TECHNOLOGICAL LEAPFROGGING AS A SOURCE OF COMPETITIVE ADVANTAGE IN THE AMERICAN AND POLISH TART CHERRY INDUSTRIES

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ABSTRACT

TECHNOLOGICAL LEAPFROGGING AS A SOURCE OF COMPETITIVE ADVANTAGE IN THE AMERICAN AND POLISH TART CHERRY INDUSTRIES

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This paper evaluates new tart cherry harvester technology and measures its ability to determine technological leapfrogging and competitive advantage between the United States and Poland. Competitive advantage is evaluated using break-even analysis, threshold farm size analysis and economic valuation.

Findings reveal that that only a small minority of Polish farmers will be able to adopt new harvesters under current conditions. This same minority of Polish farmers, however, is probably the most important group to U.S. growers in terms of international tart cherry competition. Economic valuation shows that it will be extremely difficult for Michigan farmers to remove tart cherry orchards planted for shaker-harvest before their normal lifespan without economic loss. Economic valuation also demonstrates that there is a great incentive to adopt overhead harvesters due to their ability to harvest younger trees and to decrease per unit production costs.

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CHAPTER ONE

INTRODUCTION AND RESEARCH CONTEXT

1.1 Introduction

This study provides an analysis of competitiveness for the U.S. and Polish tart cherry industries. Competitiveness is defined as the ability to produce at break-even prices and break-even yields lower than or equal to average regional yields and prices. The study evaluates competitiveness based on grower ability to lower annual operating costs or increase production volumes by adopting cost reducing, yield increasing alternative harvesting technologies. Harvester adoption is of critical importance to competitiveness given its potential to influence Polish and U.S. break-evens and because of the possibility for technological leapfrogging to occur.

1.2 Background Information

The global tart cherry industry is becoming increasingly competitive. There are several countries competing for world market share, including Hungary, Germany and China as well as Poland and the United States, who together produced a combined 29 percent of the world's tart cherries in 2004 (FAOSTAT, 2005). Given the current importance of Poland and the United States in this industry, as well as their direct involvement in the development of innovative harvesting technology, this study will focus on these two countries. The study will use the state of Michigan to represent the United States because it produces approximately 70 percent of the country's tart cherries (Sweet and Red Tart Cherry Crop Statistics and Market Analysis, Cherry Marketing Institute, 2005).

The Michigan tart cherry industry has followed a course similar to others in American agriculture; increasing farm sizes, decreasing the number of producers and investing in capital-intensive production technologies. A primary example took place in the 1960s and 70s, when Michigan tart cherry growers adopted mechanical harvesting (shaker) technology that had been originally developed to harvest California almonds and pistachios. (See Appendix 1: Photo of American Shaker Harvester and Close-Up of Shaker Head). Mechanical harvesters had a profound influence on tart cherry production and orchard design. For example, in order to maneuver a harvester within an orchard, plantings were limited to one tree every 18-22 feet, or about 120 trees per acre. In order to recover the high investment cost of expensive harvesters, producers pursued multiple strategies, including increasing orchard size, purchasing orchards throughout different climatic zones and changing the mix of crops produced in order to make additional use of the harvester. As farm size increased, other capital-intensive inputs became more affordable, such as air curtain sprayer technology and monoboom hedgers. Finally, wages rose due to numerous reasons. A drop in the labor supply occurred as the shift from labor intensive to capital intensive production methods drove workers to other regions. At the same time demand for skilled labor to operate the new machinery increased.

In Poland, tart cherry production is currently changing from a traditional system characterized by a few trees planted beside a sweet cherry or apple orchard to a modern system characterized by high planting densities and hand-harvesting. The Polish tart cherry industry's transformation and the increase in Polish tart cherry yields have been accompanied by Poland's growing access to foreign markets. Polish production started shifting outwards in the early 1990s, after the opening of Poland's economy to the western market and foreign investment. On May 1, 2004, Poland joined the European Union (EU), bringing increased market access to the 24 other EU member countries and most importantly, new government interventions and investments into Polish farms.

As in the United States, economics have had a significant influence on Polish farm design. For example, high unemployment rates in Poland (relative to the United States)[1] have led to low wages and a strong reliance on the agricultural sector to provide employment. In 2002, 27.4 percent of Poles and 58.2 percent of the total rural population lived in a household directly connected to agriculture (Polish Ministry of Agriculture and Rural Development, 2004). A natural result of the current abundance of labor is a continued reliance on hand-harvest in the Polish tart cherry production system. Hand-harvest allows Polish growers to plant trees at a higher density per acre than Michigan growers, potentially resulting in higher yields per acre. Hand-harvest also permits Polish growers to harvest younger, smaller trees. By using a hand-harvest system, there is no immediate pressure to increase farm size in order to spread out the cost of agricultural machinery. Hand-harvesting also limits soft fruit problems that are aggravated by American shaker harvester technology. Conversely, a limitation of this system is that production technology options are focused on low cost systems that are more appropriate for small farms. For example, Polish farms are more likely to use hand-powered sprayers or lower cost tractor powered sprayers.

Although Polish rural employment currently relies heavily upon manual labor, the potential to lose this supply of labor is possible due to a variety of reasons including the

[1] Poland's unemployment rate was 19.5 percent in 2004, compared to the U.S. rate of 5.5 percent (CIA World Factbook, June, 2005).

high education level of Poles, the possibility of better wages to be earned elsewhere in the EU, and continued growth in the non-agricultural sector of the economy. In anticipation of future labor conditions, the Polish tart cherry industry has undertaken the development of a new mechanical harvester. This new harvester, referred to as an "overhead" harvester, uses technology similar to an American blueberry harvester, passing over the tree and beating out fruit with rotating "fingers" rather than shaking the tree's trunk like an American harvester, or "shaker." (See Appendix 2: Photos of European Overhead Harvesters). These harvesters require a unique orchard design characterized by smaller trees with lower trunks that are planted at high density rates, (up to 1150 trees per acre or one tree every three feet), and will give higher yields than orchards designed for harvest by a shaker.

Results of the new harvesting technology remain to be seen, but potential shifts in global competitiveness could be dramatic. Already, the Michigan industry is experiencing increased international competition which has been aggravated by short crops in 2002, 2003 and 2004.[2] There is now the potential for technological leapfrogging to occur. In this scenario, an established firm is overtaken by a new competitor who is able to start with a new, more productive, technology. The established firm is unable to adopt the new technology due to prior investments in a less efficient technology and therefore loses its competitive advantage to the newcomer. In the case of Poland and Michigan, technological leapfrogging is characterized by Poland's aggressive

[2] The Michigan disaster crop of 2002 was of great importance to Polish exporters. Michigan's tart cherry yields in 2002 averaged 550 pounds per acre, a significant drop considering that yields have averaged nearly 7000 pounds per acre over the past 25 years. While most Michigan growers were able to survive the short term financial losses, they were unable to prevent the inflow of new imports from Poland and the establishment of new relationships between American purchasers and Polish exporters. The 2003 and 2004 crops were also short, and the 2005 crop was predicted to be short (June 2005).

development of a cost-reducing harvester and Michigan's inflexibility to adopt the harvester due to investments in alternate technologies and orchard designs. Given this reality, competitiveness between the Michigan and Polish tart cherry industries will be heavily influenced by their ability to adopt new harvesting technology.

1.3 Problem Statement

Competition in the global tart cherry industry is currently based on the ability to be the lowest cost producer. In Poland and Michigan, the current focus is on improving per unit costs through the development of a mechanical harvester. This paper will explore different harvesting options in order to determine their feasibility and influence on competitive advantage. Specifically, it will answer the research question "how will new harvesting technology influence competitive advantage between tart cherry farmers in Michigan and Poland?" This objective will be implemented by carrying out the following tasks:

1) Break-even analysis. Break-even yields and prices will establish a benchmark to compare competitiveness in tart cherry production. Competitiveness is defined as the ability to operate at break-even prices and break-even yields lower than or equal to the price offered or yield produced. Break-even measures will be compared with average regional yields and prices in order to evaluate the competitiveness of the two countries.
2) Threshold farm size analysis. Threshold farm size analysis measures the minimum acreage at which a Polish farm can convert to an overhead system. This is a measure of the scale of operation necessary to substitute a mechanical harvester for

hand-labor. It can also be thought of as a measure of the indifference point between labor and capital (or hand-harvest verses machine-harvest).

3) Economic valuation. This analysis will evaluate the incentive for and ability of Michigan farmers to adopt overhead harvesters. These results can then be compared with Polish threshold farm size analysis in order to evaluate competitiveness.

1.4 Procedures

1.4.1 Break-Even Analysis

Break-even analysis indicates the price or yield needed to remain competitive at a given level of production costs. The concept is especially useful because it allows comparison of producers with different production costs. Break-even analysis serves as a foundation for competitive advantage analysis by showing which regions can produce at break-even levels equal to or lower than regional yields and prices.

Normally, break-even analysis is shown as:

$$break-even\ yield = \frac{total\ production\ cost}{average\ price}$$

or

$$break-even\ price = \frac{total\ production\ cost}{average\ yield}$$

Typical break-even analysis is insufficient for the purposes of this paper because it does not account for the recovery of investments in perennial crops like tart cherries. To compensate, economic valuation techniques are adapted to calculate break-evens. A budget spanning the lifetime of the orchard that was planted in 1979 is developed.[3] Costs are represented in 2004 dollars and are compared with both historic and simulated yields,

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[3] A 25 year old orchard in 2004 would have been established in 1979.

while price is held constant. Then, using a discount rate that represents a tart cherry farmer's second best alternative, price is varied until NPV=0. This results in a break-even price that represents the entire lifespan on the orchard.

Break-even yield is calculated using a similar technique. Like break-even price, a budget is created that represents the lifespan of the orchard. Costs are represented in 2004 dollars and are compared with both historic and simulated prices, while yield is held constant. Historic price is adjusted for inflation so that it represents 2004 dollars. Yield is then varied until NPV=0, resulting in a break-even yield that represents the entire lifespan on the orchard.[4]

The break-even yields and prices derived from these calculations can be compared with historic yield and price data in order to evaluate current competitiveness. Historic yield and price data is published for Michigan in *Michigan Agricultural Statistics 2004-2005* (National Agricultural Statistics Service, 2005). For Poland, historic yield and price data is published by the Institute of Rural Economics, Main Statistical Office for Poland.

1.4.2 Threshold Farm Size

Threshold farm size is shown as $S_t = \frac{C}{L_s W}$, where

$S_t =$ threshold acreage,
$C =$ annual cost of a harvester,
$L_s =$ labor saved per acre by using a harvester, and
$W =$ wages saved by using a harvester.

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[4] Break-even yield and price is also calculated using simulated price and yield data. Simulated data is discussed in detail in chapter 3.6.

Threshold farm size is a measure of the indifference point between hand-labor and machine-harvest. Using this measure, it is possible to determine the minimum acreage needed for a Polish farmer to replant the orchard and purchase an overhead harvester. Threshold farm size is then compared with current Polish tart cherry farm structure to provide a measure of the number of farmers who are able to adopt new harvesting technology. Subsequently the percentage of Polish tart cherry acreage which could potentially be harvested mechanically is calculated.

1.4.3 Economic Valuation

Economic valuation provides multiple outputs. First, it is used as an input to calculate break-evens. Second, the measure is used to compare the ability to adopt new tart cherry harvesters in Michigan with Polish threshold farm size measures. Finally, it is used to compare the value of shaker and overhead harvesters and assess a Michigan grower’s incentive to adopt overhead harvesters.

Unlike break-even and value measures, economic valuation will use both historic yield and price data when measuring ability to adopt. An enterprise budget will be created, representing a 25-year old tart cherry orchard planted in 1979. Production costs are expressed in 2004 dollars, yields are unadjusted and historic prices are converted to 2004 dollars using the Farm Product Producer Price Index (PPI). Results can then be used to calculate the point when investment costs in a Michigan orchard are recovered; or the age when an orchard can be removed without losing the initial investment. Using actual data from the past will more accurately portray tart cherry yield and price fluctuations and their correlation compared to estimates of future yields and prices.

The use of economic valuation to measure the ability of Michigan farmers to adopt new harvesters is of particular interest because it highlights the difficulty of comparing technology adoption between two countries. The two regions have different production systems and thus require different tools to evaluate the ability to adopt technology. For example, harvester adoption in Poland is concerned with the transition from labor to capital, or hand-harvest to machine-harvest. The factor with the most influence on the analysis of the Polish industry is increasing wages. In Michigan, analysis is more focused on the potential for decreased production costs, increased yields, and extended orchard life. The issue of importance is thus the point when a Michigan farmer can opt out of an older orchard rather than the transition from labor to capital inputs.

Each current system is constrained in unique ways by former investments. In Poland, people are only deterred from investing by the scale of their current investments. As they transform their orchards to machine-harvest, they may continue to harvest by hand until they reach a size of farm where it is cheaper to machine-harvest than to hand-harvest. In Michigan, transforming an orchard from one style of mechanical harvest to another is hindered by the fact that the harvesters cannot be used in either style of orchard. Michigan farmers are left with the option to either harvest with two harvesters (almost certainly using both inefficiently), or transform the entire orchard, regardless of the age (and thus value) of the current planting. As a result, we use threshold farm size measures for Poland and economic valuation measures for Michigan.

1.5 Implications

This study will provide the first in-depth look at the factors that will influence adoption of overhead tart cherry harvesters in Michigan and Poland. The study will provide a comparison of current variable cost of production and harvesting between the two countries. The study will also explore harvester technology adoption in the tart cherry industry in order to understand the role of technological leapfrogging in sustaining competitiveness.

The most important benefactors of this research will be participants in the Michigan and Polish tart cherry industries, including growers and processors. Industry participants will gain general knowledge of the other country's cost of production and will gain a better understanding of variables that will influence future cost and yield and thus be better equipped to design competitive strategies. This research will also benefit policymakers, particularly those who create market intervening policies as well as those involved in Polish and American rural development.

CHAPTER TWO

LITERATURE REVIEW

2.1 Leapfrogging

Leapfrogging is the situation where an economically laggard firm is able to overtake a previously dominant firm by adopting technology superior to that currently in use. Chen asserts that the laggard firm is able to gain competitive advantage over the dominant firm because it is easier for the laggard firm to build a new industry than it is for a dominant firm to re-invent itself by adapting new technology when it is already heavily invested in an alternative (Chen, 1996).

An example of leapfrogging can be seen in the rise of the Japanese steel industry during a period of American dominance. During the 1950s, U.S. steel producers were world leaders in terms of productivity and were heavily invested in open hearth technology. Japan’s steel industry, on the other hand, was still underdeveloped at that time. By the 1960s, oxygen furnace technology had become more efficient than open hearth technology. As American firms resisted adopting oxygen furnace technology due to their large prior investments, Japanese firms built a new industry based on the best technology available at that time. As a result, Japan was able to enter the market with no sunk investment in outdated technology, easily adopt the more efficient technology, and gain competitive advantage over the United States.

A similar framework can be applied to the Michigan and Polish tart cherry industries with regards to harvesting technology adoption. Investing in a tart cherry harvester requires that the grower commit to a certain orchard design. Polish growers, unlike Michigan growers, have much more freedom in when and how they replant their redesigned orchards. For example, a Polish grower can replant an orchard for mechanical-harvest and continue to hand-harvest. A Michigan grower, on the other hand, cannot plant for a new style of mechanical harvester and then continue to harvest with the older style equipment. To summarize, Polish growers are not hindered by prior investments, but by the operating scale at which a mechanical harvester is affordable. They are able to invest gradually in orchards designed for mechanical-harvest and may harvest these orchards by hand until a point is reached where it is cheaper to harvest them mechanically. This is compared to Michigan growers, who in the same situation would likely be required to own and operate two harvesters at less than full capacity.

