sterility, Mendelian techniques eventually yielded to molecular genetics.

Tomato Breeding In Canada

Systematic tomato breeding in Canada began around 1900 at the Central Experimental Farm in Ottawa. The Central Experimental Farm was the keystone of a network of agricultural research institutions, the Experimental Farm System, dotting the country. Established in 1887, 20 years after Confederation, research farms were first established in Ontario, Manitoba, Saskatchewan, and British Columbia. By the start of the First World War, there were 18 research farms in the country specialising in breeding crops for their particular ecological conditions. The role of the Experimental Farm System was to support the development of a sparsely settled nation in its industrial infancy. A modern ‘scientific’ agriculture was to be the foundation of this development by providing ‘…a stimulus to all other industries of Canada’ (Fowke 1946:223). The modernisation of Canadian agriculture and the concomitant development of agrarian resources were to be accomplished by a systematic and rigorous process whereby extant and potential

148 In the production of hybrid seeds, the male-sterile plants of one parent are planted alongside unmodified plants of the other. The seeds developing in the male-sterile plants therefore can have developed only by the crossing of the two intended parents.

149 The genetic modification approach involves the introduction of genes that are active only in the male reproductive organs and that prevent the emergence of the male flowers. See Allard 1999.
agricultural commodities would be evaluated, tested and improved. New varieties of crops would be assessed for production, breeding programmes would improve the economic potential of plants, new agrarian technologies such as artificial pesticides and fertilisers would be tested and, in the end, the knowledge produced would be disseminated to the wider farming community. Like the botanical gardens of Europe, the Central Experimental Farm collected plant germplasm from around the globe. Unlike European gardens however, the goal was the development of indigenous agriculture, rather than the development and exploitation of colonial agriculture. In particular, plants from parts of the world with similar climatic conditions – wheat from Russia in particular – were imported and tested, and new species and varieties were introduced into the agricultural landscape (Anstey 1986:16).

The particular regime of accumulation within which the Experimental Farm System was established was characterised by the development, primarily, of an export-oriented agriculture centred on the production of wheat in the Prairies. As Jenson notes, wheat was the staple, the engine of economic accumulation:

> Western agriculture provided immense export earnings in addition to a market for the industrial production for eastern factories. Steel and agricultural implements manufacturing as well as railways became an important source of capital accumulation (1990:667).

The centrality of wheat to national accumulation was reflected in the emphasis on its development within the Experimental Farm System, particularly within the research farms in the prairie provinces. 150

Although wheat was under immense scrutiny, it was not the only object of inquiry. Under the direction of W.T. Macoun, Dominion Horticulturist, a breeding programme was initiated to produce tomato varieties suitable for Canada’s climate. In particular, given the short growing season in much of the country, the quality of earliness – that is, the ripening of the crop early in

150 By 1909, a measure of success had been achieved in the breeding of a wheat variety that would thrive in the particular ecological conditions of the Prairies. Marquis wheat, which matured earlier and was more resistant to pathogens than existent varieties, was used on approximately 90% of the land sown with wheat, its use also being adopted by American farmers on the Great Plains (White 1995). Marquis wheat was truly the product of the global exchange of seeds. It was the hybrid offspring of two varieties, Red Calcutta and Red Fife. As its name implies, Red Calcutta was a variety grown in India, imported by William Saunders, the first director of the Experimental Farm System. Red Fife had been imported from Scotland by an Ontario farmer at the end of the 19th century, but its origins were in the Ukraine.
the season – was highly prized. So was hardiness, the ability to withstand extremes of temperature normally crippling to tomato plants. The pursuit of these qualities, along with the expected ones of higher yield, appearance and taste, were the object of rigorous inquiry and practice at the Central Experimental Farm and its various substation throughout the country. The most notable of the varieties having their origin at the Central Experimental Farm was the Alacrity tomato which was derived from the Earliana variety. Macoun’s technique in producing the Alacrity tomato, while consistent with the horticultural episteme inspired by Livingston, was, in Canada, a pioneering effort.

Macoun…was the first to start the selection of plants showing early maturity and heavy yield, saving seed from these plants. After several generations had been grown and seed saved from early maturing desirable plants, it was found that this method of selection had so altered the type of the plants and fruits from the original Earliana, that it was decided to call this segregation "Alacrity". To the settlers of Northern Canada this variety has been a great boon, making it possible to grow tomatoes where they could not have been grown had it not been for these early efforts (Canada. Department of Agriculture 1926:53).

At some point in the 1920s, the work at the Central Experimental Farm shifted its focus to systematic cross breeding (hybridisation), followed by selection, in order to generate plant characteristics with the greatest economic potential. The dilemma faced by horticulturists was that early maturing varieties such as Alacrity and Earliana tended not to grow as strongly as late maturing varieties (Canada. Department of Agriculture 1924c:25). Furthermore, these early varieties, in contrast to late varieties, lacked desirable attributes related to the shape and size of fruit. As noted by the Dominion Horticulturist, the task at hand was:

…the selection and segregation of hybrid tomatoes for the purpose of securing a high-quality, early maturing variety, that may rank in earliness with Alacrity and possess the high quality of some of the later maturing varieties such as Bonny Best and Livingston Globe, as well as combining the sweetness of the fruit of the latter sorts… (Canada. Department of Agriculture 1926).

In general, the hybridisation experiments conducted at the time were considered successes.

151 While, in 1925, the Central Experimental Farm (Canada. Department of Agriculture 1926) in Ottawa was reporting the results of trials of hybrid tomato varieties, the Summerland research station was, in 1924, still testing a variety of selections: "(A) project was begun in 1920 with the idea of isolating superior strains of the Earliana tomato. For several years special attention was paid to securing smoothness in this variety. By 1924 distinct strains which were outstandingly smooth had been isolated but it was found that size and earliness had to a certain extent been sacrificed" (Canada Department of Agriculture 1924a:52).
During the season of 1924 the first generation of plants was grown out-doors in comparison with other commercial varieties. It was noted that hybrids showed considerably more vigour than the original varieties. (Canada. Department of Agriculture 1925).

In 1924, an extensive test of 64 varieties was conducted, including crosses between the most promising varieties such as Alacrity, Earliana, Bonny Best and Livingston’s Globe (Canada. Department of Agriculture 1925).

By the end of the 1920s, and as reflected in the periodic reports emanating from the Central Experimental Farm system, there was a shift in state-sponsored horticultural research in Canada as far as the tomato was concerned. Attempts to increase yield and earliness through hybridisation were supplemented by inquiries into the environmental context of tomato cultivation and into pathologies. For instance, in 1930, a study was made of the relationship between calcium, phosphorous, potassium or magnesium to nitrogen on the growth and yield of tomato plants. (Canada 1930). There was also a simultaneous inquiry into the nature of tomato plant pathologies such as canker, blight and blot. Resistance to such pathologies was, through hybridisation, bred into tomatoes.

The first half of the 20th century was also witness to practical experiments into greenhouse cultivation, although greenhouses were primarily used to start plants early in the season. In 1914, at the Central Experimental Farm in Ottawa, four new greenhouses, heated by boilers, were completed. One of the roles of the greenhouses was to allow year-round cross-breeding experiments, although actual tests – for example yield and hardiness – were conducted in the field. In addition to tomatoes, greenhouse trials of other vegetables, such as cucumbers and lettuces, and of flowers were also conducted. In British Columbia, the greenhouse cultivation of tomatoes had been established early in the 20th century. The relatively mild winters, compared to the rest of the country, allowed the use of greenhouses to extend the growing season and allowed multiple crops within a single year. In 1933, approximately 1.5 million kilograms of tomatoes were grown in greenhouses in the province; this was approximately 10% of the amount yielded through field cultivation (British Columbia 1935). Greenhouse-grown tomatoes, in their

152 Overall growth in greenhouse cultivation throughout the province in this period was steady. The available data reveal that between 1923 and 1939, the cultivated area under glass in the Lower Mainland approximately tripled. The number of growers on the other hand more than increased by a factor of 6.6, suggesting the proliferation of smaller greenhouse concerns. As the statistics of the Department of Agriculture at the time were correlated with the category of race – specifically ‘White’ and ‘Oriental’ – it can be revealed that most of the growth in greenhouse cultivation between 1923 and 1939 was a result
earliness, had a competitive advantage over field-grown tomatoes grown in the province. There was, however, competition from field tomatoes imported from the American South and from Mexico. For example, in 1928 the weight and low price of imported tomatoes compelled British Columbian greenhouse growers to accept lower prices for their product (British Columbia Department of Agriculture 1929).

An evaluation of hybrid greenhouse tomatoes conducted over a twenty-two-year period starting in 1946 in Ontario provides some insights into the nature of both hybridisation and greenhouse tomatoes (Kerr and Muehmer 1969). The project, concerned with the production of F₁ hybrids, evaluated not just yield but also setting ability and disease-resistance, fruit size, shape, firmness, and flavour. While the characteristics of yield, fruit setting and disease resistance were important to growers (and still are), the fact that greenhouse tomatoes were destined for the fresh market rendered the latter characteristics of fruit size, shape, firmness and flavour just as important. Field cultivars, the products of which in Ontario at the time were destined for the processing industry, were found to be unsuitable for greenhouse cultivation. As stated in the report: ‘Many of the hybrids tested in the early years were crosses between greenhouse cultivars or breeding lines and field cultivars such as Earliana, Early Chatham, Early Rutgers, Harkness and Valiant. Almost all were too soft when grown in the greenhouse and were not resistant to leaf mold’¹⁵³ (Kerr and Muehmer 1969:51). In the span of a few decades, the specialised qualities bred into field cultivars, which made them acceptable to the processing industry, were difficult to efface through hybridisation with greenhouse cultivars. The particular needs of the greenhouse industry, dictated by the growing environment and the fresh tomato market, had to be met through a specialised breeding programme.

Plant breeding in Canada was public, that is, organised, directed and performed primarily by the state in the interest of the public good. The contrast can be made with the United States where, as the early examples of Heinz and Campbell suggest, the political economy of agricultural research was characterised by the state’s service to capital (Dale 1981; Kloppenburg 1988). Canada however,

had a public seed system in the full sense of the word. Our seed supply was the result of a free flow of seeds among farmers and formal breeders, within Canada

¹⁵³ Tomato leaf mold is a pathology that primarily affects greenhouse-grown tomatoes, but it can also affect field cultivation in conditions characterised by high humidity.
and abroad. By this time [with the establishment of the Experimental Farm System], a rather loose process of farm-level plant breeding had given way to centralised breeding programs working to develop plants to meet national objectives. The ‘national objectives’ reflected the dominant socio-political forces of the time, but these programs still belonged to the public and the seeds they produced were still in the public domain. Consequently, plant breeding could be reoriented and reorganised through political change (Kuyek 2004:3).

This is not to suggest that plant breeding did not reflect the demands of capital, particularly processors.154

The political economy of seed distribution under this particular regime of accumulation was defined by the free distribution of seeds by the state, regulation governing the sale of seeds, and the presence of the Canadian Seed Grower’s Association (CSGA). The CSGA was established in 1904 and was, from the beginning, run by seed growers. The purpose of the CSGA was to ‘…provide Canadian farmers with clean and genetically pure pedigreed seed of improved crop cultivars’ (Clayton 1995:335) In essence, the CSGA was responsible for the certification of seeds as required by seed regulation. Initially, such regulation, as represented by the Seed Control Acts of 1905 and 1911, dealt with standards of seed purity and germination, and were voluntary. The Canada Seeds Act of 1923, however, required that all seed sold in Canada be certified; certification being administered by the CSGA. The Seeds Act marked the beginning of an intimate relationship between the CSGA and the state. The Seed Division of the federal department of agriculture, for example, inspected seeds, submitted reports to the CSGA who, based on the finding, would certify seeds for the market. The CSGA played a further critical role. Seed developed by the state was given to the CSGA who distributed them to its members, many of whom were farmers, who would then carry out the first two generations of multiplication. Once more seed had been produced, it would be distributed to more members who would carry out further multiplication. When enough seed stock had been produced it would then be certified, registered, and sold to farmers.155 The success of this system of public breeding and the mechanism for the distribution

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154 Again wheat will serve as an example. Technological development within the flour-milling industry had resulted in the widespread transition from stone to steel rollers. as well as towards a continuous semi-automated milling process (Varty 2005). There was, as well, an increased preference for white bread as opposed to darker, coarser and denser breads which had been produced by older milling technologies. White bread requires finely ground flour, production of which was possible through the use of steel rollers, as well as hard wheat, initially Red Fife and then Marquis, for example. The dictates of technological change and consumer preference compelled the Experimental Farm System to develop wheat varieties with hard kernels (DePauw, Broughton and Knott 1995:9). On the whole, however, breeding within the institutions of the Canadian state was independent of capital.

155 Members of the early CSGA who had been growers eventually became breeders. (Clayton 1995:343)
of the fruits of research – through independent growers – is suggested by the fact that most of the tomato varieties adopted for cultivation in Canada, with the exception of much of the processing sector in Ontario, was developed by the Experimental Farm System. (Anstey 1986)

Whither the seed industry at this time? Kloppenburg argues that the seed industry in the United States was, in the first few decades of the 20th century, a weak faction of capital. The link established between the processing industry and the state, coupled with the agrarian ideology of the public agricultural research and extension services – one which resulted in the free distribution of seeds to small, independent farmers – locked the seed industry into a subordinate position. (Kloppenburg 1988:81) Under slightly different conditions, the Canadian seed industry found itself in the same situation. Corporate seed breeding (Heinz and Campbell), a commitment to public breeding, and the central role played by the CSGA in multiplying and distributing seed resulted in the seed industry, represented by the Canadian Seed Traders Association (CSTA), struggling against this political economic complex. Attempts to challenge seed registration, for example, were unsuccessful (Szego 1995). Seed certification represented, to the seed industry, a barrier to product differentiation. Private seed-breeding in Canada only began after the Second World War with the breeding of hybrid corn varieties, and concrete links between the CSTA and CSGA were only forged in the 1960s (Canadian Seed Trade Association 1995).

The tomato has been a model plant for genetic and plant breeding research since the widespread dissemination of Mendel’s discoveries. While laboratory research into the genetic constitution of the tomato began at the beginning of the 20th century, it wasn’t until the 1940s that systematic research began (Rick 1991:2). In the U.S., the epicentre of tomato genetic research was the University of California at Davis where Charles Rick, one of the early pioneers of such research, was based. As a consequence of Rick’s genetic inquiries into the tomato and his construction of the largest collection of tomato germplasm in the world, the foundation was laid for one of the best molecular maps of the plant world. In Canada, the genetic inquiries into the tomato were centred at the University of Toronto. Work on mapping the chromosomes of the tomato was begun in 1920, and by 1947 49 genes or characters had been mapped. The practical focus of the work at the University of Toronto, and subsequently at the Ontario Agricultural College in Guelph, was to enhance the characteristics of canning tomatoes. Up to 1950, the breeding programme at the college was mono-factorial, that is, the relation of a function or trait to a single
gene. In 1955, the development of the Ferguson tomato variety, which carried multiple-factor resistance to fruit cracking, compelled multi-factorial work (Graham 1960).

The advantages to plant breeders of molecular techniques over classical breeding methods are numerous. For seed growers and plant breeders, the reduction in the circulation time of capital allowed through the use of molecular methods are significant. The process of developing ‘new’ tomatoes through classical breeding methods is laborious, often unreliable, and takes between six and ten years (Reinink 2003). The creation of new varieties through the introduction of exotic germplasm takes 20 years or more156 (Gould 1983:50-51). In addition to the time required for creating new varieties, significant land resources are also required. For example, a complex breeding program involving 21 genetic pairs requires 170,000 hectares of tomato plants. (Gould 1983:51) The use of molecular methods such as molecular markers results in a marked decrease in time as well as resources such as land and labour, although these costs are replaced by the need for sophisticated laboratories, highly skilled and educated scientists and technicians and, increasingly, resources devoted to regulatory affairs. Tomatoes seeds currently used for production in North America are not genetically modified due to consumer resistance (Jacob van den Bosche, Westgro, personal communication). However, the use of molecular technologies in breeding programmes represents an instance of the real subsumption of nature. While such technologies do not directly contribute to the attributes of the fruit – yield, appearance, shelf-life, etc. – they do represent, to the capital enshrined in seed-breeding firms, an opportunity to increase turnover time since seeds can be developed in a relatively short time.

Seeds currently used in Delta’s greenhouse industry are developed and produced by European seed companies. These firms include independent Dutch firms such as Enza Zaden, DeRuiter and Rijk Zwaan as well as Dutch subsidiaries of multi-national seed companies Monsanto and Seminis. All greenhouse tomato seed breeding occurs in Holland. As a response to the increased presence of large seed corporations in the greenhouse tomato seed breeding sector, Dutch independents have established a research entity, KeyGene, which specialises in molecular

156 The domestication of crops leads to an eventual narrowing of the genetic base: undesirable traits, and their genes, are gradually exorcised. Consequently, since around 1940, breeders have relied increasingly on exotic sources – particularly related wild species – for desired traits. Since then, accelerated introgression of useful exotic traits contributed to spectacular improvement, manifest in a four- to five-fold yield increase. Nearly unknown in tomato cultivars prior to 1940, resistance to at least 42 major diseases has been discovered in exotics and 20 of them bred into horticultural tomatoes – numbers that are continually increasing (Rick and Chetelat 1995). Tanksley (2004) notes that, despite the immense phenotypic variation, the cultivated tomato possesses less than 5% of the genetic variation of wild species of Lycopersicon.
breeding techniques. This collaborative effort allows smaller firms to remain competitive in a sector currently being transformed. While the labour-intensive process of creating hybrid varieties has been substituted by a technologically-intensive process, the production of seeds remains dependent on a large labour force. Seed production requires that plants be grown and pollinated, and the seeds collected. Until 2005, the Dutch seed industry had depended on China’s low-cost labour force for the production of greenhouse tomato seeds. However, poor quality control standards had resulted in the production of diseased seeds and, as a consequence, the production of greenhouse tomato seeds was repatriated to Holland (Jacob van den Bosche, Westgro, personal communication).

**The Ecology of Greenhouse Production**

In the following section I discuss the process of appropriation that has resulted in the unique ecology of the greenhouse.

**The Appropriation of Soil and its Functions**

I begin by charting one of the more remarkable aspects of greenhouse production, its abandonment of soil as the basis of cultivation. Greenhouse plants are grown in soilless media which merely replicate one of the mechanical functions of soil, that is, a means of holding the roots of a plant. The other functions of soil include its fertility, determined in part by the physical structure of soil, and its chemistry, which allows or disallows the cultivation of certain types of plants. Soil is composed of mineral and organic matter, water, and air. The mineral matter is constituted of a variety of minute rock fragments and the organic matter is a result of the decomposition of plant and animal remains. In the process of decomposition, some of the organic entities are oxidised to their end-products and others to an intermediate product called humus. Both the type and the relative quantity of the mineral and organic constituents of a soil determine its chemical properties which, in concert with solar radiation and water, determine the acidity or alkalinity of soil, that is, its pH level. Given that plants are sensitive to the pH level of the soil, the acidity or alkalinity of a soil historically determined which varieties of plant would flourish in a particular place. The fertility of soil is also dependent on its physical quality. Fertile soil is characterised by the ability to hold the requisite amount of water which, in concert with the salt dissolved in it, provides the essential nutrients for plant growth. The air located in the soil pores

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157 Soil of average quality consists of 45% mineral matter, 5% organic matter, 25% water, and 25% air space.
supplies oxygen for the respiration of root and soil micro-organisms and removes the carbon
dioxide and other gases produced by them (Papadopoulos 1991). It is a testament to both
scientific hubris and capital’s restlessness that an essential component of life has been artificially
replicated and successfully deployed in contemporary greenhouses.

The history of the appropriation of soil then is the appropriation of these functions. Soilless
media, as used in greenhouses, is the appropriation of a discrete element, a means of holding
roots. This requires the manufacture of discrete artefacts – nutrient solutions, which include the
chemicals requisite for growth, monitoring systems (of salinity, chemical compositions), and of
course the mechanical component – which are then recombined, at the greenhouse, in an
approximation of soil. This is the hydroponic component of greenhouse production, one which
allows an unprecedented control over plant growth and which represents a movement towards the
real subsumption of nature.