Evaluating competitiveness is challenging given that competitiveness has many different measures and does not have a well established definition (Lingard, 2003). Evaluation of competitiveness is further complicated by the need to measure both a firm/industry's ability to produce at costs relative to its competitors and also to evaluate the factors which enable the firm or industry to sustain a certain level of performance. As a result, this study bases its definition of competitiveness on the principles of comparative and competitive advantage, measuring comparative advantage in terms of break-even analysis and competitive advantage in terms of technology adoption.

2.2 Comparative Advantage and Break-Even Analysis

Comparative advantage, in the Ricardian sense, can be described as the possibility for mutually beneficial trade to occur between two nations, regardless of the fact that one country is the absolute low cost producer of both goods being traded. Benefit to the high cost producer comes in the form of gained efficiencies from trade. For example, take the situation where two goods (x and y) are produced using only one input, labor, and that the low cost producer uses the same amount of labor to produce both goods. The high cost producer in this situation uses more labor to produce either x and y than the low cost producer and the high cost producer also uses more labor to produce x than y. In this situation, the high cost producer would have a comparative advantage in the production of y and would be better off to only produce y and trade it for x with the low cost producer.

Comparative advantage analysis is a useful tool. Unfortunately many difficulties arise in its practical application, the most important of which is meeting the requirement that markets may not be influenced by foreign inputs or distorted in order for analysis to be accurate. For example, the estimation of exchange rates, land values and labor values are not always clear. In the case of agricultural goods, unique problems arise in comparative advantage analysis because of market distorting agricultural policies that attempt to protect food production from various risks.[5] Due to market distortions, several alternative measures of comparative advantage have been established. For the purposes of this paper, break-even analysis will be applied.

Lingard measures comparative advantage in terms of competitiveness, which he defines as "the ability of a farmer/producer…to survive and maintain market share at prices determined by international trade" (Lingard, 2003). Break-even analysis is a measure that satisfies this definition. On the positive side, break-even analysis is advantageous because it permits comparison of two regions with different costs, production techniques, yields and prices, and provides an accurate measure of

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[5] These risks include price fluctuations due to uncontrollable natural phenomena such as climate and the fact that farmers are often price takers.

comparative advantage and a foundation of competitive analysis. Break-even analysis is also preferable because it is based on enterprise budgets and does not need to explicitly account for market distortions such as government interventions, exchange rates, land values and labor values. The negative side of break-even analysis is that it does not give a clear idea of comparative advantage in the Ricardian sense of gains from trade. Rather, break-even analysis provides a basis from which to compare costs and their relationship with price and yield. Finally, and most importantly, break-even analysis is a simple measure reflecting production techniques and costs at one point in time. As a result, it is necessary to adopt break-even analysis to account for multi-year investments in perennial crops like tart-cherries.

Comparative advantage analysis provides the first step in comparison of Polish and American tart cherry industry performance. It does not, however, contribute to any understanding of sustained competitive advantage. For this reason, it is necessary to use competitive advantage analysis in order to better understand the causes of comparative advantage and the factors which sustain superior performance.

2.3 Competitive Advantage and Technology Adoption

One definition of competitive advantage is “a strength that clearly places a country’s industry ahead of its competition in terms of performance” (Porter, 1990). Using Porter’s definition, an industry will either have a competitive advantage from lower costs or through product differentiation. Currently tart cherry growers sell an agricultural commodity with well-defined characteristics. Therefore, competitive advantage will likely have little to do with product differentiation and more with production costs and volume of production at this point in time.

Treadmill theory states that farmers who produce as price-takers in markets that approach perfect competition (i.e., farmers who produce non-differentiated goods) are caught in a treadmill of technology adoption (Cochrane, 1979). Under these circumstances, “early-bird” farmers (i.e. first adopters) earn excess economic profits by producing with lower costs or higher yields than typical growers using conventional technology. This profit will continue as long as total market supply does not “shift” outwards. As technology adoption becomes widespread, total market supply will increase, causing a fall in price. Farmers who fail to adopt are pushed farther into economic loss and must exit in the long run. Given this scenario, a measure of the ability to adopt tart cherry harvesting technology which reduces costs and raises yields can serve as a measure of competitive advantage.

The challenge of evaluating technology adoption between Michigan and Poland is that there is not a simple comparison that can accurately summarize two unique industries. The Michigan and Polish industries differ in the sense that the Michigan industry is less flexible in its ability to transform harvesting technology due to large sunk costs in older harvesting technologies, while Poland is constrained by small farm sizes and economies of scale. As a result, evaluation of ability to adopt new harvesting equipment in Poland concentrates on the minimum farm size necessary to support new investment in harvesting equipment while in Michigan evaluation concentrates on the financial constraints of orchard replanting that prevent adoption.

Threshold farm size measures the minimum scale of operation under which a farm can substitute capital for labor. This measure was first used in order to evaluate 19^{th} century Midwestern grain farmers’ ability to replace grain harvesting labor with a mechanical reaper (David, 1966). David was able to measure the minimum farm size necessary for a farmer to be indifferent between paying harvest labor and buying a reaper.[6]

Polish tart cherry farms are similar to the 19th century Midwestern example in that they are also undergoing a capital/labor trade-off. There is, however, a fundamental difference between the two examples which must be accounted for in order to adapt threshold farm size analysis to the Polish situation. Grains are annual crops which can be transformed in the short term. Tart cherry orchards, on the other hand, are perennial crops that generally consist of several plantings (or "blocks") with different ages. As a result, the decision to exchange capital for labor must account for the fact that an entire orchard will likely be transformed over a multi-year period. In practice, this means that when using threshold farm size analysis, one cannot assume that a farmer can change his entire operation in one season. Instead, it must be assumed that threshold farm size analysis is actually measuring the minimum block size, or portion of a farm, which must be replanted initially in order to adopt overhead harvester technology. This reflects the Polish advantage of flexibility in their adoption choice. Polish farmers will be able to spread adoption out over several years, harvesting either by hand or machine, until either the old orchards reach the end of their cycle or labor costs rise too high.

Unfortunately, threshold farm size cannot be used to evaluate technology adoption in Michigan because gains from the labor/capital trade-off have already occurred. (In fact, overhead and shaker harvesters use approximately the same amount of labor and cost approximately the same amount). As a result, evaluation of the ability to adopt new technology becomes an issue of cost incentives, such as *Will the per unit cost*

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[6] This calculation assumed that there was no possibility of custom harvest

of production fall?, *Can a farmer who foresees a per unit cost decrease afford to transform his orchard for overhead technology?* and *If the per unit cost decreases, at what point in the life cycle of an established orchard does it become feasible to replant an orchard for the alternate harvester?*

In its most common form, economic valuation is used to analyze the various costs and benefits of an investment. Typically, the attractiveness of an investment is evaluated on the basis of net present value (NPV) and/or internal rate of return (IRR) calculations. In this context, economic valuation is useful for determining the attractiveness of, or incentive to adopt alternate harvesting technologies. NPV and IRR calculations, however, give little perspective on the ability to adopt. Instead, economic valuation measures the point in the life cycle of an established orchard when it becomes feasible to replant for an alternate harvester; i.e. the point when the orchard recovers its initial investment, or has a positive cash flow.

CHAPTER THREE

DATA OVERVIEW

Farmers in Poland and Michigan were interviewed during 2004/2005 in order to determine the cost of production of tart cherries. In Poland, 36 tart cherry farmers were surveyed by a partner, Dr. Robert Kurlus, of the University of Poznan, Department of Pomology. The surveys were taken from three general areas (see appendix 5):

- the Wielkopolskie region (western Wielkopolskie, 4 surveys; southern Wielkopolskie, 2 surveys; and northern Wielkopolskie, 6 surveys);
- Central Poland (the Mazowieckie and Lodzie regions, 15 surveys);
- Eastern Poland (the Lubeleskie and Rodomskie regions, 9 surveys).

In Michigan, 4 focus groups were held; 2 in the northwest, one in the west central growing region and one in the southwest growing region (see appendix 5). The first northwest Michigan group was organized for "large" farmers with approximately 200 acres or more. The second northwest Michigan group was organized for "small" farmers with approximately 200 acres or less. During each focus group, farmers were instructed to discuss and agree upon the cost of all activities that take place during their production year on a 200 acre farm with 100 acres of tart cherries during the peak production of an orchard with a 25 year life cycle.[7] Focus groups also discussed and agreed upon the cost of removing, planting and establishing an orchard, as well as the cost of conducting post harvest activities.[8] Michigan and Poland data was supplemented through call back

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[7] When focus groups were divided by large and small farm sizes, the participants were instructed to estimate costs for the same size farm (200 acres with 100 acres of tart cherries).
[8] Post harvest activities include the cost of shipping fruit to processors, operating cooling pads, etc.

interviews with participating farmers and interviews with representatives of the nursery industry, agricultural equipment dealers, and local extension agents.

3.1 Poland Data Collection

Farmers in Poland responded to questions covering multiple components of the cost of production. These include:

1) Farm use, which includes the area of land owned and rented, the area of land planted to tart cherries, the variety of tart cherries planted and tart cherry planting densities;

2) Operation costs, which include the cost of pruning trees, mowing orchards, controlling weeds and bird control, all of which are broken down by the cost of machinery, wages, materials, and equipment maintenance;[9]

3) Crop protection costs, which include the cost of purchasing and applying herbicides, insecticides, fungicides and fertilizer costs, also broken down by the costs of machinery, wages, materials, and equipment maintenance;

4) Harvesting costs, which include the cost of hand-harvest labor, fruit hauling and cold storage, again broken down by the cost of machinery, wages, materials, and equipment maintenance;

5) Land values and interest rates, which include the value of land per hectare, annual property taxes and the cost to borrow money for both long term farm improvements and annual operations;

6) Demographic information such as age, gender, education levels, and employment of all farm household members.

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[9] Equipment maintenance includes non-cash depreciation and maintenance costs.

7) Additional questions regarding how product is marketed, demand characteristics for fruit quality, and opinions on the future of tart cherry production in Poland.

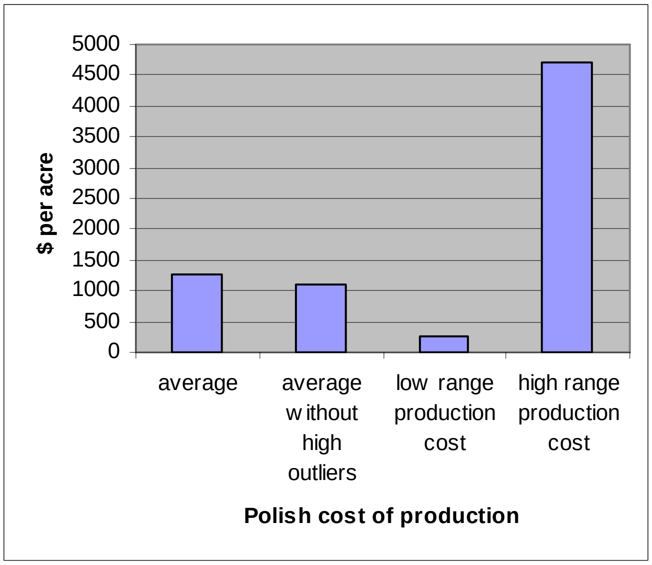
3.2 Poland Data Descriptions

3.2.1 Farm Use

Polish production costs are shown in figures 3.2, 3.2 a, and 3.2b.[10] Figures 3.2 and 3.2b shows that the average Polish cost of production among respondents is $1,279 per acre with a range of $271 to $4,709 per acre. This shrinks to $1,103 per acre with a range of $271 to $2,322 per acre when outliers that represent farms experimenting with overhead harvesters are removed. Figure 3.2b demonstrates that although the range of production values is great, nearly 60 percent of those surveyed are concentrated closely around the average. Figure 3.2a shows that harvesting and fungicide expenses are reported as the largest cost components (32 and 23 percent, respectively), which is similar to Michigan cost shares (see section 3.4). High fungicide costs, like Michigan, are primarily due to the high cost of materials. High harvesting costs, unlike Michigan, are due to labor expenses. Given the cost similarities between the two regions, it appears likely that changing from hand-harvest to machine-harvest will not drive down production costs on a cost per acre basis. The cost per unit of production, however, may be influenced by new harvesters.

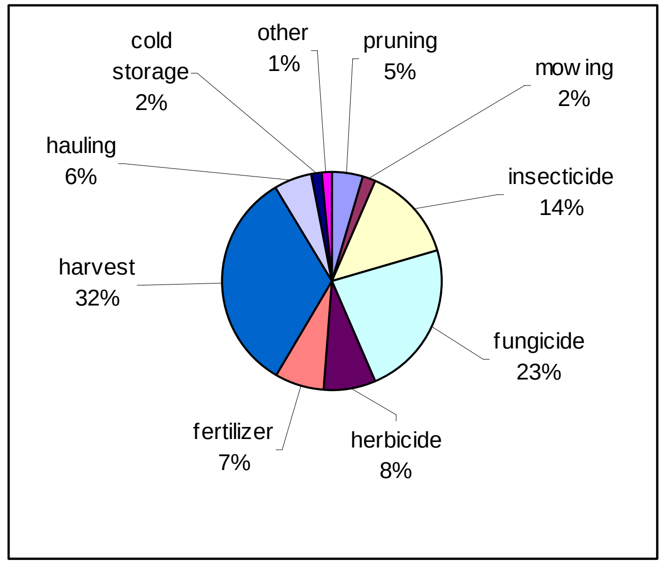
[10] Side by side comparisons of Michigan and Polish production costs can be seen in Appendix 4: Michigan and Polish Production Costs.

Figure 3.2: Polish Cost of Production Range and Averages



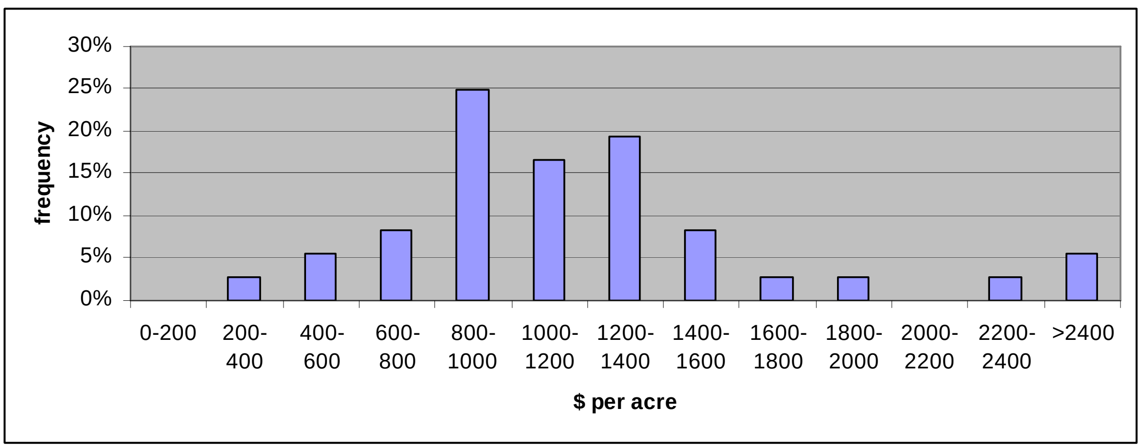
Source: Polish Tart Cherry Survey, 2004

Figure 3.2a: Polish Average Cost of Production Breakdown[11]



Source: Polish Tart Cherry Survey, 2004

Figure 3.2b: Distribution of Polish Cost of Production



Source: Polish Tart Cherry Survey, 2004

Surveyed farms reported an average size of 26 acres with a range of 10 to 254 acres. Amongst these Polish farmers, 22 percent rent land, with an average rental size of 15 acres, or 41 percent of the average farm size. None of the surveyed farmers planted

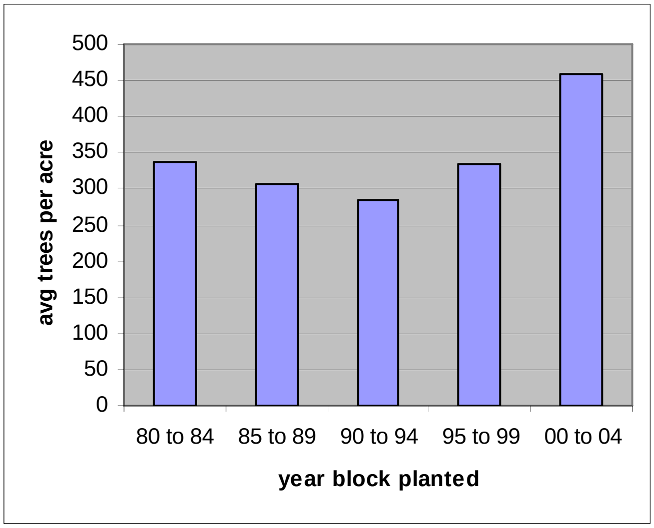
[11] Figure 3.2a is based on a cost of $1279 per acre. "Other" refers to miscellaneous crop protection and operations costs such as setting stakes, bee rental, irrigation and mouse control.

cherries on rented land.[12] There does not appear to be a clear trend in land rentals amongst different farm sizes nor amongst farms with larger or smaller acreages devoted to tart cherries. The most common variety of tart cherry planted is Lutowka (English Morello), although Nefris, Kelleris 16, Pandy, Ujfehertoi Furtos (Balaton) and North Star varieties were also reported. Of the 36 farmers interviewed, 28 farms had planted new blocks in the last 5 years. Of these, only 3 plantings were not English Morello. No plantings of Balaton cherries were reported in the last ten years among those interviewed.

Tart cherry planting densities ranged from 500 to 2850 trees per hectare, or 200 to 1150 trees per acre. Figures 3.2c and 3.2d document trends in planting density and in planting frequency. Figure 3.2c demonstrates that planting densities have increased in the last 5 years while Figure 3.2d demonstrates that the number of new plantings has increased over the past 25 years but especially in the last 10. These graphs imply that not only have Polish farmers been optimistic about the prospects for tart cherries in the past ten years, but that they are developing and standardizing their production techniques. Over the long run, it can be expected that average planting densities will stabilize near an optimal level determined by new technology and the biological parameters of each farming region.

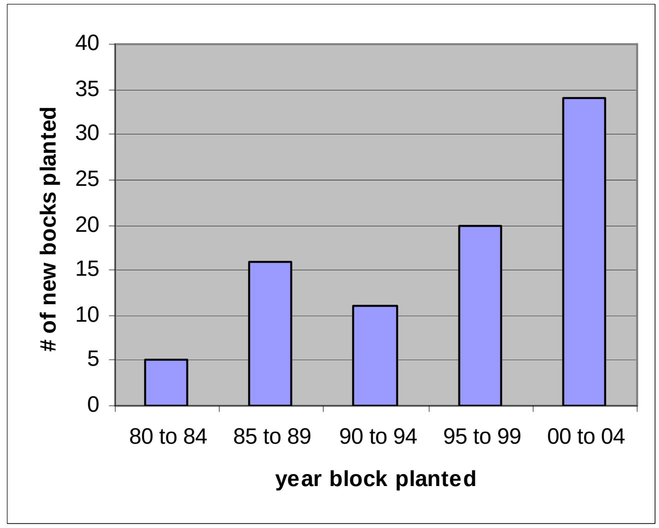
[12] This was expected given that cherries are perennial crops and farmers do not yet have access to long-term leases.

Figure 3.2c: Polish Planting Density History



Source: Polish Tart Cherry Survey, 2004

Figure 3.2d: Polish Planting History

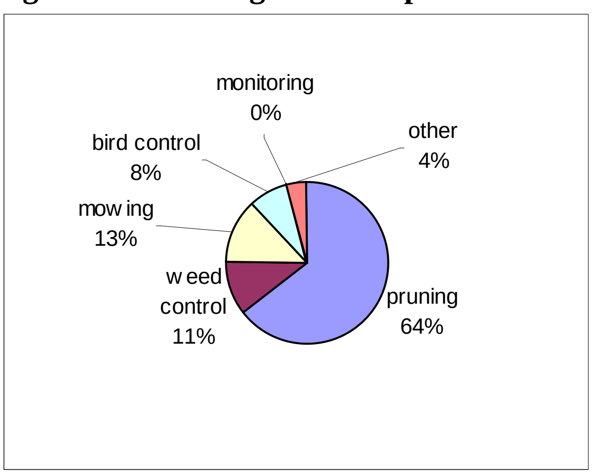


Source: Polish Tart Cherry Survey, 2004

3.2.2 Operations, Crop Protection and Harvesting Costs

Operation costs refer to all annual costs other than harvest and chemical costs (figure 3.2e). Operation costs make up 8 percent of the total reported cost of production on average. Within operations, the most important expense is pruning (64 percent). Given that pruning is labor intensive, wage rates may drive cost increases in the future. Even so, the overall influence of increased pruning expenses may not be great, since pruning makes up only approximately 5 percent of the average total budget.

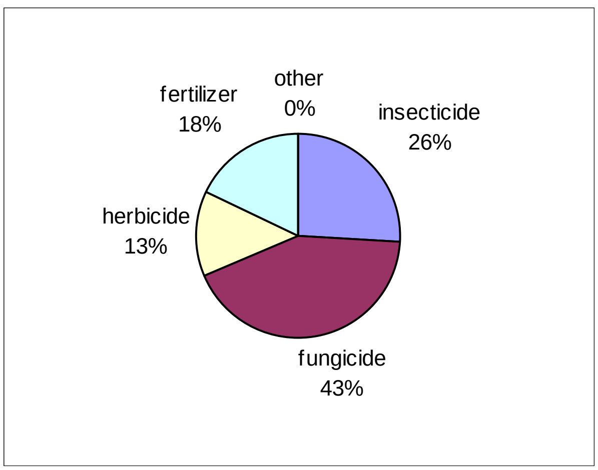
Figure 3.2e: Average Polish Operation Costs



Source: Polish Tart Cherry Survey, 2004

Crop protection costs on average make up 43 percent of the total cost of production (see figure 3.2a). Of interest is the high cost of fungicide applications, which is driven up by the high cost of materials. Fungicide material purchases make up 18 percent of average Polish producer's cost of production (see figure 3.2a) and 43 percent of average chemical purchases (see figure 3.2f). Polish growers indicated that "Miedzian," "Captan," "Rubigan," "Syllit," and "Punch" were the most frequently used fungicides; "Owadofos," "Decis" and "Pirimor" were the most frequently used insecticides; and "Roundup" and "Chwastox" were the most frequently used herbicides.

Figure 3.2f: Average Polish Crop Protection Costs[13]

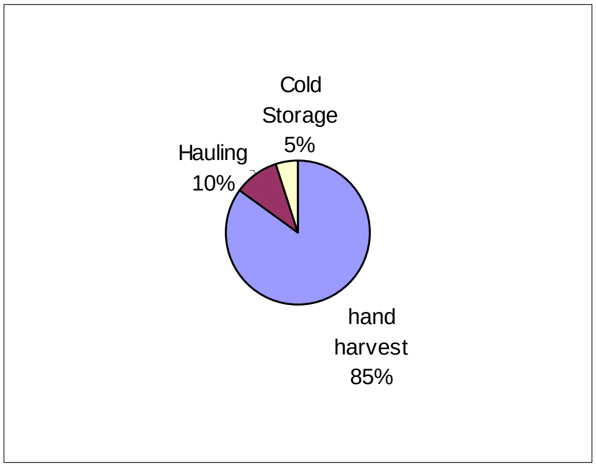


Source: Polish Tart Cherry Survey, 2004

Harvesting costs make up 45 percent of Poland's average total cost of production (figure 3.2g). The single most important expense within harvest costs is the cost of labor, which alone accounts for 35 percent of the total cost of tart cherry production. Hauling and cooling costs are less significant, which is partly due to the large role brokers play in Polish tart cherry markets and the fact that the only tart cherry farmers who provide their own cold storage are those that also grow apples.

[13] Average Polish Crop Protection Costs refers to all materials, labor, and machinery costs. The average crop protection cost is approximately $550 per acre

Figure 3.2g: Average Polish Harvest Costs[14]



Source: Polish Tart Cherry Survey, 2004

The role of brokers is an important one in Polish harvesting costs, and one that will evolve as Polish producers become more concentrated. Currently, brokers provide almost all transportation and harvest containers, and also manage nearly all export sales. Some larger growers receive price premiums to deliver directly to processors using their own transport and containers. The large majority of Polish growers are, however, too small to gain any advantages from managing their own containers and transport and are also unable to negotiate direct sales to processors due to a lack of volume. The implication of this is that as more small growers exit the Polish market, the growers that remain will more than likely see their transportation and container related costs increase and their fees paid to broker decrease.[15] This process may evolve more slowly in the case of export sales, which depend heavily on brokers for information and contacts.

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[14] Average Polish harvest costs are approximately $575 per acre.
[15] Brokers do not actually receive a fee. They are normally compensated by paying growers a lower price per pound.

3.2.3 Land Values and Interest Rates

Reported land values averaged $1,637 per acre and ranged from $443 to $5,540 per acre. After removing data falling outside of 2 standard deviations, the average falls to $1,407 per acre and the range reduces to $443 to $3,435 per acre.[16] A wide range of long-term interest rates were also reported.[17] These fell between 1.2 percent and 15 percent. Short-term rates also varied considerably, ranging between 1.4 percent and 15 percent. Growers commented in the surveys that long term investments were subsidized by the SAPARD program, which reimbursed 50 percent of their farm investments.[18]

3.2.4 Demographic Information

The average Polish farm family surveyed had 4 members, 2 of whom worked on the farm. On average, family members had 15 years of education, or the approximate equivalent of a Bachelors degree in the United States. The average age of a grower is approximately 45 years old. Age distribution (shown in figure 3.2h) shows that approximately 70 percent of growers are between 41 and 55 years, 10 percent are between 56 and 65 years and that 20 percent are between 21 and 40 years.

The age distribution shows that although more growers have entered in the last ten years than those who will retire in the next 10 years, the majority of farmers are in the 41 to 55 year bracket, and will be retiring within 10 to 25 years. The implication of this is that despite the overall enthusiasm that Polish farmers have shown for the industry (i.e. increased plantings in the last 5 years), fewer members of the youngest generation are

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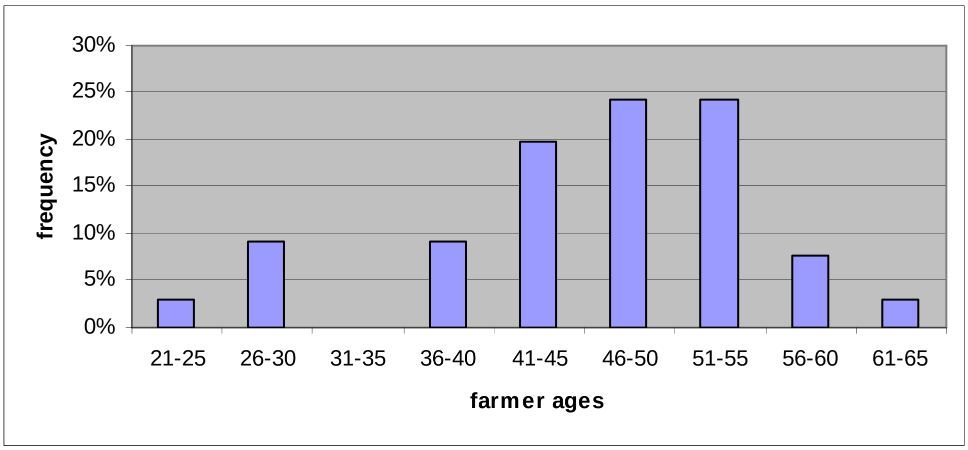
[16] The large range of land values is possibly due to speculation in the land market after accession to the EU.
[17] The large range of interest rates is possibly due to the presence of an informal credit market.
[18] SAPARD, or the Special Accession Programme for Agriculture & Rural Development, is a European Union program intended to help the 10 beneficiary countries of Central and Eastern Europe deal with the problems of structural adjustment in their agricultural sectors and rural areas during their accession to the EU.

becoming farmers, suggesting that young people have better off-farm employment options. The trend of fewer younger people entering the tart cherry market supports the trend of increasing farm sizes, more efficient farms, and predictions for a more concentrated industry, especially as the current generation of 40 to 65 year old farmers retire.

Figure 3.2h Polish Farmer Age Distribution

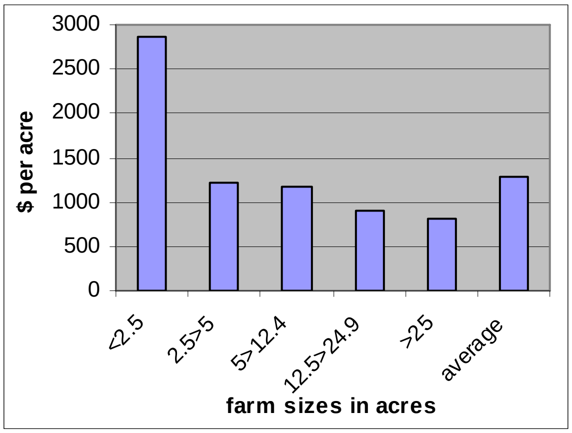


Source: Polish Tart Cherry Survey, 2004

3.2.5 Other Poland Data Observations and Trends

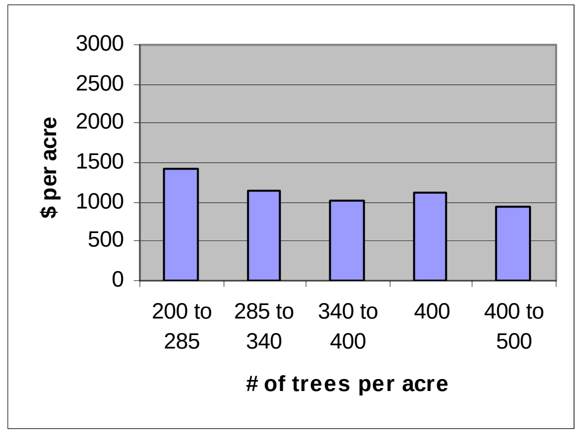
Polish data shows a clear trend of decreasing costs as farm size increases, with farms smaller than 2.5 acres having the above average cost of $2,794 per acre and farms larger than 25 acres having a below average cost of $829 per acre (figure 3.2i). Polish data also shows a trend of decreasing costs when cost of production data is organized by planting density (figure 3.2j). The density measure shows a range of $1,430 per acre when 200-285 trees per acre are planted and $829 per acre when 400-500 per acre are planted. These trends imply that larger, higher density farms are more efficient than smaller, low density farms. A possible explanation of this trend is that of the 125,000 Polish farmers with less than 2.5 acres, many are not specialized in tart cherry production and may operate in a less efficient manner than larger farms. Figure 3.2k shows a clear trend of increased specialization as farms increase in size. For example, farms smaller than 2.5 acres plant less than 10 percent of their land to tart cherries while farms larger then 25 acres plant up to 50 percent of their land to tart cherries.