The industrial appropriation of soil had its origins in the 19th century when the potential for
synthetic fertilisers was discovered.158 For millennia, fertilisation had been accomplished entirely
within the confines of the farm. Animal manure and decomposed vegetation produced on the
farm had served as the means of restoring fertility lost to continuous cultivation. This spatially
bounded system of fertilisation served until the development of capitalist agriculture in the 17th
century. The enclosure movement, the development of market relations, and the intensification of
agriculture led to improved techniques of crop rotation, maturing, drainage, and livestock
management in the attempt to increase productivity. But, with respect to soil fertility, there were
limits to this particular ecology of farming within the context of capitalist agriculture. In the first
place, animal manures were slow acting and had little effect, by themselves, on increasing yield
which farmers, under competitive pressure, were forced to increase. This was a problem
exacerbated by the depletion of nutrients hastened through intensive farming. Secondly, there was
a crisis of manure supply as the demands of cultivation began to outstrip the on-farm supply of
manure, a process that had been initiated earlier as animal husbandry yielded to cereal production
in feudal Europe (Anderson 1974:198). By the 19th century, declining soil fertility was, argues

158 This development was predated by the industrial appropriation of the various implements required for
tilling, ploughing, harvesting, threshing, etc. which led to the emergence of an industrial sector
producing such implements (Cochrane 1993; Goodman et. al. 1987; Rasmussen 1963). My concern here
is with the appropriation of the functions of soil. The use of implements, as a corrective to the effects of
permanent agriculture, soil compaction for example, represents a restoration of the soil’s ability to
perform certain functions.
Foster, the ‘…the chief environmental concern of capitalist society throughout Europe and North America…’ (2000:149). This crisis, as Foster reveals, animated Marx who situated it within the context of the development of capitalism in the West. Marx argued that declining soil fertility was the result of a ‘metabolic rift’, that is

(I)t [capitalist production] prevents the return to the soil of its constituent elements consumed by man [sic] in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil...All progress in capitalist agriculture is a progress in the art, not only of robbing the worker but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress toward ruining the more long-lasting sources of that fertility (Marx 1976: 637-638).

This metabolic rift was not the result of just the intensification of agriculture but also of the spatial character of capitalist production. The simultaneous development of industry and of industrial agriculture, the latter serving the former in the form of cheap foodstuffs for industrial labour, witnessed a large-scale migration of labour, compelled by the enclosure movement, from the country to the city. This led to a disruption of the ecological relationship between pre-industrial farming and the land. In essence, these farms functioned within the limits of their local ecologies. Production was for local consumption – the export of food and fibres is cited by Marx as a contribution to the crisis – and wastes were returned to the soil thus completing a virtuous cycle of replenishment.159

There were two responses to this crisis in the 19th century. The first was the adoption of guano, deposits of sea birds found along the coast of South America, Peru in particular, and of saltpetre (sodium nitrate) deposits in Chile. By the mid-19th century, guano and saltpetre were being imported into both Europe and North America and had become the most important fertilisers due to their ability to significantly increase yield, a function of their nitrogen content (Hillel 1991).160 However, trade disruptions and war made the supply unreliable, and transportation and scarcity made guano and saltpetre expensive. A simultaneous development was the extraction of fertiliser

159 This is not to argue that so-called ecological crises emerged only under capitalist conditions of production. Hughes (1996) cites examples of such crises within antiquity. And Anderson (1974) argues that the crisis of feudalism was as much about ecological degradation as it was about social relations.

160 The importance of capitalist agriculture, imperialist competition, and the need to find new sources of fertiliser drew both the British and American states into the hunt. In Britain, the Royal Navy was charged with searching the world for sources (Cordle 2007) which, when they found guano in Peru, they then monopolised. The United States, in an attempt to challenge this monopoly, passed the Guano Act of 1856 which gave American capitalists the power to seize uninhabited island with guano deposits (Mazoyer and Roudart 2005). Sixty islands were seized in this manner between 1856 and 1903. The history of guano use in Canada has yet to be written.
through the manufacture of superphosphates. Ground bones and rocks containing phosphorus, one of the elements necessary for plant growth, were treated with sulphuric acid to yield a compound that could be utilised as fertiliser. The production of superphosphates, in both Britain and the United States, while not synthetic, marked one of the first instances of the appropriation of one of the functions of soil. By 1880 in the United States, fertiliser firms were combining guano, superphosphates and potassium from potash in various combinations as a complete package (Wines 1985). Despite the significance of these developments, such fertilisers, in widespread use well into the first half of the 20th century, were still dependent on ‘found’ materials, which were relatively scarce, and, in the case of phosphates and potassium, had to be subjected to further processing.

These developments in the manufacture of fertiliser were founded on a discovery made by Justus von Liebig (1803-1873), a German chemist, of the nutrients necessary for plant growth. In 1840, Liebig published his *Organic Chemistry in Its Applications to Agriculture and Physiology*, commissioned by the Royal Agricultural Society, in which he demonstrated that plant growth was not a result of humus (composted organic matter) in soil but of the presence of nitrogen compounds, carbon dioxide in the air, and minerals such as potassium and phosphorus. Liebig’s findings, by identifying these essential nutrients, acted as a fillip to the emergent discipline of soil science – the Royal Agricultural Society was established as a response to the crisis in agriculture and its earliest mandate was to seek a resolution to soil infertility – which led to the discovery of the elements and compounds described earlier (Foster 2000). Despite Liebig’s discovery, the development of a means to manufacture artificial fertiliser did not occur until 1909 when Fritz Haber (1868-1934), another German chemist, discovered a means of producing synthetic ammonia from which nitrates could be derived. In 1913, the German chemical corporation BASF started commercial production of artificial nitrates. As Goodman et. al (1987) note:

> This innovation, which created a major new world industry in the inter-war years, represents a revolutionary advance in the industrial appropriation of the natural cycles of agricultural production…The ammonia synthesis is the culmination of the long struggle to bring the supply side of the ‘nitrogen economy’, the major determinant of crop growth in intensive systems, under direct industrial control (1987:31).

The spectacular productivity yields of Fordist agriculture were, in no small part, due to the availability of synthetic nitrogen based fertilisers (Smil 2004). Synthesised nitrogen, along with phosphorus and potassium which continue to be mined from deposits, are the three most important elements for cultivation, and now constitute part of the suite of inputs produced by
industrial capital. This appropriation is complete. The agro-chemical industry, which produces pesticides as well, is dominated by a handful of corporations. In 2004, six firms – Bayer, Syngenta, BASF, Dow, Monsanto and DuPont – controlled 77% of the worldwide market for agro-chemicals and had sales of over US $ 25 billion (United Nations Conference on Trade and Development 2006). These chemicals are used in the greenhouse industry. In the following section, I illustrate the process through which the soil itself, as opposed to its discrete functions, are appropriated.

The Abandonment of Soil as the Basis of Cultivation

As noted earlier, soilless media, or hydroponics, is one of the defining characteristic of contemporary technology intensive greenhouses. Prior to the use of hydroponics in large-scale greenhouses, soil management was a highly labour intensive activity. As David Ryall of Gipaanda, who has practiced greenhouse agriculture since 1967, notes:

> Each year we had to replace the soil in the greenhouse for sanitary reasons. The whole greenhouse had to be cleaned. We brought new soil in and then we had to treat it with methyl bromide and steam it. It was a lot of work. (Personal communication)

Furthermore, over the production period, the two-foot layer of soil would physically break down and would require amendment in order to allow the next production cycle. But the build-up of soil borne pathogens introduced thorough contaminated plants and personnel necessitated a complete annual replacement. David Ehret, an Agriculture Canada greenhouse crop physiologist notes that this time-consuming annual clean-out ‘…prevents year round production’ (Personal communication). From the perspective of the Mann-Dickinson thesis, despite the extension of the growing season enabled by greenhouses using soil as a growing medium, the inherent risks of agricultural production, which include disease, remained present and were exacerbated under less sophisticated conditions of greenhouse production (David Ehret, personal communication). Thus, despite the fact that cultivation took place within a greenhouse, the rural labour process associated with agriculture with respect to soil preparation and enhancement had yet to be appropriated by off-farm concerns. Given the spatial constraints represented by a closed greenhouse with a relatively small footprint, the mechanisation of soil preparation – tractor 161 The use of soilless media is universally, and confusingly, referred to as hydroponics. This implies the absence of any solid media in plant cultivation. While such systems exist and are used by commercial greenhouses, particularly to grow lettuce, they are referred to as nutriculture or nutrient film technology (NFT). In general, usage of the term hydroponics implies the use of some sort of growing media for the replication of some of the functions of soil.
powered ploughing, tilling, harrowing – possible within extensive cultivation, was not available to greenhouse growers. The further limitation of soil-based greenhouse agriculture was that yields per crop-cycle were not that much greater than those produced by open-field cultivation. Casey Houweling of Houweling Nurseries states that ‘….although we could have more harvests…our yield wasn’t that good’ (personal communication). Greenhouse production based on soil had had partial success in overcoming the nature-centred obstacles to capital. In particular, the number of turnovers of capital was increased as a consequence of the extension of the growing season, and the risks attendant with weather and climate – frosts, drought, hail, wind, rain, were ameliorated. As a particular hybrid of protected agriculture and open field agriculture, however, soil-based greenhouse production created its own set of obstacles.

While there are still greenhouse, usually small, which use soil as a medium, it will be argued below that the use of soilless media allows the scale and intensity, and consequent yield, which define modern greenhouse production. In other words, the real subsumption of nature. Soilless media are not a recent intervention. Towards the end of the Renaissance, scientists interested in identifying the nutrients required by plants, and their source, conducted experiments with plants grown in containers in which a small amount of soil was dissolved in water. These early experimenters correctly concluded that nutrients, which had yet to be identified by Liebig, did indeed come from the soil, but they failed to realise that they needed carbon dioxide and oxygen from the air. In 1699, John Woodward (1665-1728), an English naturalist and geologist, grew plants in water containing varying quantities of soil and found that the greatest growth occurred in water with the most soil. Rather than concluding that the nutrients were contained in the water itself, Woodward postulated that the nutrients were contained in the soil and had been dissolved by the water.

The next significant advance occurred in 19th century France, when Jean Boussingault (1802-1887), building on Liebig’s discovery of the centrality of nitrogen to plant growth, identified the mechanism of the nitrogen cycle; that is, the path of nitrogen as it cycles between living organisms and the environment. The significance of Broussignault’s work was the discovery that humus, as opposed to soil, was not necessary for plant growth.

162 Most of this section on the history of hydroponics is derived from Gericke (1937) Resh (1995) and Savvas (2003).
163 The cycle proceeds as follows: Organic material decays and forms ammonia; bacteria use nitrogen from ammonia or from the air to make nitrate compounds; nitrates are absorbed by plants and used to make proteins; plants are eaten by people and other animals; and when plants and animals die and decay, their nitrogen compounds are recycled to the soil.
Nineteenth century Germany was then witness to a discovery, by German botanist Julius von Sachs (1832 –1897) that marked the dawn of modern hydroponics as characterised by the complete abandonment of soil as a medium. What Sachs had established was that plant growth could occur normally without soil through the immersion of the roots in a nutrient solution. This discovery also had the effect of confirming Liebig’s findings that certain elements are necessary for plant growth. But the greater precision of Sach’s work allowed him to identify seven more elements that were also required by plants, albeit in minor quantities. In effect, through these discoveries, Sachs developed the technique of preparing nutrient solutions – particular combinations of chemicals – tailored to the individual requirements of plants. Thus, between the mid to late 19th century and the early 20th century, once the defining mechanics of soilless plant propagation had been identified, scientific inquiry was oriented towards the refinement of nutrient solutions and their practical application. This took the form of determining the quantities and relative proportions required by particular plants for optimal growth. Given the impediments of soil culture – structural deterioration, loss of fertility and soil borne disease – there was also a stirring of interest in commercial greenhouse growers in the potential of the new technology. These developments were motivated, in part, by the deleterious effects of capitalist agriculture that had been recognised by, inter alia, Marx and Liebig. In particular, the expansion of agriculture was increasingly bringing marginal land into production, population growth and the migration of rural labour into the cities was creating a crisis of nutrition, and intensive cultivation was having a deleterious effect on the mechanical properties of the soil. Velho and Velho (1997) argue that the institutionalisation of agricultural scientific research – many of the earlier experiments had been conducted in private facilities – through the establishment of university departments and state agricultural experimental farms in 19th century Europe was a response to the general crisis of European agriculture and the more particular local crises of food production and nutrition.

In 1937, the term hydroponics was coined by Frederick Gericke, a soil scientist at Berkley who had witnessed the success of commercial greenhouses using sand and gravel as a soilless medium.

164 One of Boussingault’s concerns (Aulie 1970)
165 This institutionalisation was uneven. While the process had been completed in Germany by 1862, state sponsorship of agricultural research in England did not begin until just before the First World War (Velho and Velho 1997).
Thus further evidence has been established that production of certain crops without soil is practicable and it appears that the introduction into the economic field of a new method of production, essentially another origin of agricultural crops, may well be considered as the birth of a new art and perchance a new science which should be designated by a distinctive name. (emphasis added) (Gericke 1937:177)

Gericke’s publicising of the technique and subsequent research by state agricultural researchers caught the attention of growers. However, hydroponic systems of the time utilised concrete beds for holding the medium and the cost of such beds prevented the technology's widespread adoption (Jensen and Malter 1995). With the development of mass produced and affordable plastic film in the 1950s, there was a resurgence in interest in hydroponics since the plastic could replace concrete as a waterproof barrier. This was followed by the rapid growth of the industry, particularly in Europe and Asia and in arid climates in California, Arizona and the Middle East (Jensen and Malter 1995). One British Columbian innovation during this period was the successful substitution of sawdust for soil in greenhouses. In a response to the presence of soil borne disease in greenhouse tomato crops, researchers at the Experimental Farm Research Station in Saanichton on Vancouver Island, used bags of sawdust, readily available on the West Coast, to anchor tomato plants which were then automatically fed a nutrient solution. In the 1970s, sawdust was ‘...used by nearly all growers in many parts of Canada and the United States' (Antsey 1986:140). However, the energy crisis which began in 1973 had the effect of increasing greenhouse heating and cooling cost to an untenable level, which led to a general decline in the industry and associated research efforts.166

There was one exception to this general trend, the Netherlands, where greenhouse cultivation was a significant component not only of the agricultural sector but of the national economy as well, and which continues to be the epicentre of the world's commercial greenhouse research. Responding, again, to problems with greenhouse soil – which, as discussed in Chapter 3, took place within the second food regime characterised by Fordist production – Dutch horticulturists began experimenting with rockwool – sawdust being a relatively scarce commodity in Holland – as an inert growing medium. Rockwool is an energy and resource-intensive industrial product requiring a number of complex manufacturing stages including melting, binding with industrial adhesives, and curing. It is made by melting a combination of basalt rock and sand and then spinning the mixture to make fibres. The advantages of rockwool included its sterility, guaranteed

166 The crisis did, however, have the effect of spurring research into greenhouse energy conservation. For example, the Research Branch of Agriculture Canada contracted 39 projects during the 1970s aimed at reducing energy costs. (Antsey 1986:164-165)
by its manufacturing process which involved temperatures as high as 1600° Celsius, and its hydraulic properties, that is, its ability to hold water in suspension and releasing it as required by roots (Schmidt et. al. 2004). The use of rockwool had a massive effect on hydroponic greenhouse cultivation in the Netherlands: in 1976 there were five hectares of soilless grown crops, eight years later there were 1,500 hectares, 2,500 by 1989 and 41,000 by 1996 (Savvas 2003).

Rockwool was first adopted in British Columbia in the mid-1980s by Houweling in Delta and rapidly became the standard medium for soilless cultivation in the area (Resh 1995). Rockwool's displacement of sawdust as the preferred medium was due to the latter's disadvantages. These included the tendency to accumulate salts to a level toxic to plants, the necessity of sterilising before use, and a tendency towards decomposition which requires the periodic addition of new sawdust (Resh 1995:345).

However, within contemporary greenhouse production, rockwool has been replaced by coconut derived coir pith. Coir, produced primarily in India and Sri Lanka, is a by-product of the food industry: the husks of the coconut fruit are composted, soaked in water for six week and then mechanically spun into yarn (Hanson 2003). The by-product of this process is coir pith or dust that is combined with shorter fibres through mechanical processes. Coir’s ability to hold more water and oxygen than rockwool, and its effective but partial mimicking of soil without the disadvantages, has resulted in a widespread adoption by the commercial greenhouse industry. The shift from rockwool to coir is an interesting case in terms of the dynamics of appropriation and the subsumption of nature. The industrial production of rockwool – composed of basalt, sand and significant amounts of energy – is founded on a logic of extraction, of the formal subsumption of nature. Coir on the other hand is based on the logic of cultivation since it is harvested from coconuts grown on plantations. The real subsumption of nature represented by these plantations however, is driven by the production of coconuts for their food content rather than their fibre content. Whether the market is large enough to compel the real subsumption of coconut trees for their fibre content remains to be seen.

The current use of artificial media in greenhouses represents the complete appropriation of soil by off-farm concerns. Industrial inputs in the form of soilless media are reintroduced into the greenhouse. But the appropriation of the soil also represents the appropriation of a discrete component of a natural production process, that is, the soil’s function as a crucible of plant growth. This requires then, the reintroduction into the greenhouse of nutrients, which, combined with the mechanical function performed by soilless media, results in the whole required for plant growth. Nutrients, supplied by the agro-chemical industry, are introduced into the greenhouse
environment through a computer-controlled system of pipes. The soilless media, into which the plant has been introduced, sit in large troughs through which nutrient solution flows. The nutrient solution, the exact composition of which is calculated by the head growers— as Gary van Stolen of Millenium Pacific notes this is ‘…more of an art than a science’ – is introduced into the system based on a series of sensors that continuously measure the quality and quantity of solution.

What of the control over plant growth that David Ryall, quoted earlier, so admires? In chapter 4, I made the argument that the Netherlands had established itself as the global centre of greenhouse research and production. Three times a week, greenhouse growers in Delta courier a sample of their plants to commercial laboratories in the Holland for analysis. These labs analyse, among other things, the presence of certain nutrients and their proportions, and the results are delivered through the internet (Gary van Stolen, personal communication). Based on the results of this analysis, interpreted by growers, changes can be made to the nutrient solution as well as to its rate of release into the troughs. This allows a very precise control over this nature-based production process, one that could not be replicated in open fields. The argument can be made that greenhouse production is the most accomplished instance of the real subsumption of nature with respect to plant growth.

Given this control over the production process, achieved through the appropriation of discrete components, does nature still pose an obstacle to capital as proposed by the Mann-Dickinson thesis? Van Stolen observes that,

> There’s a state of emergency always around the greenhouse because we’re growing in these coir bags, these growing medium bags and if the irrigation is off for an hour, you lose your crop.

There are other examples which will be discussed below, but this suggests that the artifice that is technologically intensive greenhouse production, while representing a mastery over certain other ‘natural’ obstacles, is itself vulnerable. This ‘new’ vulnerability is itself a result of the particular process of appropriation, and the particular recombination of the discrete elements of the production process in the greenhouse, that currently characterises contemporary greenhouse production.

**Beneficial Insects**

Contemporary greenhouse production in Delta is characterised by the use of biological agents, as opposed to synthetic pesticides, as a means of controlling pests and pathogens. Biological
controls are primarily predatory insects introduced into the growing environment to prey on a specific pest.

The purpose of this section is twofold: a) to develop the argument that the use of biocontrols is determined by a specific mode of social regulation within Canada which precludes the use of chemicals in greenhouses. This is a further example of the link between regulation and capital’s nature. And b) to demonstrate that despite the seemingly esoteric character of biocontrol there has been a process of appropriation. But this has been a curious process of appropriation in which the relationship between nature and capital is reconstituted in novel forms. Furthermore, there is a tendency towards concentration within the biocontrol supply industry.

As an introduction to the section, I begin with a brief discussion of biocontrol use in local greenhouses. Due to the complexity of the issues, generated by the large number of pests and pathogens within greenhouse systems, I will focus on the biological control of one of the more ubiquitous pests, the whitefly. The whitefly is pervasive, found in most of the world, and feeds on approximately 250 species of plants (Osborne and Landa 1992). Adult whiteflies are small, winged, white insects about 1.5–2 mm long. They get their name from the coating of white powder that covers their wings. Eggs are laid on the underside of the youngest leaves, and are too small to be seen clearly without the aid of a microscope. A female whitefly may lay up to 300 eggs during her lifetime, and live as long as 42 days (Lang and Bronson 1981). The Solanaceae family of plants – which includes the primary greenhouse crops tomatoes and peppers – is one of the main targeted groups. Climatic conditions along the west coast of North America, along with an abundance of crop and weed species suited for its propagation, have facilitated the recent explosion in summer populations of the whitefly (Wintermantle 2004). Whiteflies can only thrive outside in hot conditions, but once introduced into greenhouses, find an ideal environment independent of season. Greenhouses are infected by the pest either by introduction through contaminated seedlings or through openings such as ventilation flaps.167 Whiteflies damage plants by sucking fluids from leaves, distorting and shrivelling them which consequently stunts plant growth. The clear, sticky residue excreted by the insect on to leaves and fruit results in the development of black, sooty mould fungi which reduces photosynthesis and compromises the appearance of the tomato fruit. In addition, the whitefly is a carrier or transmitter – entomologically speaking, a ‘vector’ – of specific strains of crinivirus genus. (Wintermantle

167 One tomato greenhouse in California lost an entire crop in 2001 through whitefly infestation, the result of a tear in the screen over a ventilation flap. (The source of this information requested confidentiality)
The virus has the effect of yellowing leaves which interferes with the photosynthetic ability of the plant thus leading to reduced plant vigour and yield.