Figure 3.2i: Polish Cost of Production per Acre



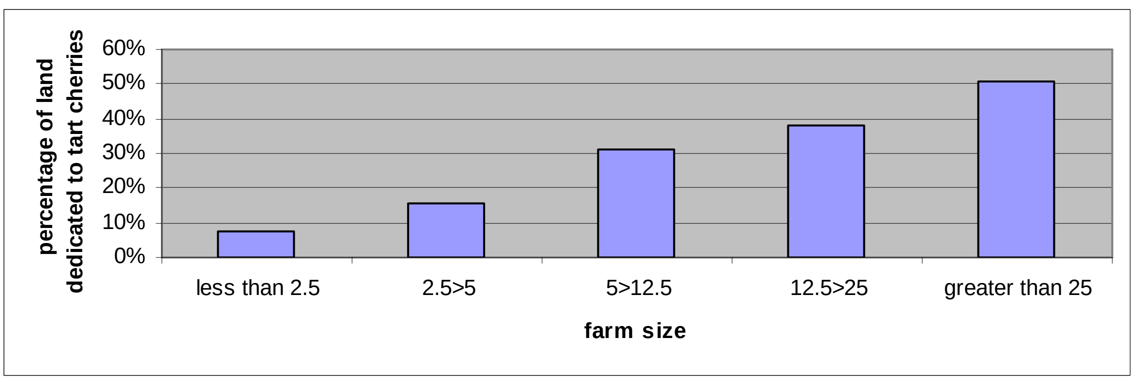
Source: Polish Tart Cherry Survey, 2004

Figure 3.2j: Polish Cost of Production by Tree Planting Density



Source: Polish Tart Cherry Survey, 2004

Figure 3.2k: Polish Crop Specialization



Source: Polish Tart Cherry Survey, 2004

The level of specialization amongst Polish farmers reveals other interesting characteristics. Of the 133,343 plus tart cherry growers in Poland, the majority are producing either as subsistence farmers or as part-time growers. These growers sell primarily to brokers, who in turn sell a lower quality product that is not traceable back to a particular grower and is not likely acceptable outside Poland and some eastern

European markets. Larger Polish growers, on the other hand, offer a product with characteristics such as traceability and other physical attributes that are acceptable on the international market. As a result, it is likely that Polish producers competing for lucrative tart cherry markets in Germany and the United States make up only a small portion of the total producers in Poland.

3.3 Michigan Data Collection

Focus groups in Michigan discussed and agreed upon costs that best represented a farm of 200 acres with 100 acres of tart cherries. The discussion started with the assumption that the orchard being discussed was in its 12th year of production (i.e. full production). Growers agreed on the typical equipment that is used for a given task and then agreed on the amount of time necessary for the task, materials cost, and machinery cost. Growers also agreed on wage rates for different skill levels and assigned a skill level to each task. Non-cash costs of capital recovery, storage, repairs and insurance were estimated using American Society of Agricultural and Biological Engineers formulas (ASAE, 2003). Chemical material costs were estimated by collecting grower spray records and calculating average quantities applied. Growers then followed the same exercise in order to establish the cost of removing and replanting an orchard, as well as giving a detailed budget for the first five years of the orchard’s life-cycle before trees are normally harvested. Growers also discussed the orchard life-cycle, estimating typical yields at various ages and indexing production costs to yields.

3.4 Michigan Data Descriptions

Michigan cost of production can be viewed by region. Figure 3.4 shows the average cost of production in each production region, with the northwest region divided into large and small growers. Results indicate small northwest growers have a higher cost of production than the other three groups. This measurement may be slightly over-reported due to variability in the cost of used harvesters. For example, some growers from northwestern Michigan with less than 200 acres reported purchasing used harvesting equipment for prices as low as $5,000.[19] This is compared to the average value established by the cost of production focus group of $85,000. It was also assumed that large growers use new shakers, which currently sell for $160,000. High quality used equipment and factory-rebuilt shakers may reduce harvest costs substantially for small northwest growers.

Michigan data shows that on average, growers across all regions, regardless of size, reported an annual cost of production of $1,176 per acre. The range of costs falls between $1,040 and $1,369 per acre. Of interest is harvest cost, which, like Poland, is Michigan's largest expense at 35 percent (figure 3.4a). Crop protection costs, again like Poland, are lead by the high cost of fungicides, which make up 15 percent of the total budget.

A brief summary of different production costs shows the following:

1) Pruning costs make up the largest portion of cultural expenses (68 percent), due to the high cost of labor. Pruning makes up 10 percent of the total budget.

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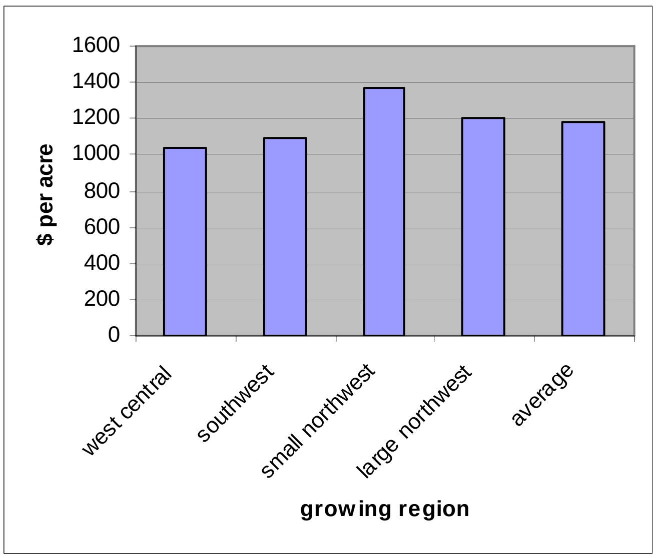
[19] $5,000 is the extreme low-range of the reported purchase costs of tart cherry harvesters. This figure does not, however, include the cost of reconditioning and maintenance.

2) Harvest costs are driven up by the high cost of owning a cherry shaker; however, high labor costs and other equipment costs (fork lifts and tractors) also contribute significantly. Shakers make up 25 percent of the harvest budget and account for 9 percent of the total cost of production.

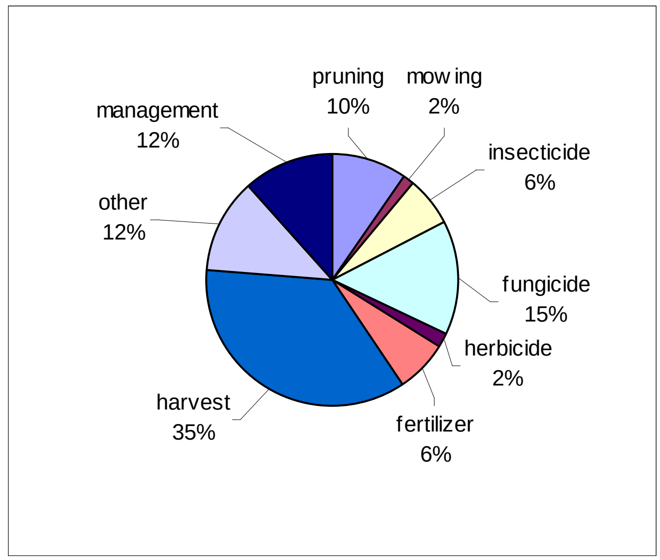
3) Chemical costs are lead by fungicide costs. Figure 3.4b shows all chemical inputs.

Figure 3.4: Michigan Cost of Production by Region



Source: Michigan Tart Cherry Focus Groups, 2004

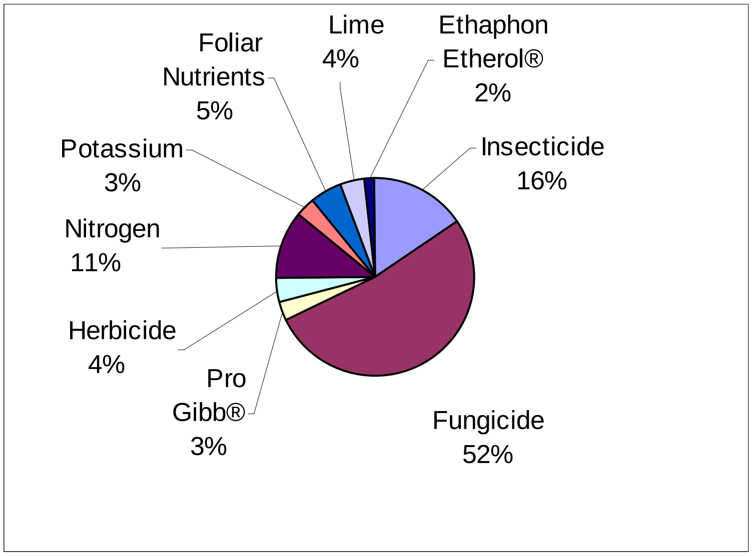
Figure 3.4a: Michigan Average Cost of Production Breakdown [20]



Source: Michigan Tart Cherry Focus Groups, 2004

[20] Note that "Other" in figure 3.4 refers to gibberellic acid applications, pickup truck operation, property taxes, interest on operating capital, I.P.M. service and bee rental. The average cost of production in Michigan is $1176 per acre

Figure 3.4b: Average Michigan Crop Protection and Fertilizer Costs [21]



Source: Michigan Tart Cherry Focus Groups, 2004

3.5 Historic Price and Yield

In order to calculate break-even price and yield and threshold farm size, a time series of regional yield and price data is necessary. In Poland, historic data is collected and made available from the Institute of Rural Economics. In Michigan, similar data is available from the National Agricultural Statistics Service (N.A.S.S.), Michigan Agricultural Statistics. (See appendixes 6 and 6a).

Of interest in the secondary data is the clear trend of increasing production in Poland. According to the Polish Institute of Rural Economics, this trend is due to increased plantings, resulting from "an increased demand for tart cherries in Europe, mainly in Germany, as well as the stagnation of tart cherry production in Serbia and Hungary" (Institute of Rural Economics, 2005). Polish yields have also been increasing due to increased efficiency in tart cherry production techniques that are the result of the development of more intensive orchards.

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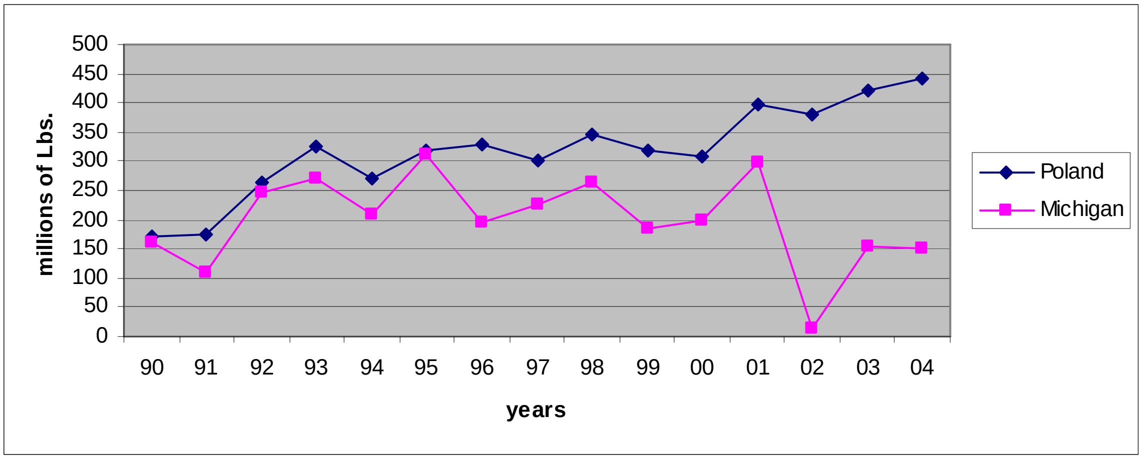
[21] The average cost of chemicals in Michigan is $277 per acre. This breakdown only represents chemical costs. The costs of labor and machinery are not included.

Figures 3.5 and 3.5a display total Polish and Michigan production and acres planted since 1990. Not only is Polish production increasing, but it appears to have less variation than Michigan production. Polish acres planted increased rapidly during the early 1990's, but have since stabilized while Michigan acres planted have declined slightly, but generally remained constant throughout the entire period. The implication of these trends is that in Michigan, farms have generally consolidated as farmers have exited, although some tart cherry land has gone to other crops or housing development.[22] Polish farms have expanded production due to good tart cherry prices and favorable government incentives such as SAPARD. Polish area planted may decline over the long run if small farmers exit the tart cherry market and choose to convert their small holdings for alternative personal use. Planted area may also decline if prices decline or production costs rise. In terms of per unit production costs, these trends imply that Polish farm yields are increasing faster than area planted and therefore per unit costs are likely decreasing. Michigan farm yields are highly variable and are neither increasing or decreasing while area planted is stable, implying that per unit costs are relatively stable.

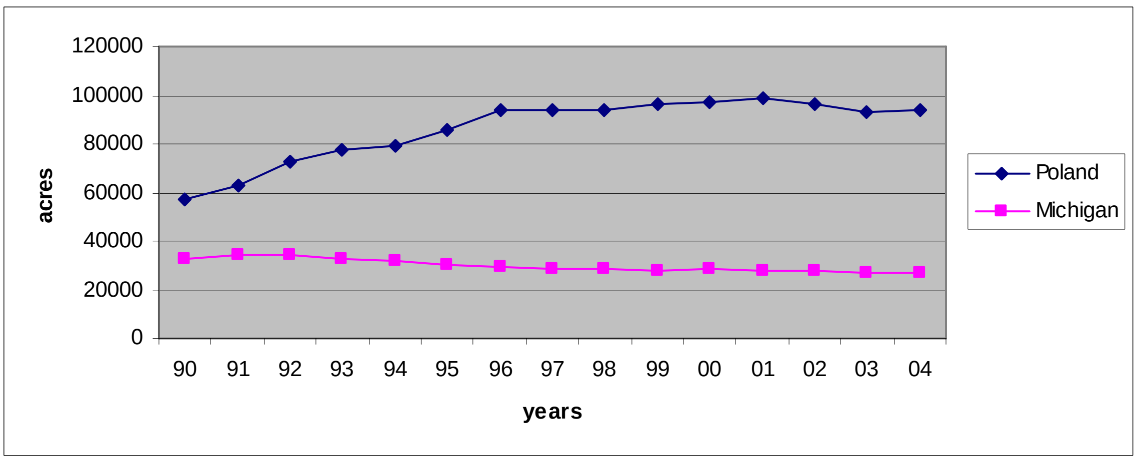
[22] The consolidation of Michigan tart cherry farms is evidenced by the decrease in the number of tart cherry farmers in Michigan compared to the overall stability of total acres planted. In 1994 there were 845 tart cherry farmers in Michigan while today there are 600 (*Michigan Fruit Inventory*, National Agricultural Statistics Service, 2004). This is compared with the total acres planted, which has remained fairly constant during this same time period (see figure 3.5a).

Figure 3.5: Total Michigan and Polish Production in Millions of Pounds, 1990-2004



Source: Institute of Rural Economics, 2005 and USDA Non-Citrus Fruits and Nuts, Various Issues, 2005

Figure 3.5a: Michigan and Polish Acres Planted, 1990-2004



Source: Institute of Rural Economics, 2005 and USDA Non-Citrus Fruits and Nuts, Annual Summaries, 2005

3.6 Projected and Claimed Price and Yield

Historic data is advantageous because it captures proven yield cycles and variations. Historic data, however, has some disadvantages when projecting future trends. These disadvantages include an inability to account for future factors that may influence yields and prices and the fact that individual growers in both regions are able to achieve yields consistently above average. For example, many Michigan growers claim that the 7000 pounds/acre state average is inaccurate, and that 10,000 pounds/acre is closer to what they receive. (Michigan Producer Focus Groups, 2004). Polish experts have indicated that a better estimate of yields is three times greater than the average reported by the Institute of Rural Economics (Kurlus, Personal Communication, 2005).[23] In response to these criticisms, two forms of simulated price and yield are used for break-even calculations in this analysis.