Whiteflies can be controlled either through chemical pesticides or by biocontrol agents. Delta’s greenhouses use the latter. The agent of choice is a wasp, the female *Encarsia formosa*. They are tiny, less than 1mm in length, with a dark brown to black head and thorax and a bright yellow abdomen. The female will locate a whitefly pupa and lay an egg: the parasite develops inside the pupae consuming it in the process. Once a new adult emerges from the pupa it repeats the process. (Hoddle and van Driesche 1996). *Encarsia formosa*, by destroying the pupa, also has the effect of destroying the vector for the viruses that whiteflies carry.\(^{168}\)

The control of pests through biological controls is not new. For example, systematic entomological research into the biological control of pests in Canada began in 1882, when the Director of the Central Experimental Farm, William Saunders, imported a species of insect which, by laying its eggs in its targeted pest, parasitized it. Parasitisation occurs when the predator occupies and consumes its host. Most of these early efforts consisted of introducing an exotic species to control a pest that was itself exotic (Anstey 1986). Biological-control research specific to greenhouses was initiated in 1935 when, coincidentally, the natural predator or parasitoid of the whitefly, *Encarsia formosa*, was imported from England and mass produced at the Research Institute for Biological Control in Belleville, Ontario. Between 1938 and 1954, approximately 18 million parasitoids were dispatched to Canadian greenhouse growers\(^{169}\) (Elliot 2005:2). This research into biocontrol was compelled, in part, by the relative inefficiency of chemical pesticides at the time. These early pesticides, like the pre-synthetic fertilisers, were derived from minerals such as copper, sodium, mercury, tin and arsenic. Their efficacy was compromised by their indiscriminate toxicity to both pestilential and beneficial creatures. Their relative scarcity, cost, and labour-intensive quality restricted the use of these chemicals to space-intensive, high-value crops – fruit trees for example. The availability of DDT in 1945, a product of military research, heralded a new era of pest control and led to the development of a whole host of organochlorines which were deployed in the fight against pests. Organochlorines, which are completely synthetic, severed pesticide production from nature, its constituent elements were

\(^{168}\) Insects are not always so easily pressed into their new, appropriated roles. For example, attempts to genetically modify *Encarsia formosa* to increase its resistance to insecticides, its fecundity, and performance have failed. (Hoddle et. al. 1998)

\(^{169}\) As Anstey (1986:68) notes, there were impressive achievements in other entomological areas: ‘In 1938, for instance, the laboratory reared 175 million parasites representing 14 species for release in eastern provinces against the European spruce budworm (an increase from 2.5 million raised in 1935!’)
not the production of extraction (mining), and eased the path towards a more complete appropriation. While the widespread adoption of synthetic pesticides such as DDT in the 1940s led to a decline in the use of biocontrols, it created its own set of contradictions.

During the 1960s two events occurred which were to have a galvanising effect on the nascent environmental movement. The first was the publication of Rachel Carson’s *Silent Spring* in 1962, which documented the deleterious effects of pesticide use on both human and animal health. The second was the publicising of the consequences, primarily birth defects, of widespread mercury poisoning in Minamata. As a consequence of these and subsequent events, there was a resurgence of interest in biological control agents on the part the Canadian state. The resumption of the mass production of whitefly parasitoids (insects whose larvae are parasites that eventually kill their hosts) in Ontario in the early 1970s signalled this resurgence. In British Columbia, research was initiated into biological control agents at Agriculture Canada’s Research Station in Saanitchson, the fruits of which were distributed free to growers. Elliot (2005) notes that in 1985, 38% of greenhouse tomato growers in British Columbia had adopted biological control as part of an Integrated Pest Management strategy; twenty years later it is 100%.

Why this wholesale adoption of biocontrol agents in Delta? The short answer is that growers don’t have any choice due to the current pesticide regulation regime. The Pest Control Products Act, administered by the Pest Management Regulatory Agency (PMRA), dictates that all pesticides in the country must, in the interest of human and environmental safety, be registered for use. However, the spatiality of greenhouse production, particularly the concentration of labour, mitigates against the use of pesticides which have been approved for open cultivation. Thus, although pesticides have been registered for use against whiteflies, these pesticides cannot

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170 See Paehlke (1989). See Casida and Quistad for a history of the development of chlorinated pesticides such as DDT.

171 IPM is distinguished from pure chemical pest control by the integration of biological control agents in the pest control regime. It is thus a combination of both chemical and biological control. IPM is adopted as a strategy by growers making the transition from conventional to organic agriculture and, voluntarily by conventional growers for reasons of sustainability and economics. A survey commissioned by the British Columbia Ministry of Agriculture, Food and Fisheries on the adoption of IPM in the province found, for example, that 85% of field crop cultivation was characterised by some degree of IPM. (MacDonald 2003). A further result in the adoption of IPM is the tendency of pests to develop resistance to chemical controls.

172 In the Netherlands, consumer awareness and resistance to pesticide accumulation in foods coupled with stringent European Union directives resulted in the adoption of biological control. This presented an opportunity for capital to commence the industrial production of beneficial insects. The Spanish case is different. Indiscriminate pesticide use by Spanish growers, compelled in part by the relative crudity of their greenhouses, led to a build-up of resistance in pests to chemicals. As a consequence, Spanish growers had little choice but to adopt biological controls.
be used inside greenhouses due to concerns over their effects on human health.\textsuperscript{173} The unavailability of effective pesticides for greenhouse production, of lower toxicity to humans, is a function of the political economy of pesticide production. In the larger scale of things, and compared to open-field agriculture, the spatial extent of greenhouse production is relatively small. Given the cost of the development of pesticides and of registration within particular regulatory regimes, and weighed against potential returns from their adoption by greenhouse growers, the agro-chemical industry has eschewed the production of pesticides which might be used in Canadian greenhouses. In the United States, and although biocontrols are used in that country, the relatively liberal, or more responsive, regulatory regime permits the use of open-field pesticides in greenhouses. However, newer chemical pesticides have been developed which could be safely used in the greenhouse but are restricted by the PMRA. To some growers, such as Jonathan Bos of BC Hot House (now Village Farms), this is a source of chagrin.

The ability of the Canadian grower’s facility to have access to the best chemicals is very, very limited. Europeans and even our American counterparts have vastly better tools at their disposal. We have a regime which is not at all that facilitatory to new chemistries (Personal communication)

Bos argues that the newer chemical pesticides, which are more specific in their targets and do not persist in the environment for as long, should be registered by the PMRA. But again, the cost of registration, and of field trials which may last as long as four years, represent a significant barrier.\textsuperscript{174} At best, greenhouse growers in Canada can only use registered pesticides, registered for uses other than greenhouses that is, under emergency situations. However, the approval for the use of pesticides under such conditions may take as long as three weeks (David Ryall, Gipaanda Greenhouse, personal communications).

While biological control agents have been forced upon the Canadian greenhouse industry, their use represents an appropriation of the agricultural labour process. This has not resulted in a reduction of labour – pest control had already been appropriated through the industrial production of agro-chemicals. Whereas the application of chemical pesticides to greenhouse crops is initially more labour intensive – every plant has to be sprayed – the use of biological controls requires greater monitoring – at least once a week – after \textit{Encarsia formosa} has been

\textsuperscript{173} There are currently only 19 pesticides registered with the PMRA for use on greenhouse tomatoes.

\textsuperscript{174} Bos suggests that one possible avenue for facilitating the use of new chemicals in Canadian greenhouse is through a harmonisation program involving the Organisation for Economic Cooperation and Development. Given both Canada and the United States’ membership in the OECD, for Bos this should be sufficient for registration in Canada without having to conduct trials.
released. If the monitoring detects an increase in pest population – a certain minimal population level is required for the biocontrol agent to feed on and thus reproduce – the release rates of *Encarsia formosa* are increased. What biological control has resulted in is the de-skilling of the labour process. Under the current pesticide regulatory regime, and in the interest of health and safety, pesticide application can only be accomplished by a licensed technician. Biological controls, in contrast are relatively simple, consisting in placing, throughout the greenhouse, packages of whitefly pupae. Before I discuss the industrial appropriation of biological controls, I must introduce another insect that has had a significant impact on greenhouse production. This is the bumblebee and its role in the pollination of greenhouse plants.

Both reproductive organs are contained within a single tomato flower. In order for pollination to occur, pollen from the male organ (anthers) must be dislodged on the female organ (stigma). In the open, pollination is usually accomplished by the action of the wind or through the agency of bees. In order for proper fruit development to occur, complete pollination must be effected, particularly in the context of an intensive production system. Prior to the introduction of bumblebees to the greenhouse, pollination was accomplished either through the use of mechanical vibrators that would stimulate the anthers at a specific frequency, or through the generation of an artificial breeze. Pollination through the disturbance of the greenhouse atmosphere is not very biologically efficient, and if accomplished manually, tomatoes must be pollinated three times every other day. One study reveals that the manual pollination of a greenhouse tomato crop in 2.1 hectare facility in British Columbia took two full time employees (Resh 1995). Given that there are approximately 112 hectares currently under production, around 100 employees devoted to the act of manual pollination would be required by the local industry. Labour costs, issues with labour supply, and the possibility of increased yield compelled the industry to adopt bumble bees as an agent of pollination. (Velthuis 2002)

The discovery of the utility of bumble bees in industrial greenhouses is relatively recent and occurred in Belgium. In 1985, R. de Jonghe, a veterinarian with interest in bumble bee taxonomy and an experienced breeder, made his first observations on the value of the bumblebee at his home greenhouse. He then convinced a commercial grower in Holland to test the efficacy of the bumble bee as an instrument of pollination. As a result of the experiment, its success at the complete pollination of the flower, the grower produced fruit of a significantly higher yield and quality that fetched record prices (Velthuis 2002). de Jonghe's success, which, in a few years, had resulted in the wholesale adoption by Dutch greenhouse tomato growers of the bumble bee, led
him to the industrialisation of bumble bee production. In 1987 de Jonghe founded Biobest, now one of the world's largest biological control and pollinator companies.

Why bumble bees? In Peru, the native habitat of the wild progenitor of the contemporary tomato, pollination was accomplished by a species of bee specifically adapted to the task (Rick 1978). This bee, however, failed to accompany the tomato in its global dispersion (see Chapter 2). As a consequence, tomato pollination was either left to contingency in the form of an appropriate breeze or by an insect not adapted to the task, or through breeding exercises that attempted to reconstruct the morphology of the tomato flower. As discussed in Chapter 3, morphological change involved the adjustment of the relative sizes and positions of the anthers and stigma to aid the trajectory of pollen from one to the other.. However, the complete pollination that resulted from the evolutionary pairing of the original tomato and its bee could not be replicated on the scale of industrial production without the deployment of labour.

The secret of the bumblebee is its ability to ‘sonicate’, in other words, its buzz. Sonication is the result of the vibration of the wing muscles without flight. Once the bee attaches itself to the tomato flower, the vibration shakes the pollen off the anthers onto the bee’s body and into the stigma (Westerkamp and Gottsberger 2000). While other bees such as the honey bee also sonicate, they lack the particular fit that de Jonghe stumbled upon. Tomato flowers do not produce nectar which honey bees, unlike bumble bees, tend to seek. The only way a honey bee can be compelled to visit a tomato flower in a greenhouse is through population pressure which forces it to seek nectar in extraordinary plants, such as tomatoes. The bumble bee’s visit to tomato flowers is for the collection of pollen rather than nectar (McGregor 1976). In addition, bumble bees are active in a wider range of conditions related to humidity and light, which is of significance to Delta’s greenhouses. The use of bumblebees represents a classic instance of the appropriation of the labour process, albeit within a particular form of capitalist agriculture. However, most examples of appropriation involve the industrial production of machines or synthetic chemicals. In the next section I demonstrate that living organisms – the bumblebee, Encarsia formosa and other beneficial insects – have also been subjected to an industrial production process. M. Harvey et. al. (2002:119-120) offer a description of the production of Encarsia formosa:

At the Novartis Great Hawkesly [United Kingdom] production site, there are several large glasshouses full of tobacco plants, the ideal plant for whitefly infestation...the whitefly larvae-infested plants are then taken into Encarsia wasp breeding glasshouses, which [the wasps] then parasite the larvae. The Encarsia
develop and are themselves harvested. A continuous wasp production process is established, with a turn around of plants and insects, all at different stages of development, between different glasshouses.

The pupae are then packaged by gluing them to cards which are hung throughout the greenhouse.

The mass production of tomatoes requires the mass consumption of beneficials which, in turn requires their mass production, up to 50 million a week in Europe alone. (Fravel 2005:378)

The supply of biological control agents to the region’s greenhouses used to be local. Don Elliot (2005:2), who owns Applied BioNomics in Nanaimo comments on the changes in the industry:

The development of successful biological control programs is long-term work: from research and development through to commercialisation requires 5-10 years or more. This fact, along with high local production costs and inefficiencies of scale has limited the number of biological production facilities in Canada to four…(T)hus the majority of biological control agents currently used in Canadian greenhouses are produced offshore by the three largest multinationals: Koppert, Biobest and Syngenta Bio-line.

Biobest, based in Belgium, has facilities throughout Europe and one in Canada, located near the centre of greenhouse production in Ontario, and Koppert, based in the Netherlands, has subsidiaries in 11 countries including Spain, Mexico, Canada and the United States. The third entity, Syngenta Bio-line, is a subsidiary of Syngenta, one of the largest agri-business concerns in the world. In 2004, Syngenta’s sales from seed alone was US$1.2 billion (ETC Group 2005).

Elliot’s company, Applied BioNomics had established a sales and marketing agreement with Evergro, the largest supplier of inputs for the greenhouse industry in Western Canada. As Bruce Vance, the Marketing Director of Evergro, notes, the changes within a greenhouse industry forced certain changes on the biocontrol supply sector:

Quite a number of years ago we took a focus on biologicals and partnered with BioNomics…We were in early [the biocontrol sector] but Koppert emerged and competed basically on price…we’re not as big a player…a lot of competition by price has limited our penetration in that market (Personal communication)

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175 Traditionally a producer of agro-chemicals, Syngenta’s presence in the biological control market place, and its ascendance, can be explained by its acquisition of a biological control producer in England in 1992. The tack taken by agri-business, in general, with respect to biological control is to rely on their biotechnology expertise. Rather than develop biological control agents, corporation have developed, and offer as an alternative, genetically modified plants which ‘display’ biological control properties (Altieri et. al. 1997).
The appropriation of labour processes related to pest control and pollination within greenhouse has resulted in the industrial production of living organisms. With respect to pest control, appropriation was a consequence of regulation rather than an attempt to reduce labour costs. Manual pollination however, which is highly labour intensive, was replaced through the industrial production of the bumblebee. In the next section, I consider the ecology of the greenhouse in its totality.

The Ecology of the Greenhouse

The growing environment of technologically sophisticated greenhouses offers a measure of control over agricultural production that is unprecedented. As discussed in Chapter 4, the greenhouse industry in the Netherlands, as a response to a crisis in labour supply, adopted computers as a means of controlling growing conditions. These developments, and their subsequent refinements, have been adopted wholesale in Delta. Temperature, humidity and carbon dioxide content of the greenhouse atmosphere are controlled automatically, based on parameters supplied to the computer. In the event, for example, of rising temperature within the greenhouse, vents situated in the walls and roof of the greenhouse are automatically opened. This control over the growing environment, mediated through computer technology leads David Ryall to note that greenhouse cultivation is ‘predictable’. The vicissitudes of nature to which open-cultivation is subject have been negated. In essence, greenhouse production represents an accomplished example of what Boyd et. al. term the real subsumption of nature: ‘systematic increases in or intensification of biological productivity (i.e. yield, turnover time, metabolism, photosynthetic efficiency)’. Conventional means of enhancing biological productivity in open agriculture include the use of fertilisers and other agro-chemicals. A more recent technique is genetic engineering. And one not considered in the literature in the greenhouse.

The almost complete control over the conditions of growth has been enabled by the successful appropriation of discrete components of the agricultural production process, with the exception of labour and the handling of commodities. Capital has also successfully taken command over the biological production at the core of greenhouse production. Does this then suggest that within agriculture, greenhouse production is an exceptional case? The intractability of the disunity of production time and labour time apart, is greenhouse production a reasonable approximation of capital’s control over nature within agriculture? Greenhouse production, despite the apparent mastery over production, is still resolutely dependent on particular aspects of nature. With respect to the case study, the production of tomatoes, I speak of the importance of light levels and an
appropriate climate, of the centrality of nature. These ‘natural’ conditions, by themselves, are not significant. Greenhouse production is not necessarily tied to place: given free and unlimited energy sources, greenhouses could be established anywhere. The importance of these characteristics manifest themselves, however, in the context of capitalist competition. Delta’s greenhouse growers must compete with other growers throughout the continent and one way they do that is through the advantages conferred by the particular place they occupy. An advantage, growers argue, that is not available anywhere else. Using technologies adopted throughout by all large greenhouses, Delta’s greenhouses have the highest tomato yields in the world, without the benefit of technical advantage. But this advantage is ephemeral; it could be eroded at any time by any number of factors, such as a crippling rise in energy costs or a shift in exchange rates that is disadvantageous to exports from Canada. With respect to greenhouse production, the nature-based production process and place are important, but the specific relationship between the two is highly contingent in the context of capitalist competition.

Earlier in this chapter I mentioned the vulnerability of greenhouse production, citing the example of the failure of the irrigation system. Another is offered here. The example is Houweling’s greenhouse in California, in the Central Valley, an agricultural area. Over the course of a number of years, there was an increase in the population of whiteflies in the Central Valley. Unscreened vents in the greenhouse allowed a build up of whiteflies inside the greenhouse, which pest control could not manage, which had an adverse effect of yield and fruit quality. In 2001, Oxnard installed screens over ventilation openings to act as a barrier against the whitefly. In 2002, the screens began to prematurely fail due to a manufacturer’s defect. The result was a massive infestation resulting in the complete destruction of the crop. While the failure of the screens allowed whiteflies ingress, the spatially concentrated and enclosed character of greenhouse production makes it that much more vulnerable to such contingencies. Furthermore, place again matters. Houweling chose the Central Valley as the location for his greenhouse primarily because of the climate and this was determined primarily by competitive pressures (Peter Cummins, Houweling Greenhouse, personal communication)

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176 This is currently in the process of changing. New greenhouses in the Netherlands are being built as completely closed systems, which allows even more precise control over the growing environment, and utilise a heat exchange system which leads to a dramatic reduction in energy costs. Because these greenhouses have to be taller than existing structures, retrofitting is not cost effective.
Another example is related to the size of greenhouses. Gary van Stolen of Millenium Pacific Greenhouse suggests that there is a limit to how big greenhouses can become, citing EuroFresh’s 86 hectare greenhouse in Arizona as an example.

EuroFresh is big but cannot grow anymore…it [the greenhouse itself] is unmanageable…their productivity has dropped over the years.

The reason, van Stolen argues, is that a greenhouse that size requires an organisational structure characterised by centralised decision making. The head office issues ‘blueprints’ to the greenhouse’s growers on the parameters to be used in production. Such parameters include, as usual, the temperature, the particular composition of the nutrient solution and schedules for pest monitoring. This rigidity might seem reasonable in the context of the control over greenhouse production. The problem, and nature-centredness raises its head again, is that there are numerous variations in condition within the greenhouse, variations to which plants react differently. For example, sections of the greenhouse may be more humid or warmer than others which – a condition which afflicts all large greenhouses. This in turn, and in order to restore the balance required for maximum yield, requires an adjustment to the composition of the nutrient mix. Van Stolen observes that growing is a territory still untouched by science and that it is ‘more of an art’. This may be overstating the case but it does perhaps point to the sheer obstinacy of nature-based production to conform to the discipline of greenhouse cultivation.