Two forms of simulated price and yield are based on models developed for the Michigan industry by Beedy, Nyambane and Black. In Michigan simulated yields assume that orchards will first yield at year 6, that yields will increase linearly until year 12 when the orchard reaches full production, and that starting at year 22, orchard yields will start to decline (figure 3.6). Simulations for the Polish industry adopts the same pattern, with the difference that production starts in year 3, peak production starts in year 8 and ends in year 22. Simulated Michigan prices are taken from the Tart Cherry Investment Tool (Pileus Project, 2005), which estimates expected price as an average of historic Michigan price.[24] Polish simulated price is based on the same concept.

There are two different forms of simulations. The first, referred to as "projected," is based on reported average yields. Under this simulation, Michigan yields will change at the rate outlined by Beedy et al. but the actual quantities yielded are indexed to the reported state average. Polish "projected" yields are calculated using the same concept. The second simulation, referred to as "claimed," was developed in response to growers in both regions who claimed that the reported averages were too low. Claimed simulations

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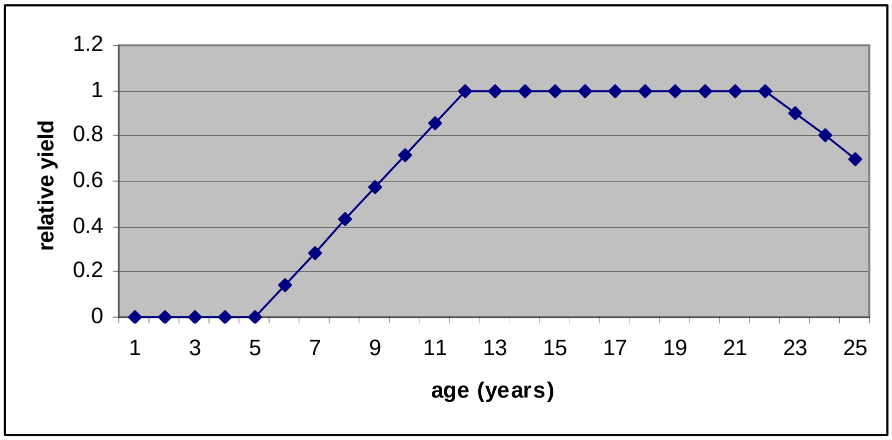
[23] Individual Polish growers report average yields between 12,000 to 15,000 pounds per acre, and have experienced yields as high as 25,000 pounds per acre (Thornsbury, personal correspondence, 2004). The figure of 11,000 lbs per acre suggested by Kurlus represents the most conservative estimate.

[24] The Tart Cherry Investment Tool simulates tart cherry yields based on the model by Beedy et al. The average of all simulated yields throughout the lifespan of an orchard are calibrated to equal the average historic yield of an orchard of the same age.

follow the same procedure as projected simulations, with yield indexed to the values cited by Polish and Michigan growers rather than reported average yield.

Figure 3.6: Michigan Simulated Yield Cycle



Source: Beedy, Nyambane and Black, 2005

3.7 Cost per Unit Estimation

Cost of production on a per pound basis depends critically on total cost and yield per acre. Wide variation in production techniques complicates the ability to accurately specify a representative Polish yield per acre and per acre production cost. Two points indicate that Polish yields per acre are higher than Michigan yields per acre. First, reported planting densities in Poland vary from 200 to 1250 trees per acre (see figure 3.2c Polish Planting Density History). Michigan planting densities average 120 trees per acre, have a very small range (perhaps 110 to 130 trees per acre), and are planted at this density in order to optimize yields while using shaker-style harvesters (see section 1.2). [25] Given that it costs Polish farmers more to plant higher density orchards, it is likely that their incentive to do so is higher yields. Michigan farmers, on the other hand, might plant higher density orchards if harvesting technology permitted it. The second point is that Polish farmers have all claimed a range of yields much higher than Michigan growers

[25] There are a limited number of Michigan orchards with planting densities greater than 150 trees per acre. These orchards are unusual and are difficult to harvest with conventional harvesters.

(see sections 3.6). Polish growers have claimed that they are able to average yields ranging from 12 to 15 thousand pounds per acre, and have experienced yields as high as 25 thousand pounds per acre (Thornsbury, personal correspondence, 2004).[26]

If higher yields are realized, it is reasonable to conclude that Polish per unit costs are lower than Michigan per unit costs. The magnitude of the difference however, is uncertain. Table 3.7 shows an estimate of cost per pound based on 2004 reported high, low and average production costs per acre and average historic and claimed yields.[27] Polish production costs range from $271 to $2322 per acre compared to the much smaller range of $1040 to $1369 per acre reported for Michigan production. Per pound costs calculated from average production costs and claimed yields demonstrate that Polish per unit cost is likely slightly lower than Michigan costs. This conclusion seems reasonable considering that the Polish claimed 11,000 pounds per acre is a conservative estimate that could easily rise as high as 15,000 pounds per acre.

Table 3.7: Cost per Pound Estimates

Michigan				Poland			
cost per acre (outliers removed)		reported yield (6,872)	claimed yield (10,000)	cost per acre (outliers removed)		reported yield (4,719)	claimed yield (11,000)
		$/pound	$/pound			$/pound	$/pound
average	$1,176	.171	0.117	average	$1,103	.233	.100
high	$1,369	.199	0.136	high	$2,322	.492	.211
low	$1,040	.151	0.104	low	$271	.057	.025

Source: Author's calculation, 2005

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[26] Claimed Polish yields, however, are listed by the most conservative estimate of 11,000 lbs per acre (Kurlus, 2005). Michigan growers have claimed average yields closer to 10,000 pounds per acre (see section 3.6).

[27] Michigan average historic yields per acre were calculated from the years 1985 to 2004. 2002 was omitted. Polish historic yield is represented by the 2004 yield due to the fact that Polish yields are increasing.

3.8 Concluding Points

Overall, Michigan and Poland have similar production costs per acre. Polish growers have demonstrated they are becoming more efficient by improving yields per acre. There are many incentives for Polish farms to become larger in size and fewer in number including economies of scale, improved vertical coordination and better off-farm options for younger workers. These factors suggest that over the long-term Michigan and Poland production costs on a per acre basis will converge.[28]

Michigan and Polish growers will likely be vulnerable to production cost changes in any category that is tied to wages. Poland, however, will also likely see cost increases related to the eventual exit of tart cherry brokers. These cost increases however, may be accompanied in the short-run by price premiums offered to vertically aligned growers. Over the long-term, higher prices gained by taking on the roles of brokers will depend on how well tart cherry farmers are able to organize and influence prices.

[28] Production costs on a per unit basis may also converge in the event that both production regions adopt the same production techniques.

CHAPTER FOUR

RESULTS

4.1 Break-Even Analysis

Break-even analysis is used to estimate the minimum price and yield necessary to remain competitive at a given level of production costs. For an annual crop, break-even analysis is normally calculated as:

$$break-even\ price = \frac{total\ \ production\ cost}{average\ \ yield}$$

and

$$break-even\ yield = \frac{total\ \ production\ cost}{average\ \ price}.$$

For the purposes of this study however, economic valuation techniques are adapted to account for perennial crops. The following methodology describes these calculations, which are shown in Appendixes 7 through 7d.

1) Each calculation assumes that an orchard will last 25 years and that the orchard is left fallow during year 0. In Michigan it is assumed that an orchard will bear fruit from year 6 until year 25. In Poland it is assumed that an orchard will bear fruit from year 3 until year 25.

2) The discount rate was chosen in order to represent grower's second best option. It is set at 4.5 percent in order to represents the 30 year bond rate.

3) Michigan production costs are based on primary data and are shown on a per acre basis. Years 0 to 5 show establishment and maintenance costs for young, unharvested orchards. These costs are shown in appendix 10d. Years 6 through 25 show annual costs of harvested orchards. Production costs for years 6 to 25 are itemized in appendixes 10,10a, 10b and 10c.[29] Annual costs from years 6 to 25 are adjusted in order to reflect the yield variations that orchards experience as they mature (see figure 3.6). As a result, years 12 through 22 show full production costs while years six to 11 increase in order to reflect gradually increasing yields. Likewise, years 23 to 25 decrease in order to demonstrate decreasing yields. Average costs from years 6 to 25 are indexed to the focus group average costs. Thus, the average of the production costs from years 6 to 25 equals approximately $1,173 per acre. Table 4.2 shows the percentage cost adjustments for years 6 through 11 and years 23 through 25.

Table 4.1: Estimated Percentage Reduction in Production Costs Due to Less than Full Average Yields in Michigan Orchards

6	7	8	9	10	11	23	24	25
-12.5%	-11.1%	-8.3%	-5.5%	-3.3%	-1.67%	-1.167%	-2.3%	-3.5%

4) Polish production costs are based on primary data and are shown on a per acre basis. Years 0 to 2 show establishment and maintenance costs for young, unharvested orchards. Polish establishment costs differ from Michigan establishment costs in that they are estimates. These cost estimates are listed in appendix 11a. Years 3 through 25 show annual costs of harvested orchards and like Michigan are adjusted in order to reflect the yield variations that orchards

[29] Note: land values are not included in Michigan or Polish production costs given general disagreement between growers as to a standard value.

experience as they mature. Thus, years 8 through 22 show full production costs, years 3 to 7 increase in order to reflect gradually increasing yields and years 23 to 25 decrease in order to demonstrate decreasing yields. Average costs from years 3 to 25 are indexed to the average costs indicated in the Polish production cost survey ($1,279 per acre). Table 4.1a shows the cost changes for years 3 through 7 and years 23 through 25.

Table 4.1a: Estimated Reductions in Production Costs Due to Less than Full Average Yields in Polish Orchards

3	4	5	6	7	23	24	25
-18.2%	-14.5%	-10.9%	-7.2%	-3.6%	-2.1%	-4.3%	-6.5%

5) Michigan yield for break-even price is based on three different estimations. These estimations are referred to as historic, projected, and claimed.

a) The first Michigan estimation, historic yield, is shown in Appendix 7. Historic yield is based on actual yields reported by the National Agricultural Statistics Service, but has been adjusted by indexing historic yields to Beedy and Black's model (see figure 3.6) in order to simulate the orchard's production cycle. This adjustment is made by multiplying the actual historic yield by the factor shown in the budget entry "Beedy's Model" in appendix 7.

b) The second Michigan estimation, projected yield, is shown in appendix 7a. This yield is constructed by selecting values that follow the cycle of Beedy and Black's model and whose average from years 6 to 25 is set equal to the historic average reported by the National Agricultural Statistics Service (6556.5 pounds per acre from 1985 to 2004).

c) The third Michigan estimation, claimed yield, is shown in appendix 7b. Claimed yield is identical to projected yield, with the exception that instead of setting the average of years 6 to 25 equal to 6556.5 pounds per acre, it is set to equal 10,000 pounds per acre, the average yield that Michigan farmers claim they are able to achieve.

6) Polish yield for break-even price is based on the historic, projected and claimed yields.

a) The first Polish estimation, historic yield, is shown in appendix 7. Like Michigan estimates, historic yield is based on actual yields reported by Poland's Institute for Rural Economics. Unlike Michigan estimates, pre-1990 data is unavailable, and as a result, is estimated by replacing the years 1979 to 1989 with data from 1994 to 2004. Historic yields are indexed to a yield cycle model by multiplying the historic yield by the factor which is shown under the entry "Beedy's Model" in appendix 7.

b) The second Polish estimation, projected yield, is shown in appendix 7a. This yield is constructed by selecting values that follow a yield cycle model. Unlike Michigan, projected yield was not set to equal a reported multi-year average. Instead, the average of projected yield was set to equal the most recent value reported by the Polish institute for Rural Economics (4719 pounds per acre for 2004). The reason for this is that the Polish industry is reporting increasing yields from year to year, and an historic average does not represent present day and future yields.

c) The third Polish estimation, claimed yield, is shown in appendix 7b. Like, Michigan claimed yield, Polish claimed yield is identical to projected yield, with the exception that instead of setting the average of years 3 to 25 equal to the National Agricultural Statistics Service's average from years 1985 to 2004, it is set to equal 11,000 pounds per acre, the average yield that Polish farmers claim they are able to achieve.

7) Yield for Michigan and Polish break-even yields is held constant throughout each multi-year budget. Each yield was set at the point where NPV equals 0.

8) Michigan price for break-even yield is based on two different estimations. These estimations are referred to as historic and projected.

a) Michigan historic break-even yield is calculated using historic price and is shown in appendix 7c. Historic prices are published by the National Agricultural Statistics Service and are not adjusted.

b) Michigan projected prices are a price cycle estimate that is shown in appendix 7d. Average prices from 1985 to 2004 are set to equal the historic average price from 1990 to 2004 (21 cents per pound).

9) Polish price for break-even yield is based on historic and projected estimations.

a) Polish historic break-even yield is calculated using historic price and is shown in appendix 7c. Historic prices since 1990 are published by the

Institute for Rural Economics. Price data prior to 1990 was estimated by substituting 1993 to 2004 data for 1979 to1989.

b) Polish projected prices are a price cycle estimate that is shown in appendix 7d. Average prices from 1985 to 2004 are set to equal the historic average price from 1990 to 2004 (18 cents per pound).

10) Price for Michigan and Polish break-even prices is is held constant throughout each multi-year budget. Each price was set at the point where NPV equals 0.

11) Project inflows are the total revenues that a farm should earn on a per acre basis. Appendixes 7 through 7d show inflows as the yield multiplied by price.

12) "Net Cash In" refers to total revenues minus total costs. Appendixes 7 through 7d show Net Cash In as the inflow minus cost.

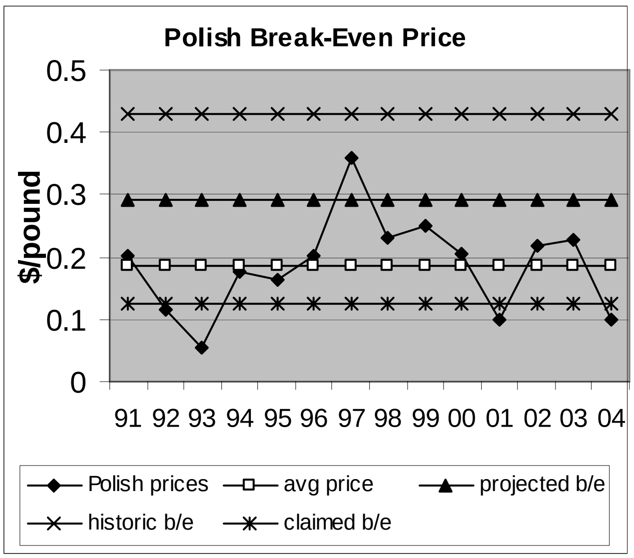
13) "Discount Cash Flow" refers to "Net Cash In" discounted by the discount rate of 4.5 percent.

14) NPV, or net present value, refers to the sum of all discounted cash flows.