**Conclusion**

One of the purposes of this chapter has been to illustrate the transformation of the tomato through its industrial appropriation. The deployment of breeding methodologies and techniques in the 20th century has resulted in the adaptation of the tomato to meet certain economic requirements. Tomatoes have been bred for particular applications and growing environments – processing, field, and greenhouse. And they have been bred to meet consumer demands of appearance and taste, and growers’ need for increased yield and disease resistance. Climatic conditions have also been responded to: tomatoes bred in Canada have almost always sought the characteristic of earliness in order to maximise the relatively short growing condition. Both the phenotype and genotype of the fruit have been altered, distancing it from its wild relatives, to create a ‘modern’ tomato responsive to changing production and consumption circumstances. While classical breeding methodologies wrought enormous change on the tomato, the advent of molecular methods heralds further transformation. These technologies, however, are currently only applied to the breeding process.
A further purpose of this chapter has been to demonstrate how particular aspects of the greenhouse production process have been appropriated by agro-industrial capital. Furthermore, the adoption of biological controls was a result of a specific mode of social regulation which presented an opportunity to producers of biocontrol agents. The reassembly of these appropriated discrete components results in the distinct production system that is the modern greenhouse. This reassembly, however, created a new set of contra-distinctions that manifest themselves as a vulnerability to shocks. The spatiality of greenhouse production and the co-dependence of the various subsystems – the failure of one (e.g. irrigation) could lead to the failure of the whole system – has not resulted in the diminishment of nature’s agency. It seems rather to have heightened its potential.
CHAPTER 7: CONCLUSION

Why is the overwhelming majority of the Lower Fraser Valley greenhouse production of tomatoes concentrated in Delta? This is the question that motivated my thesis. In addressing this question I began by setting out an explanatory framework drawing from three interlinked sources: regulation theory, the concept of food regimes and agrarian political economy. Linking the three is a political economic sensibility that is concerned with understanding agricultural processes such as those found in Delta in terms of larger socio-economic transformations involving commodity production, capital, technological change, the exploitation of labour, state regulation, and the production of nature.

With the theoretical framework clarified, in the historical chapter that followed I focussed on Delta. My point in beginning the substantive part of the thesis in this way was to demonstrate that place had been ‘produced’, that Delta had been undergoing a process of agricultural transformation since its settlement. In the case of Delta, I demonstrated in particular the role of the state in effecting that transformation as part of a broadly envisioned strategy of province-building. Regulation played a central role in this instance as the state tried to create a capitalist agriculture; one which would produce food for a burgeoning urban population that had hitherto depended on imported commodities. A critical component here was the Natural Products Marketing Act (Act) introduced in 1927 that was aimed at protecting small farmers. In essence, the Act was a component of a mode of social regulation which served the regime of accumulation identified with province-building. Agricultural development in British Columbia was further enabled by the federal ban on the sale of margarine. While margarine production represented an instance of what, following agrarian political economy, I called “substitution”, its absence in the market created the space for the process of “appropriation”. The specific example I used was the establishment of creameries in Delta and elsewhere in the province. These creameries, early examples of the industrialisation of agriculture, displaced butter production from the rural household.

The state also played a central role in creating the legal and physical context for the development of a capitalist agriculture. This was accomplished, for example, through legislation enabling the pre-emption of land that created regime of private property rights, and which made settlement more attractive to prospective farmers. Furthermore, local regulation, such as that which
facilitated the construction of dykes in Delta, made farming less risk. In one sense, the transformation of agriculture in British Columbia and Delta represented what one would expect to occur under an extensive regime of accumulation such as the expansion of the transportation network and the increase in the area of land used for agriculture. We also find, after the First World War, some of the features of an intensive regime of accumulation such as the creameries which reorganised the labour process and thus increased productivity. Furthermore, the transition towards an intensive regime of accumulation was accompanied by increased mechanisation and the intensification of agricultural production.

I situated the emergence of Delta’s greenhouse tomato industry, in the late 20th century, within the transformations attendant with the transition towards a post-Fordist regime of accumulation in general and the third food regime in particular. One of my main findings in this respect was that the consolidation of retail capital led to an accumulation strategy on the part of the Lower Fraser Valley’s greenhouse owners which resulted in the concentration and intensification of greenhouse tomato production in Delta. Specifically, large retailers’ demand for greenhouse tomatoes in significant quantities – a demand growers had to meet if they wanted to keep such customers as Costco and Wal-Mart – created a competitive climate which led both to relocation as well as an increase in productivity. As I demonstrated, the two are intimately connected. In addition, compared to any other location in the Lower Fraser Valley, or indeed anywhere else in British Columbia, Delta’s micro-climate conferred an advantage in the form of both increased yield and quality of fruit. On a continental scale this advantage still holds, despite the lower input costs of the Mexican industry and the economies of scale captured by EuroFresh and Village Farms. This competitive advantage could only be garnered through production in Delta.

I also analysed the role of regulation in this process towards the concentration of greenhouse tomato production in Delta. Of particular interest were my findings with respect to the relationship between the mode of social regulation and the regime of accumulation. In Chapter 3 I argued that the Natural Products Marketing Act represented an instance of social regulation that completed the regime of accumulation which characterised province-building. However, by the late 20th century, this Act has proved to be a fetter to the accumulation strategies of Delta’s greenhouse tomato producers. The Act dictated that agricultural commodities produced in British Columbia had to be marketed by a single institution. However, the contraction of the supply chain attendant with the concentration of retail capital, characterised by a direct line of communication between producer and retailer, is ill-served by a single-desk marketing structure. As a
consequence the Act has been subjected to deregulation, the manifestations of which are the emergence of new agencies closely aligned with individual producers. This represents not only a shortening of the supply chain but also the vertical integration of that chain in the case of Windset and Village Farms. In this instance the Act represented a regulatory institution established during an earlier regime which acted as an obstacle to accumulation within a new regime of accumulation. Consequently, the case study provides empirical evidence for Swyngedouw’s (1997) ‘glocalization’, particularly with respect to the notion of the intertwining of regulatory processes ostensibly located at various scales.

This particular example supports the regulationist claim that an earlier mode of social regulation can represent an obstacle within a new regime of accumulation. In the example of greenhouse tomato production of Delta, the regulation represented by the Act has been induced to change in order to facilitate accumulation under the current regime. But it is also apparent that earlier modes of social regulation can be entirely compatible with newer regimes. The ALR is a case in point. I argued that the ALR serendipitously created a space in Delta for the greenhouse tomato industry. The ALR, as a mode of social regulation, was forged during an earlier regime but, unlike the Natural Products Marketing Act, enabled rather than fettered the greenhouse tomato industry. In this sense, the example of the ALR supports the claims of geographers who argue for the necessity of considering local regulation, of being sensitive to the particularities of local and regional spaces, as a corrective to the abstraction of regulation theory writ large.

What of the empirical and conceptual findings with regard to the ‘nature’ of greenhouse production? Using the conceptual tools offered by the political economy of agricultural industrialisation, I argued that contemporary greenhouse tomato production represented unprecedented control over the cultivation of plants. With the exception of plant maintenance and harvesting, all aspects of the agricultural labour process have been appropriated. Control over the conditions necessary for plant growth – temperature, irrigation, nutrition, pest control – are exercised through industrially produced devices and, in the case of wasps and bees, through industrially produced organisms. Nature, however, remains recalcitrant. The non-identity of production time and labour time, for example, dictates a necessity for a distinctly flexible labour supply mechanism. Peak labour demands at harvest time are a result of the rhythm of greenhouse tomato stamping its mark on the labour process.

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177 For a similar example in the Australian dairy industry see Pritchard (1998).
Furthermore, in the final chapter I illustrated the way in which aspect of the greenhouse production process had been appropriated by agro-industrial capital and reassembled as the greenhouse production process. While this has resulted in greater biophysical productivity it has also resulted in the creation of a fundamentally fragile artificial ecosystem. Even though it is the result of perhaps one of the more complete processes of appropriation within agricultural production, the greenhouse growing environment is marked by an absence of resiliency. I cited the example of the failure of the irrigation system, the effect of which is the complete loss of a crop. As well, greenhouses function within a very narrow range of physical attributes such as temperature, light and humidity and an extreme of any one of these is a potential for decreased yield or crop loss. In sum, the case study represented the first application of the conceptual tools of the political economy of agricultural industrialisation literature to greenhouse production.

The commodity in question, the tomato, had also experienced a process of transformation. By the late 19th century, it was being incorporated into industrial production processes. With the emergence of Heinz and Campbell’s in the early 20th century, processed tomatoes became one of the earliest mass produced food products. In other words, the preservation of tomatoes for future consumption, and which had been a process undertaken within the household, had been appropriated by capital. Furthermore, breeding programmes, both public and private, attempted to create a tomato more suitable for the rigours of industrial production. In Canada, the state also played an active role in moulding the tomato to the dictates of production and consumption. This was particularly true for the breeding of tomatoes that would grow in the often harsh climatic conditions found throughout the country. The tomato was one of the first fruits to be subjected to molecular re-engineering. Even though there are currently no genetically modified tomatoes on the market, molecular technologies play a critical role in their breeding. In particular, the application of such technologies – an instance of the real subsumption of nature – reduce the turnover time for capital.

As discussed in Chapter 1, both regulation theory and the concept of food regimes have been critiqued for their tendency towards abstraction, for neglecting geographic specificity. This is apparent, for example, in the inability of the food regime theory to account for the geography of agriculture in late 19th and early 20th century agriculture in British Columbia. The theory’s emphasis on the export of wheat during the 19th and early 20th centuries from settler states to Europe, effectively occludes British Columbia’s agrarian history. British Columbia was not an
exporter of staple foods, and its agricultural development was primarily locally based, proceeding in the context of a discourse of province-building. Indeed, it was not until the advent of the third food regime that the globalising processes identified by the literature bore explicitly on BC, in particular, putting Delta’s greenhouses on the world stage. The addition of regulation theory, I argued, particularly the concept of local regulation, goes some way towards capturing the nuances missed by food regime theory. That said, food regime theory, I maintain, remains a useful device for identifying changes in the agri-food sector.

There is another connected issue. Food regime theory tends to portray globalisation as a hegemonic force (Gibson-Graham, 1996). But as Larner and LeHeron (2002) note, ‘Globalisation looks different from different places’ (2002:770). So the theory would lead us to think that agri-food landscapes like Delta’s are bifurcated into either industrial agriculture like the greenhouse tomato growers or farmers who produce for so-called niche markets (organic, locally embedded). But such a portrayal is not accurate, obscuring the diversity of farming practices and organisations. As Morris and Evans (1999) note, recent changes in agriculture contain ‘greater diversity than the dominant political economy discourse would suggest…’ (1999:349). Wilson (2000), further argues that the structuralist, economistic approach represented by political economy, which includes regulation theory and food regime theory, fails to acknowledge the possibility of changes from within. That is, there is a neglect of local action and thought. Ward (1993) argues that ‘to understand how new sets of regulatory, market and social pressures impact upon farm businesses and household, models will need to be more sensitive to the actions and values of individual actors involved’ (1993:362). The deployment of actor-network theory (ANT), for example, might have served this end, albeit in its ‘weak’ form which, as Castree (2002) advises, is compatible with a political economic approach.

As previously noted, Goodman and Watts (1994), in particular, have raised concerns about the relative inapplicability of regulation theory and its derivatives – which were derived from empirical analyses of manufacturing – to agricultural production. There is, within the food regime literature, a tendency to treat food and agricultural commodities as an undifferentiated whole in terms of their nature-based specificity. A sensitivity to this specificity is necessary for the continued relevance of the concept of food regimes. For example, my empirical work revealed that the type of greenhouse commodity – tomato, pepper, cucumber – makes a difference. This is revealed in the concentration of greenhouse tomato production in a single locality, Delta. The tendency of the food regimes approach to generalise, its level of abstraction, would have led to the omission of this detail. The importance of the specific ‘natural’ requirements of greenhouse
tomatoes – increased light levels and moderate temperature – played a not insignificant role in the agricultural restructuring of the locality. In other words, the type of agricultural commodity being produced must be accorded a central role in the analysis of particular paths of agricultural industrialisation. However, this is not to suggest a recourse to environmental determination in which all that matters in the commodity. As I contend in this thesis, the concentration of greenhouse tomato production in Delta had as much to do with broader structural forces as it did with the ‘nature’ of the greenhouse tomato.

More generally, I recognise that the thesis is inflected by both essentialism and a form of totalization: essentialism because of the central role accorded to the imperative of capital accumulation and totalization because of my presumed subsumption of social life by the logic of capitalist reproduction. While my thesis illuminates certain aspects of, inter alia, agriculture, regulation, and greenhouse production, my choice of approach also occludes. For example, I characterise individual growers as motivated by only their desire to accumulate. As Marx put it, “accumulate, accumulate, says Moses and the prophets.” I contended that the rationale for the establishment of greenhouses in Delta is firmly situated within the context of the imperative to maximise profits. Consequently, I have necessarily neglected the extra-economic factors that might play a critical role in grower’s behaviour. I have, similarly, portrayed greenhouse enterprises as coherent (capitalist) entities rather than as units embodying multiple, potentially conflicting interests. Furthermore, this thesis would have likely benefited from my thinking of capitalism as ‘a set of different practices scattered over the landscape that are (for convenience and in violation of difference) often seen as the same’ (Gibson-Graham 1996:260). This would have forced me to take into account those social practices and processes – non-market transactions, for example – which may have played a contingent role in the development of regional agriculture and the emergence of the greenhouse industry.
Suggestions for Future Research

The future of the industry? That’s a tough question to answer at this stage but I think... there are some very prudent operators, they understand the financial world out there, the ups and down, the vagaries in the marketplace, I think they will survive. But I think there’s going to be a couple or three who won’t (John Savage, Delta farmer and member of British Columbia Vegetable Marketing Commission, personal communication).

The greenhouse [industry] … let’s face it, it’s dead…in Canada. You know, they’re building in Mexico, they’re building in Arizona, in a place called Snowflake [EuroFresh], it’s huge business … and these guys here, you know it’s just a matter of time that the competition gets too much … I would say it’s dead but I hope it isn’t dead for the people that have invested in it and trying to make a living off it … you know, that’s how quick agriculture changes (Jack Bates, Delta farmer and President of Delta Farmer’s Institute, personal communication).

I think it’s going to be the survival of the fittest. I think it’s [the greenhouse tomato industry] going to reduce itself down to some major competitors and I think that at that point … you’re going to have a very small number of really big producers (Brian Beggs, President of BC Hot House Foods, personal communication).

Whither Delta and its greenhouse tomato sector? These observations come from outside the greenhouse industry but from people well placed within the local and regional agricultural community. Greenhouse growers themselves admit that the industry is facing increased competition but, rather more optimistically, argue that the solution is both to reduce their costs of production, labour in particular, and to increase yield. While I have sketched the landscape of greenhouse tomato production in North America, future research may be directed to a more detailed analysis of the tendencies within the United States and Mexican industries. The latter in particular is in a state of rapid transformation as there has been an increase in the construction of large technologically sophisticated greenhouses. Skilled growers from both the Netherlands and Canada have been recruited to oversee production and the quality of tomatoes has increased markedly in the space of three years (Brian Beggs, personal communication). Future inquiry should be directed towards an analysis of the political economy of the Mexican greenhouse sector. In other words, the structure of ownership, the structure of the supply chain, relations between greenhouse capital and the state, the labour market and the regulatory context. In terms of the geography of production, the constraints and opportunities faced by Mexican producers need specification.
The whitefly can be used as an example here. In Chapter 6 I went into some detail about the whitefly as a greenhouse tomato pest and its method of control. Control is achieved by a biological agent, *Encarsia formosa*, which requires a base population of whiteflies in the greenhouse so that it can parasite their eggs. In Mexico, however, whiteflies are also carriers of a virus which is a threat to tomato plants. As a consequence, a base population cannot be tolerated and, in the absence of an effective alternate biological control agent, chemicals controls must be used. The Mexican whitefly increases the vulnerability of the greenhouse ecosystems because, in the first place extra measures must be taken to prevent their entry into the greenhouse, either through vents or plant stock, and secondly, chemical control must be deployed judiciously to avoid harm to the bumble bee pollinators. Given the potential for greenhouse tomatoes to develop a resistance to chemical control – as they did in Spain and which forced Spanish growers to adopt biological controls – and the fact that the greenhouse tomato industry in Canada and the United States, as part of its marketing campaign, stresses the absence of chemical controls, the impact of these and perhaps other obstacles and surprises posed by nature on the competitiveness of the Mexican greenhouse industry require monitoring. These issues are important in light of the United States Department of Agriculture’s observation that

*The greatest source of uncertainty for the future of the North American greenhouse tomato industry will be the changing structure of the Mexican industry, which is still seeking out the best locations, technology packages, and management practices* (Cook and Calvin 2005:26, emphasis in original).

Another topic for future research is the greenhouse industry in Ontario, established just after the Second World War by Dutch and Italian immigrants. While the concentration of greenhouses in Delta occurred over a space of approximately 5 years, Leamington’s industry has been evolving for over 50 years. There is also less of a consolidation of ownership; along with the larger greenhouses, some of the largest in North America, there are numerous smaller producers. Given the absence of smaller greenhouse tomato producers in Delta, how do the smaller enterprises in Leamington compete, particularly in the face of heightened continental competition? There may be a more important question related to geography. Local growers argue that Delta has the best climate in the country for growing greenhouse tomatoes, a climate which has, to date, garnered them a competitive advantage. There are fears, however, that this advantage is in the process of being eroded. If this is the case, where does the advantage of Leamington’s growers lie? Is it a function of the pattern of ownership – perhaps smaller producers are more flexible in responding to competition –, or a result of the absence of single-desk marketing?
A further possible avenue for future research is to apply a commodity systems approach to the production of greenhouse tomatoes (Friedland 1984, 2001). While this approach was eschewed in this thesis because of its inability to capture the regulatory context of the emergence of greenhouse tomato production in Delta, there is merit to it as an approach. The commodity systems approach considers one agricultural commodity at a time, and traces production from first agricultural inputs through farm production to food processors, wholesalers, retailers and, finally consumers. Its utility as an approach lies in its identification of actors in the chain – points at which value may or may not be captured – and the spatial extent of the chain. The approach has thus far resulted in enlightening and useful observation on the globalisation of food production and consumption. Through its intense focus on the commodity itself, the commodity systems approach is able to chart the spatial dimension of the chain. In the section above I suggest that the North American greenhouse tomato industry is currently subject to pressures which may induce change, particularly with respect to sites of production. The specification of potential and actual realignments in the spatial dimension of the commodity chain could be accomplished through a commodity chain approach.

Finally, one other potential avenue of research stemming from the thesis is the emergence of alternative food networks (AFN) (Goodman 2004). Such networks are counterposed to industrial systems of food production of which greenhouses are but one example. AFN’s produce food that has symbolic meaning. Meaning is attached either to the way in which food is produced – sustainably as in the case of low-input or organic agriculture – and/or to the place in which food is produced – particularly local production as opposed to global chains. Although the scale and intensity of inputs qualify greenhouse tomato production as industrial food production, the branding strategy of Delta’s growers includes explicit reference to the fact that pesticides and herbicides are not ordinarily used in production. Greenhouse growers and their representatives also make claims for the sustainability of their production systems. These claims are based on the fact that greenhouse production systems are, with the exception of supplementary energy for heating or cooling, essentially closed systems. Specifically, the recycling of water and the absence of pesticide runoff distinguish greenhouse production ‘ecologically’ from open field production. In terms of the social movements which have emerged around consumption and the meaning of food – the latest instance is that which advocates a ‘100-mile diet’ – and the AFNs,

178 See, for example, the collection of studies edited by McMichael (1994).
how is greenhouse production to be situated? What are the consumption implications of the (partial) confounding of the distinction between greenhouse grown and organic foods? Does the local consumption of greenhouse tomatoes grown in Delta trump the consumption of organic tomatoes produced further afield. In other words, there is a need to conceptualise contemporary greenhouse tomato production in terms of the AFNs.

Making sense of complex social and economic processes is never easy. What I have presented in these pages can only be partial, and is reflective of a particular set of theoretical constructs. This being said, however, there is fervent hope that I have illuminated the ways in which an agricultural commodity, place, capital, and the state have interacted in a particular way at a particular time to yield the greenhouse tomato industry as it exists in Delta.
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**PERSONAL COMMUNICATIONS**

Jack Bates, Delta farmer and president of the Delta Farmer’s Institute

Shirvan Bakhtiyari, Millenium Pacific Greenhouse

Brian Beggs, BC Hot House Foods

Jonathan Bos, Village Farms

Peter Cummins, Houweling’s Nursery

David Ehret, Agriculture and Agri-Food Canada

Casey Houweling, Houweling’s Nursery

Simon, Kruitoff, Houweling’s Nursery

John Newell, Windset Greenhouses

David Ryall, Gipaanda Greenhouses

John Savage, Delta farmer and member of the British Columbia Vegetable Marketing Commission

Marcy Sengret, Corporation of the City of Delta

Andre Solymosi, British Columbia Vegetable Marketing Commission

Bruce Vance, Westgro

Jacob Van Den Bosche, Westgro

Gary Van Stolen, Millenium Pacific Greenhouse