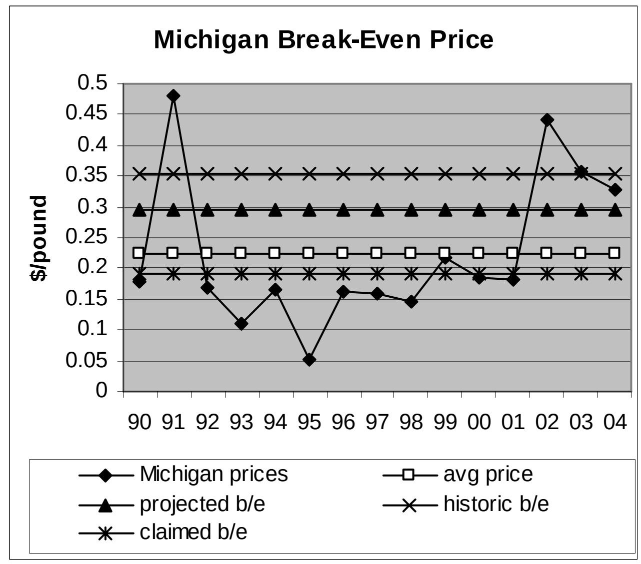
4.1.1 Break-Even Price Analysis

Poland and Michigan break-even price calculations were conducted using standard economic valuation techniques with historic yield data and with two versions of projected yield data. Figure 4.1 and table 4.1 summarize results from three different measures of break-even prices, and compares them with the historic prices that growers received (Polish/Michigan prices) as well as the historic average. The first break-even price, "historic break-even," is calculated by estimating production costs, indexing historic yields to Beedy's Model (section 3.6) and then determining what average price will set net present value equal to zero. The second break-even price, "projected break-even," is calculated the same way, except that projected yields are substituted for historic yields (see section 3.6).[30] The third break-even price, "claimed break-even" is similar to projected yields, except that the projected yield is based on the average yield that growers report they achieve.

Figure 4.1: Break-Even Price



Source: Polish Tart Cherry Survey, 2004 and Author's Calculations



Source: Michigan Tart Cherry Focus Groups, 2004 and Author's Calculations

Table 4.1b: Break-Even Price Data

	Avg. price	Historic break-even	Projected break-even	Claimed break-even
Poland	0.186	0.430	0.293	0.125
Michigan	0.222	0.355	0.295	0.193

Source: Polish Tart Cherry Survey and Michigan Tart Cherry Focus Groups, 2004 and Author's Calculations

Projected and historic yields each have advantages for break-even comparisons. Historic data captures yield cycles and accounts for the relationship between price and yield while simulated data is able to take into account future events that will likely affect yields. At the same time, historic data does not reflect present and future changes in the tart cherry production system and simulated data does not show any relationship between

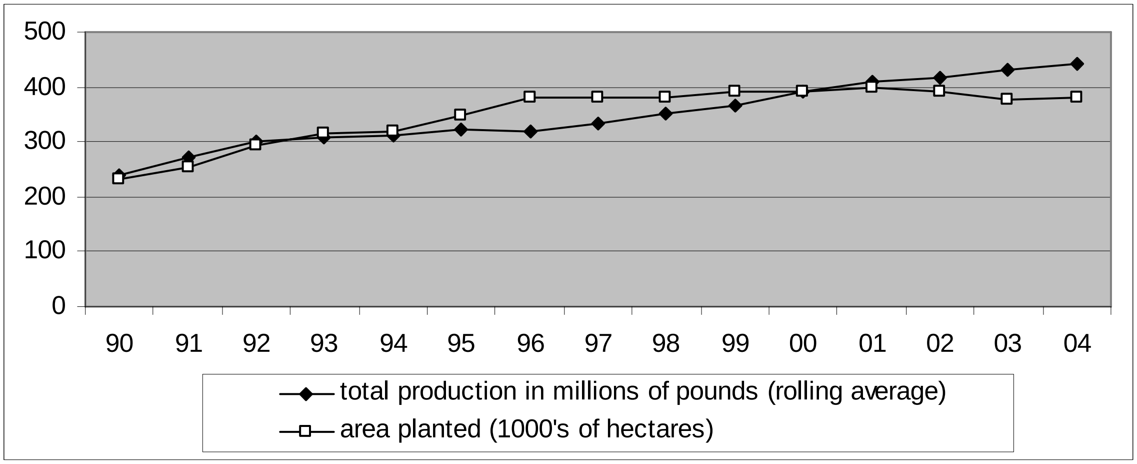
[30] Polish historic yield data prior to 1990 is unavailable from the Institute for Rural Economics. This was corrected by replacing 1979-1989 data with 1994-2004 data. This adjustment is further justified given that the Polish yield and price was distorted by Poland's pre-1990s centrally controlled economy.

price and yield. Growers often fault historic data because regional averages do not reflect their own yields or their particular advantages (such as site, skill, growing technique, overall strategy, and the proportion of bearing orchard to non-bearing orchard).

The results of break-even calculations indicate that historic data is susceptible to the cited disadvantages and therefore produces an inferior estimate. For example, historic break-even prices in Poland and Michigan are significantly higher than average prices received (see figure 4.1 and table 4.1). In the case of Poland, the historic break-even price is two standard deviations greater than the average. Historic break-evens also do not reflect the wide variety of production techniques that are used in Poland. Referring to figures 4.1a and 4.1b, note that Michigan production appears more closely correlated to area planted compared to the Polish data.[31] Polish data shows that yield increases before 1996 were strongly correlated to area planted (.97), while after 1996, yields increased at a faster rate than area planted (correlation between total production and area planted fell to .22). Michigan total production, on the other hand, shows increasing correlation with area planted over time (before 1996 correlation is .24 and after 1996 it is .65). This implies that Michigan production techniques are well-standardized and that yields, although decreasing somewhat, are stabilized. Polish production techniques, on the other hand, are rapidly evolving. More land has come into tart cherry production in recent years and the land that was already in production is producing better yields.

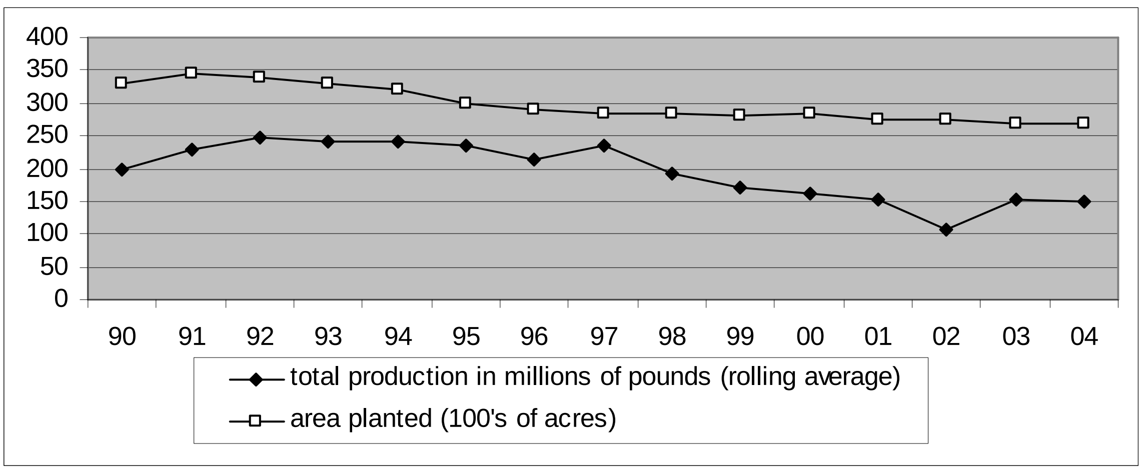
[31] Total production is presented in Figures 4.1a and b as a five year rolling average. Rolling average is the average of the present year plus the four following years. The last four years are shown as the average of each of the years following. Thus, 2002 is the average of 2002, 2003 and 2004; 2003 is the average of 2003 and 2004; and 2004 is unadjusted.

Figure 4.1a: Total Polish Production vs. Area Planted



Source: Institute of Rural Economics, 2005

Figure 4.1b: Total Michigan Production vs. Area Planted



Source: USDA Non-Citrus Fruits and Nuts, Various Issues, 2005

Figures 4.1a and b indicate that Polish producers are increasing their production efficiency by adopting new production methods, while Michigan farmers appear to be using a standard production technique. This implies that as Polish production techniques become more homogenous, the rate of Polish yield change should stabilize. Thus, due to the changes occurring in Polish production techniques, historic yields are not as good an indicator of what is occurring at the present time as are yield projections.

Projected data addresses the problems of historical data by using standard indexed values for yield. Unfortunately, this technique is still susceptible to the same problems of historic data when projected data is indexed to regional average yields because projected yields do not account for the inclusion of non-bearing acres within the regional average and also because many growers claim to achieve higher yields. As a result, a second simulation is calculated where data is indexed to what growers claim they can grow, (i.e. “claimed” break-evens).

Growers in both Michigan and Poland report they are producing higher yields than those cited by either Michigan Agricultural Statistics or the Polish Institute of Rural Economics. In northwest Michigan, farmers claim their average yield is closer to 10,000 pounds (Michigan Producer Focus Groups, 2004). Table 4.1a shows an estimate based on National Agricultural Statistics Service (N.A.S.S.) statistics of historic yields when broken down into regions. Northwest Michigan has substantially higher yields per acre than the west central and southwest regions, and when the 2002 crop is removed from the averages, northwest yields approach 9,000 pounds per acre. N.A.S.S.’s definition of “non-bearing acres,” however, refers only to orchards that are six years old and older. Although this is a good estimate, some northwest orchards may not bear until their 7^{th} or 8^{th} year, in comparison to southwest and west central Michigan orchards, which generally can be harvested earlier. As a result, the grower claimed average yield of 10,000 pounds per acre appears accurate for growers in northwest Michigan.

Table 4.1c: Estimated Michigan Yield Distributed by Region (Pounds per Acre)

Year	Historic Michigan Average	Northwest Michigan	West Central Michigan	Southwest Michigan	Northwest Michigan w/o 2002	West Central Michigan w/o 2002	Southwest Michigan w/o 2002
2004	5520	5919	4035	7568	5919	4035	7568
2003	5700	6525	3980	5990	6525	3980	5990
2002	550	67	657	2024	**X**	**X**	**X**
2001	10840	12391	9206	8553	12391	9206	8553
2000	7020	7095	7481	5482	7095	7481	5482
1999	6580	7571	5122	6450	7571	5122	6450
1998	9260	12841	6295	3961	12841	6295	3961
1997	7920	9665	7469	3301	9665	7469	3301
1996	6700	9919	3590	3818	9919	3590	3818
1995	10330	10996	9452	10000	10996	9452	10000
1994	6560	6443	4944	9722	6443	4944	9722
Avg	**6998**	**8130**	**5657**	**6079**	**8936**	**6157**	**6484**

Source: Michigan Regional Production Source CIAB and *Michigan Fruit Inventory*, National Agricultural Statistics Service, 2004

Polish growers also report their average yields are closer to 11,000 pounds per acre.[32] This claim appears credible for three reasons. First, the Institute of Rural Economics includes non-bearing trees when calculating average yields per acre. When non-bearing acres are removed, yield per acre increases. Second, Polish statistics include about 125,000 farmers with less than 2.5 acres who produce tart cherries as a source of supplemental income, suggesting that the majority of Polish farmers invest their time and resources heavily in other activities. The resulting average would likely under-represent yields for commercial cherry growers. Third, survey results demonstrated that Polish farmers pursue a wide variety of production techniques. It is thus likely that there is a large standard deviation on the reported average. For these reasons, the Polish "Claimed

[32] Based on grower interviews, Thornsbury reported that average Polish yields were 12,000 to 15,000 lbs. per acre. Kurlus suggested that average yields were three times the published rate, which would equal approximately 11,000 lbs. per acre. 11,000 lbs. per acre was chosen for break-even analysis because it represents the most conservative estimate.

Break-Even" category may show the most accurate break-even price for Polish growers with larger, more specialized farms.

4.1.2 Implications

Although "claimed" break-even price is below the average price received, Michigan and Poland historic and projected break-even prices are well above reported prices. The following points summarize additional factors that might reduce production costs or explain why growers may operate at a loss:

- Michigan growers may operate used harvesting equipment that is less expensive than the example harvesters cited in the focus groups. (This is especially true in west central and southwest Michigan).
- Polish growers may lower out-of-pocket costs if they can harvest their entire crop using only family labor. For example, assume it takes 800 hours to harvest 2.5 acres. This can be accomplished by a family of five working 40 hour weeks for 4 weeks. This estimate is especially reasonable if it is considered that many Polish farms are smaller than 2.5 acres, that farming families work more than 40 hour weeks and that harvest time falls during traditional vacation periods.
- Production cost calculations charge growers for non-cash costs (i.e. equipment depreciation). It is possible that growers do not account for non-cash costs on an annual basis, which would lower their perceived cost of production and subsequently their break-even price.
- Michigan farmers may be growing tart cherries as a secondary activity. They may be farming in order to offset the cost of owning a piece of investment property or in order to "keep a farm in the family."

- Farmers in southwest and west central Michigan have more diversified operations. As a result, they are less dependent on tart cherries, and may view them as supplemental income, or as a way of keeping a work crew occupied throughout an entire season. This is consistent with the fact that growers in these regions spend less on maintaining their orchards and have lower yields than northwest growers. This point also holds for smaller Polish growers.

Finally, although all these reasons suggest ways in which Michigan and Polish farmers may be lowering their break-even prices or surviving with high break-even prices, there is still the possibility that some growers may be operating at a loss. This is especially the case in Michigan, where the number of growers has dropped from 845 in 1994 to 600 in 2003 (*Michigan Fruit Inventory*, National Agricultural Statistics Service, 2004). Steady growth in Polish acres planted indicates that Polish farmers are not yet exiting, and that most are probably selling cherries at a price above break-even.

4.1.3 Break-Even Yield Analysis

Break-even yield analysis is approached the same way as break-even price analysis, modifying the standard break-even formulas to account for a perennial crop. Figure 4.1c shows two measures of break-even yields, and compares them with the actual yields that growers received (Polish/Michigan yield), the averages of the actual yields (average yield), and the yields that Michigan and Polish producers report they receive (claimed yield).[33]

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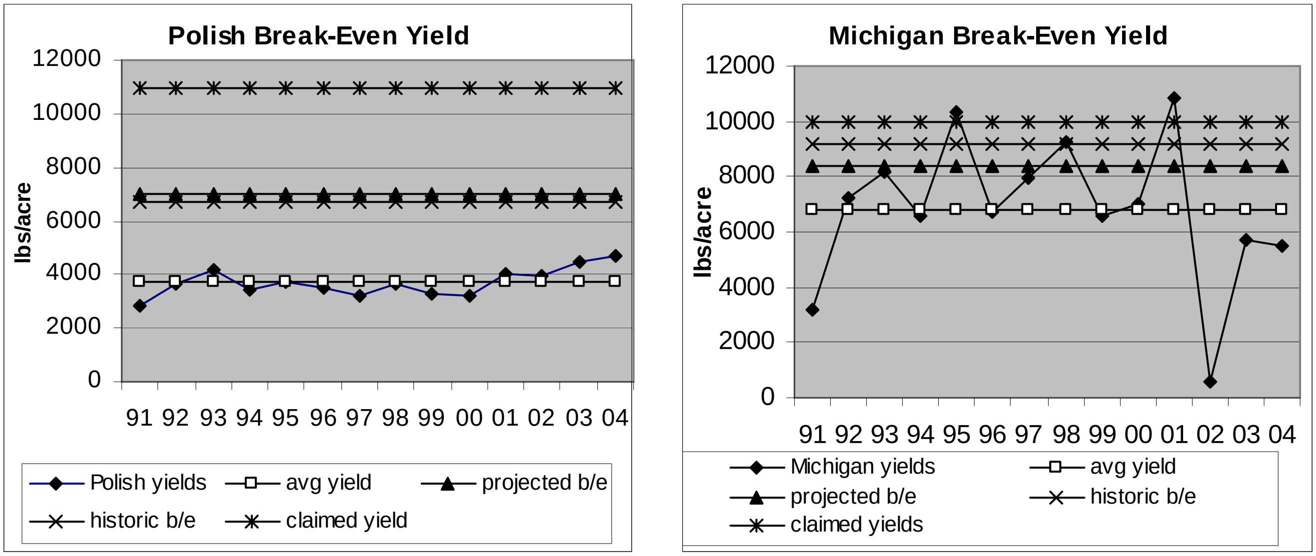
[33] There is no "claimed" break-even yield. In order to have a "claimed" break-even yield, growers would have had to have claimed a different price than the price that was reported.

Figure 4.1c: Break-Even Yield



Sources: Polish Tart Cherry Survey and Michigan Tart Cherry Focus Groups, 2004

Table 4.1d: Break-Even Yield Data (pounds per acre)

	Avg. yield	Historic break-even	Projected break-even	Claimed yield
Poland	3698	6734	7043	11000
Michigan	6827	9188	8350	10000

Source: Polish Tart Cherry Survey and Michigan Tart Cherry Focus Groups, 2004

Historic break-even was calculated using historic prices. Reporting Polish historic prices is problematic. Before the 1990s Polish tart cherry prices were controlled by the government.[34] In order to compensate for this, the historic price series from 1993 to 2004 was repeated for the period of 1979 to 1990. The second break-even yield, "projected break-even," was calculated by estimating production costs and then projecting prices based on average historic prices, (as described in chapter 3.6).

Results indicate that historic and projected break-even yields are higher than the average yields of either region (see table 4.1b). There are, however, extenuating circumstances which mitigate this problem. For example, as explained in the break-even price section, it is possible that many growers have lower than average production costs.

[34] The Polish Institute of Rural Economics does not publish price data from before 1990.

Growers who have higher production costs may be experiencing higher yields than the averages reported by N.A.S.S and the Institute for Rural Economics. Thus, it is likely that growers with low production costs have lower break-even yields and those with higher production costs have an average yield similar to the "claimed yield" shown in figure 4.1c, which is well above their break-even yield.

4.1.4 Break-Even Analysis Summary

Overall, both countries have break-even prices and yields that are close to or lower than actual prices and claimed yields. Considering that Poland has expanded production in recent years while some Michigan farmers have exited, it is also likely that Poland has lower break-evens and a slight competitive advantage over Michigan. Competitive advantage analysis, however, must also consider transportation costs when comparing two industries competing for foreign markets. Specifically, Poland may have a slightly lower break-even price. This advantage may not be significant, however, if it is not great enough to cover the cost of transport to markets in North America. The same issue is also true for Michigan growers, if they are interested in competing for European markets.

4.2 Threshold Farm Size

Threshold farm size analysis measures the minimum acreage at which a Polish farm can economically convert to an overhead system. Threshold farm size can be described as a measure of the indifference point between labor and capital (hand-harvest verses machine-harvest). This measure is calculated using the formula:

$$S_t = \frac{C}{L_s W}$$, where

$S_t =$ threshold acreage,
$C =$ annual cost of a harvester,
$L_s =$ labor saved per acre by using a harvester, and
$W =$ wages saved by using a harvester.

The annual cost of a harvester is based on the manufacturer's projected price for a new Polish harvester of $84,000, which equals $10,442 annually, assuming a 12.5 year lifespan. Labor saved per acre by using a harvester is calculated by subtracting the difference between the labor hours necessary to hand-harvest an orchard and the labor hours necessary to machine-harvest an orchard. Approximately 800 to 1100 labor hours are necessary to hand harvest one hectare of tart cherries (325 to 445 hours per acre), while 30 labor hours are necessary to machine-harvest one hectare (12 labor hours per acre).[35] Thus, L_s equals 770 to 1070 hours per hectare (310 to 430 hours per acre). Finally, W, or wages saved by using a harvester, is simply the hourly rate of labor multiplied by hours of labor saved. Hourly wage rates are estimated to fall between $1.2 and $2 per hour. (Dr. Robert Kurlus, personal correspondence, 2005). Using these values, results indicate that threshold farm size falls within the range of 12 to 27 acres (Table 4.2).

Considering that similar American machines (like blueberry harvesters or tart cherry shakers) are valued around $150,000, the estimate for the cost of the Polish harvester seems low. As a consequence, threshold farm size is measured a second time, using the value of $150,000, or $19,812 annually for C. Using these values, results indicate threshold farm size falls within the range of 22 to 53 acres (Table 4.2).

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[35] The range of harvest hours is a function of yield. Yield fluctuations are the result of both varying orchard density and nature.

Table 4.2: Threshold Farm Size Results

	W= $1.2/hour @770 hours/hectare	W= $2/hour @ 1070 hours/hectare
New Harvester= $84,000	11.301 hectare = **27.924 acres**	4.8794 hectares= **12.057 acres**
New Harvester= $150,000	21.442 hectare= **52.982 acres**	9.258 hectares= **22.876 acres**

Sources: Polish Tart Cherry Survey and Michigan Tart Cherry Focus Groups, Authors calculations, 2004

Threshold farm size results indicate a range of approximately 12 to 50 acres. Although the range appears large, it reveals a considerable amount of information regarding the ability of Polish farmers to adopt the new technology. Table 4.2a shows a breakdown of Polish farm sizes in 2004. The most conservative estimate of threshold farm size for conversion to overhead harvesters falls at the very top end of the 5 to 12.4 acres farm size. If all 2,343 farmers with more than five acres are able to adopt tart cherry harvesters, this would only account for 1.7 percent of all Polish tart cherry farmers. This number drops to 0.2 percent if only farmers with more than 12.5 acres are able to adopt. Estimates indicate that farms larger than five acres use only 16.3 percent of the actual land being used to grow tart cherries in Poland. Farms larger than 12.5 acres use only 5.6 percent of actual Polish tart cherry land (Table 4.2b). Considering that the most conservative estimate of threshold farm size is about 12 acres, it is reasonable to assume that tart cherry harvesters can be adopted by less than one percent of Polish farmers on less than six percent of total acres given current conditions.

Table 4.2a: Breakdown of Polish Farm Sizes in 2004

Polish Farm Size (acres)	**Number of Farms**
<2.5	125,000
2.5-4.9	6,000
5-12.4	2,000
12.5-24.9	265
25-50	78
Total	**133,343**

Source: Robert Kurlus, Pomology Dept. University of Poznan

Table 4.2b: Estimate of Polish Acres Planted

Farm Size (Acres)	Number of Farms	Estimated Average farm Size	Total Acreage per Farm Size	Reported Total Acres Planted*	% of Total Land
<2.5	125,000	0.5	62500		67.3
2.5-4.9	6,000	2.5	15000		16.1
5-12.4	2,000	5.0	10000		10.7
12.5-24.9	265	12.5	3312.5		3.5
25-50	78	25.0	1950		2.1
Total			***92762.5***	***93898***	

Source: Robert Kurlus, Pomology Dept. University of Poznan and Author's Calculations, 2005
* not available by farm size

4.3 Economic Valuation

Economic valuation is used to evaluate the ability and incentive of Michigan farmers to adopt overhead harvesters. Ability refers to the financial capacity to remove a shaker-harvested orchard before the end of its productive life and replace it with an orchard designed for overhead-harvest.[36] Incentive refers to the reward or benefits that a Michigan grower would receive for planting an overhead-orchard and adopting the new technology. These results can then be compared with Polish threshold farm size analysis in order to evaluate ability to adopt new technology. The following methodology describes these calculations, which are shown in Appendixes 8 through 9a.

[36] Michigan farmers report that the productive life of an orchard is generally 25 years.

1) Like break-even analysis, each calculation assumes that an orchard will last 25 years, that the orchard is left fallow during year 0 and that Michigan orchards will bear fruit from year 6 until year 25. The discount rate of 4.5 percent is also used.

2) Michigan production costs follow the same assumptions as are detailed in break-even analysis methodologies and are shown in 2004 dollars. One exception to this is appendix 8b, where costs are deflated by 2.5 percent annually. The rate of 2.5 percent was chosen for this valuation because Michigan growers stated that this figure represents typical annual cost increases.

3) Yield data is based on historic yields reported by the National Agricultural Statistics Service. In appendix 8, yield is shown unadjusted, while in appendixes 8a to 8d, yield is adjusted by indexing historic yields to Beedy and Black's model (see figure 3.6) in order to simulate the orchard's production cycle. This adjustment is made by multiplying the actual historic yield by the factor shown in the budget entry "Beedy's Model" in appendix 8a. A second adjustment is made to yield in Appendix 8d, where yields are increased until NPV equals 0. This is accomplished by increasing each yearly yield by the same factor. Results of this calculation are shown in the entry "yield increased by 1.778."

4) Price data is based on historic price reported by the National Agricultural Statistics Service. In appendixes 8 to 8b, prices are left unadjusted. In appendixes 8c and 8d, price is adjusted to 2004 dollars using Producer Price Index-Farm Products data.

5) Inflow, net cash in, discount cash flow and NPV are all calculated using the same methodology as break-even analysis.

Results of economic valuation show that Michigan tart cherry orchards do not recuperate their investment costs until the latter stages of their life. The most liberal estimate shows that NPV = 0 at year 25, but only when average yield approaches 9,750 pounds per acre. It can thus be concluded that Michigan tart cherry farmers have little ability to remove or replant orchards earlier than 25 years.

Economic valuation also shows that high density orchards planted for use with overhead harvesters are attractive to Michigan growers. These orchards, although more expensive to install, are advantageous because they extend the number of years an orchard can be harvested and have the potential to increase yields. Extending the number of years an orchard can be harvested reduces the yield increases that are necessary to make NPV = 0.

4.3.1 Economic Valuation to Determine Ability to Remove Orchards Early

Economic valuation is carried out four different ways. First, historic price, average historic yield, and cost of production data were used to estimate the net present value (NPV) of investing in an acre of tart cherries (Appendix 8). This resulted in a NPV of -$7,208 per acre with a discount rate of 4.5 percent.[37] This estimate, however, does not account for the yield fluctuations that an orchard produces as trees mature.

In order to account for this, a second valuation is carried out where yield is indexed to the model developed by Beedy et al. (see figure 3.6 and Appendix 8a). Under these assumptions, NPV is -$9,793 per acre with a discount rate of 4.5 percent. Assuming that growers are indifferent (i.e. the discount rate = 0), the sum of annual

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[37] The discount rate is a conservative estimate of a tart cherry grower's second best option and is based on the 30-year Treasury bond rate of approximately 4.5 percent during August/September of 2005.

revenues minus costs was approximately -$11,000.[38] Given losses of this magnitude, results do not appear to accurately reflect industry conditions.

A third valuation is conducted by reducing production costs by 2.5 percent over the past 25 years to reflect inflation and changes in real prices since 1979 (Appendix 8b).[39] Historic yield remains indexed to Beedy's model and historic price is not adjusted. Leaving the discount rate at 4.5 percent, results indicate that NPV increases to -$4,048 per acre. If growers are indifferent, the sum of annual revenues minus costs increases to -$3,617.

Although adjusting costs by 2.5 percent did give more reasonable results, there is some doubt regarding the accuracy estimating historic production costs with this technique. An alternative is to leave production costs in real terms and to adjust historic prices by the annual rate of inflation (*Producer Price Index, Farm Products,* www.bls.gov, September 2005). This fourth valuation resulted in an NPV equal to -$8,333 per acre. If growers were indifferent, the sum of annual revenues minus costs is approximately -$8,545 (Appendix 8c).

Given that NPV results were negative for all four valuations, average yield data in the fourth valuation was varied until NPV = 0 (Appendix 8d).[40] (Cost was left in real dollars, price was adjusted for the annual rate of inflation, and yield was indexed to Beedy's model). Results show that yields need to be approximately 78 percent higher than average reported yields, or 9,750 pounds per acre in order for NPV = 0. This is

[38] "Indifferent" implies that growers either do not have a second best option, or are willing to choose to grow cherries despite the possibility that better returns can be held elsewhere.
[39] Michigan grower focus groups identified 2.5 percent as the typical annual increase in production costs.
[40] Negative results in the valuations are likely due to interpretation of average yield data. Several criticisms of N.A.S.S. average yield data are documented in sections 4.1.3 and 4.1.4.

lower than the yields that northwest Michigan growers claim they average and is close to the estimated average of northwest growers without 2002 yields (see table 4.1a).[41]

All economic valuation calculations indicate Michigan tart cherry farms operate at a loss when calculated with historic average yields, average prices, and estimated production costs. Historic data estimates show that NPV = 0 when average yields equal 9,750 pounds per acre, which is approximately the same yield that Michigan growers claim they produce. Compared with the results of break-even analysis, economic valuation implies that Michigan orchards are, at best, likely to earn back their initial investments near the end of their lifespan (25 years) and that early replanting for overhead harvest will result in economic loss.

4.3.2 Incentive to Adopt Overhead Tart Cherry Harvesters in Michigan

Economic valuation has shown that Michigan orchards tend to earn back initial investments only near the end of their productive lifespan. If high-density orchards require higher investment costs, how much must yields increase in order to maintain a Michigan orchard's cost per unit of output?

In order to measure incentive to adopt, economic valuation was performed following the assumptions of the fourth economic valuation (appendix 8c) with the following adjustments:

1) Costs were left unadjusted and are shown this way in appendix 9. The results shown in table 4.3a, however, were taken using appendix 9 and were obtained by adding an additional establishment expense of $7.50 per tree as planting densities increased.

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[41] 2002 produced record setting low yields.

2) Historic yields were extended to include years 3, 4 and 5. Yields were indexed to show linear increases from years 3 to 7 and linear decreases from 23 to 25. These adjustments are shown under the entry "Beedy's model".

With yields at historic levels, planting density at 120 trees per acre, and marketable yield measured starting at year three, NPV remains negative (table 4.3). Thus, any planting density greater than 120 with the same conditions will also have an NPV less than zero, given that the only changes will be increased investment costs. Planting densities were varied from 200 trees per acre to 1250 trees per acre (table 4.3a). At 200 trees per acre, historic yields must increase by 35.6 percent in order for NPV to equal 0. Yield increases required for NPV to equal zero increased linearly up to 87 percent when the planting density is set at 1250 trees per acre. Although an increase of 87 percent appears high, this is compared to the 78 percent increase necessary for an orchard designed for shaker-harvest with 120 trees per acre to have an NPV greater than zero.

Table 4.3: Yield Increases Necessary for NPV to Equal Zero in a Michigan Shaker Harvested Orchard

	Trees/ Acre	Yield Increase for NPV=0 (percentage)	Avg. Yield (Lbs. per Acre)	Avg. Cost ($ per Acre)	NPV
Harvest starts year 6	120	78	9747	1190	0
	120	0	5483	1190	-8332
Harvest starts year 3	120	31.6	8234	1190	0
	120	0	6255	1190	-4576

Source: Author's calculation

Table 4.3a: Yield Increases Necessary for NPV to Equal Zero in a Michigan Overhead Harvested Orchard

Trees/Acre	Yield Increase for NPV=0 (percentage)	Avg. Yield (Lbs. per Acre)	Avg. Production Cost ($ per Acre)
200	35.60	7738	1213.31
225	36.83	7808	1220.52
250	38.07	7879	1227.73
275	39.31	7950	1234.94
300	40.55	8021	1242.15
325	41.79	8091	1249.37
350	43.03	8162	1256.58
375	44.27	8233	1263.79
400	45.51	8304	1271.00
425	46.75	8374	1278.21
450	47.99	8445	1285.42
475	49.23	8516	1292.63
500	50.47	8587	1299.85
885	69.57	9676	1410.90
1250	87.67	10709	1516.19

Source: Author's calculation

4.3.3 The Influence of Early Low Revenues on NPV

The accuracy of NPV measures depends on the point in an orchard's life cycle when greater revenues occur. Specifically, NPV is larger when high yield and high price years occur earlier in the orchard's life cycle and lower when low yield and low price years occur earlier in the orchard's life cycle.

In order to measure variability in economic valuation, NPV was calculated under the same conditions as section 4.3.2, except that historic revenues are sorted in ascending order (Appendix 9a). Arranging revenues in ascending order shows the combination of revenues that result in the lowest possible NPV. This provides a "worse-case" measure of the yield increases necessary for NPV = 0 when planting high-density orchards. Results indicate that in the worst possible conditions based on historic revenues, yields would have to increase by 44 percent with 200 trees per acre and 99.66 percent for 1250 trees per acre (table 4.3b). The yield increases necessary to support poor early revenues are of a magnitude that is achievable. Results also demonstrate harvesting younger trees greatly benefits growers by shortening the period they must wait for positive cash flows and increasing NPV.

Table 4.3b: Yield Increases Necessary for NPV to Equal Zero in a Michigan Overhead Harvested Orchard with Ascending Historic Revenues

Trees/ Acre	Yield Increase for NPV=0 When Historic Yields Are Placed in Ascending Order	Yield Increase for to NPV=0 With Historic Yields (percent)	Yield Increase for NPV=0 When Historic Yields Are Placed in Ascending Order (Lbs. per Acre)	Avg. Cost ($ per Acre)
120	40.04	*31.60*	7990.87	1190.23
200	44.26	*35.60*	8231.75	1213.31
225	45.58	*36.83*	1572.03	2548.74
250	46.89	*38.07*	8382.30	1227.73
275	48.21	*39.31*	8457.57	1234.94
300	49.53	*40.55*	8532.84	1242.15
325	50.85	*41.79*	8608.11	1249.37
350	52.17	*43.03*	8683.39	1256.58
375	53.49	*44.27*	8758.66	1263.79
400	54.81	*45.51*	8833.94	1271.00
425	56.13	*46.75*	8909.21	1278.21
450	57.45	*47.99*	8984.49	1285.42
475	58.77	*49.23*	9059.76	1292.63
500	60.09	*50.47*	9135.04	1299.84
885	80.40	*69.57*	10294.26	1410.90
1250	99.66	*87.67*	11393.27	1516.19

Source: Author's calculation

If a worse case scenario can be calculated by organizing historic revenues in ascending order, then a best case scenario could theoretically be calculated by organizing historic revenues in descending order. The accuracy of the best case scenario calculation, however, is questionable given the biological life-cycle of an orchard. Descending revenues imply that an orchard's greatest possible yields are achieved as an orchard's first harvest. Given that an orchard's first harvest is likely one of its smallest, descending revenues do not accurately represent a best case scenario and are therefore not computed.

Not only is the best case scenario measure inaccurate, but it is also not relevant. The worse case scenario calculation above provides a measure of the maximum increase in yield necessary to ensure a positive NPV with new harvesting technology. Likewise, the best case scenario calculation would be a measure of the minimum change necessary to ensure a positive NPV with new harvesting technology. Considering that the worse case scenario is calculated to demonstrate the maximum yield increases necessary for new technology to be profitable, a measure of the minimum change necessary is less important.

4.3.4 Economic Valuation Conclusions

Economic valuation shows that the possibility for Michigan growers to remove orchards early is limited. Economic valuation also shows that increasing the number of times an orchard can be harvested reduces the yield increases necessary to make NPV positive.[42] Finally, NPV outcomes depend on what point in the revenue cycle (price/yield) the orchard is planted.

Economic valuation makes a strong case for adopting overhead harvesters in Michigan. Although the ability to adopt them is limited, overhead harvesters allow for earlier harvests. Earlier harvests generate revenues earlier in the orchard's lifecycle, and therefore help improve NPV. Economic valuation also shows that the higher cost of planting a high-density orchard for overhead harvest requires increased average yields in order for NPV to equal 0. Thus, as long as overhead-harvested orchards achieve higher average yields than shaker-harvested orchards, the ability to harvest younger orchards should create an incentive to adopt new harvesters.

Finally, although economic valuation has determined that replanting orchards for new harvesters is difficult, recent research in the area of overhead harvesters has yielded

[42] Increasing the number of times an orchard can be harvested refers to the ability of overhead harvesters to harvest trees as young as three years old, compared to shaker harvesters, which cannot harvest trees younger than five years.

preliminary results from an intermediate technology. Specifically, the same technology used in overhead harvesters could be used in a modified harvester that is adapted to shaker-style orchards. This harvester prototype would function much like an overhead harvester, removing cherries with finger-like appendages. Instead of passing over the row, however, it would be moved along either side of a tree simultaneously, much like a double-incline shaker. (See appendix 3, Photo of American Prototype Harvester). This prototype has the potential of being an intermediate technology. It has the ability to harvest both styles of orchards, and as a result, Michigan farmers would not have to suffer the consequences of removing orchards early in order to adopt new harvesting technology.

CHAPTER FIVE

CONCLUSIONS

5.1 Summary

Analysis indicates that growers in both Poland and the United States produce tart cherries at regional averages near or above break-even prices and yields at the present time. It is likely that Polish producers have slightly favorable break-evens, given that some Michigan farmers have exited over the past ten years, while Polish farmers have increased plantings.

Threshold farm size indicates that only a small minority of Polish farmers will be able to adopt new harvesters under current conditions. This same minority of Polish farmers, however, is probably the most important group to U.S. growers in terms of international tart cherry competition. Economic valuation shows that it will be extremely difficult for Michigan farmers to remove tart cherry orchards planted for shaker-harvest before their normal lifespan without economic loss. On the other hand economic valuation demonstrates that there is a great incentive to adopt overhead harvesters due to their ability to harvest younger trees and to decrease per unit production costs.

Results indicate that short-run comparative production costs for Michigan growers and the majority of Polish growers are not likely to change dramatically because of new harvesting technology. Large Polish growers, however, may see improved per unit production costs as higher density plantings improve yields per acre. Over the long run, production costs on a per pound basis in the two regions appear to be converging. This implies that in the short run, economic leapfrogging may occur with results including the eventual exit of some Michigan growers. Over the long run as both regions are able to adopt new technologies, neither region will have a clear advantage in terms of per unit production costs.

5.2 Present Time

Break-even analysis indicates that both countries currently have break-even yields and prices close to or lower than actual prices and claimed yields. Poland, however, is likely in a slightly better competitive position at the present time. Although analysis showed that both countries have break-evens lower than expected yields and average prices, Poland has a larger margin; i.e. Poland's break-even yields and prices were much lower than Michigan's break-evens relative to their expected yields and average prices. This point is supported by the fact that Poland has slightly better expected yields than Michigan and a similar cost of production. Another point of interest is that although both regions have good break-evens, Polish growers have been increasing their production while some Michigan growers are exiting. Secondary data shows that in 1995, there were 845 tart cherry farmers in Michigan and 600 in 2004 (National Agricultural Statistics Service, 2004). Secondary data, however, also shows that production is stable to slightly declining. The implication of this is that Michigan break-evens are increasing and that the Michigan farmers who are still competing are doing so due to economies of scale on larger farms.

Any current advantage by Polish farmers is countered by various points that helps keep Michigan farmers in business. Michigan growers have a geographic advantage when it comes to selling product in the United States. Domestically and internationally, the Michigan industry has the advantage of its reputation. Michigan tart cherry products are known not only for their quality, but also for attributes related to primary variety produced in the U.S.

5.3 Short-Run Competitiveness

Short-run evaluation of Polish and American competitiveness is distinguished from long-run evaluation by the lack of significant wage increases and structural change in the Polish production system. Specifically, over the short run, significant wage changes will not occur in Poland. Likewise, structural transformation characterized by the exit of small Polish growers and emergence of a more concentrated industry characterized by larger, mechanized, more specialized growers will not occur.

Threshold farm size indicates that less than one percent of current Polish farmers will be able to adopt overhead harvesters on less than six percent of the tart cherry land. Economic valuation shows that Michigan farmers will face serious constraints transforming their orchards to overhead harvesters. Although these measures show that only a minority of Polish and Michigan producers can adopt new technology in the short-run there is still a possibility of leapfrogging. This is possible given that this small minority of Polish farmers is the group of farmers best able to compete with Michigan producers for international markets. This does not imply that Polish product will dominate the U.S. market, but that some Polish growers will be competitive. Thus, Polish tart cherry imports are not likely to return to pre-2002 levels (i.e.: zero).

Results also indicate that the trend of Michigan producers exiting and the consolidation of tart cherry acreage will continue. This is likely given that economic valuation shows that small Michigan growers are not able to adopt more efficient harvesters within the normal 25-year production-cycle without economic loss. Larger growers potentially have the scale to operate two technologies simultaneously and thus make a more gradual transition. Michigan farmers who are most likely to be able to exit are those who either cannot afford to adopt, those with inferior growing sites and those who operate on a scale large enough to own two harvesters.

Finally, current research has suggested that it may be possible to develop an “intermediate” harvester capable of harvesting both orchards designed for use with shaker-harvesters and overhead-harvesters. Although this research is not yet conclusive, this harvester has the potential to handle more graduate transformations on a smaller scale and reduce potential for leapfrogging. If this harvester were to become viable, Michigan growers would be able to make smoother transition to high density orchards and maintain or improve break-evens over the short-run.

5.4 Long-Run Competitiveness

In contrast to short-run competitiveness, long-run competitiveness is distinguished by significant wage changes and a structural transformation in the Polish production system. Specifically, wages are expected to rise as they find a new equilibrium with employment alternatives throughout the European Union and a structural transformation will occur that is brought about by the exit of small producers due to the rise of these alternate employment opportunities.

The data collected from Poland indicates that over the long-run, mechanical harvesters are likely to become more common. Over time, Polish farms are anticipated to increase in average size, and as farm sizes increase, mechanical-harvesting will become less expensive than hand-harvesting. There are several reasons why farm sizes may increase. First, the Polish data clearly demonstrates economies of scale as farm sizes become larger. This is well illustrated in figure 3.2i, which shows decreasing production costs as farms get larger. Second, the majority of the current Polish tart cherry sector is made up of small farms with less than 2.5 acres. These growers are often less specialized than larger growers and often have off-farm work. It appears likely that over the long-run, these farms will exit tart cherry production as higher off-farm wages attract the next generation of small growers elsewhere. Third, figure 3.2k demonstrates that the majority of these small farms are less specialized. If small farms are less efficient and thus have higher production costs, then it is likely that over time small farms will be merged into larger farms or converted to other uses. Finally, larger farms currently have the advantage of being able to vertically align with processors and demand price premiums. Although price premiums are not guaranteed over the long-run, they provide an economic incentive to the Polish tart cherry sector to concentrate.

Economic valuation indicates that although a short-run switch to overhead harvesting in the Michigan industry is unlikely, there are incentives to adopt overhead harvesters in the long-run. Specifically, early adopters of new harvesting technology will benefit from increased yields and from the ability to harvest younger trees. The adoption process will likely be similar to that outlined in treadmill theory, where early adopters gain excess economic profits from reductions in per unit production costs (economies of scale) and additional harvests from younger orchards. As additional farmers also adopt, the yield increase will shift supply outwards, subsequently reducing price and returning economic profits to zero. Given that tart cherry farmers are locked into long-term investments, it is likely that transformation of the Michigan industry will be drawn out over at least 25 years, corresponding with the typical lifespan of Michigan orchards.

Per unit production costs in both regions show signs of convergence over the long-run if both regions adopt similar production techniques. With the development and adoption of a standardized harvesting system, Polish production techniques will become more homogenous within the country and very similar with those in Michigan. Likewise, given that Polish wages are expected to increase over the long-run, Polish labor costs will be increasingly similar to Michigan labor costs. The combination of similar yields per acre and costs per acre therefore indicates a long-run trend of converging production costs on a price per unit basis.

A more specialized Polish industry with larger farms and fewer growers will have other positive implications for the Michigan tart cherry industry. Specifically, the Polish tart cherry industry is now made up of at least 125,000 growers with less than 2.5 acres and less than 350 growers with more than 12.5 acres. The industry is characterized by a lack of organization, distrust in cooperatives, strong brokers, and farmers who are price takers. As small farmers exit, the possibility to organize, vertically align with buyers, and influence prices becomes easier and more reasonable. If this were to happen, Polish growers may benefit from a more efficient industry with higher and more stable prices. The U.S. industry is likely to benefit from a more efficient Polish industry that can support higher Polish tart cherry prices. Specifically, the Michigan industry stands to gain from a better organized Polish production system because a better organized production system implies grower influence over prices. As Polish growers organize, they can build cooperatives and offer specialized products and services for premiums.

5.5 Further Research

The need for further research in the area of competitiveness in the international tart cherry market is great. In Poland, more information is needed regarding yields. Specifically, there is a need for more accurate yield per acre historic data and also a need for better estimates of the relationship between planting densities and yields on Polish farms. There is also a need for an expanded cost of production survey in Poland, as that the current sample is small. Another point of importance relating to the Polish industry is a better estimate of how planted acres will vary as small Polish farms exit. Will these small farms be merged into larger farms, or will the land be used for other purposes? In the Michigan industry, there is a need for more information on the feasibility of intermediate harvesters as well as a need for better information on the possibilities for improved yields with high density orchards. For example, useful studies would examine Michigan grower's ability to switch to dwarf trees or explore the feasibility of custom harvest in Michigan, especially during the period of transition from shaker harvest to overhead harvest.

Appendix 1: Photo of American Shaker Harvester and Close-Up of Shaker Head

Source: Wright, 2004

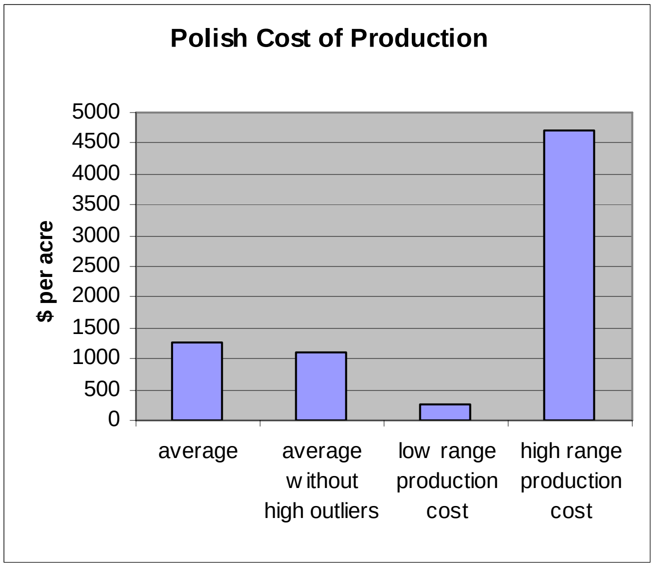
Appendix 2: Photos of European Overhead Harvesters

Source: Kurlus, 2004

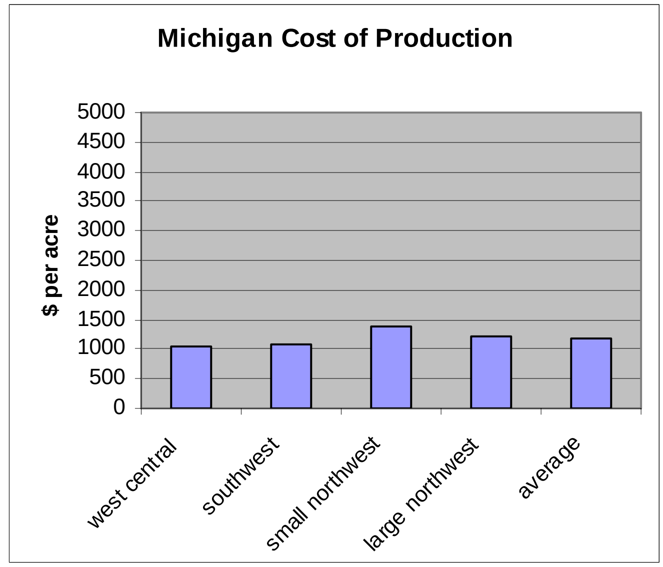
Appendix 3: Photo of American Prototype Harvester

Source: Wright, 2005

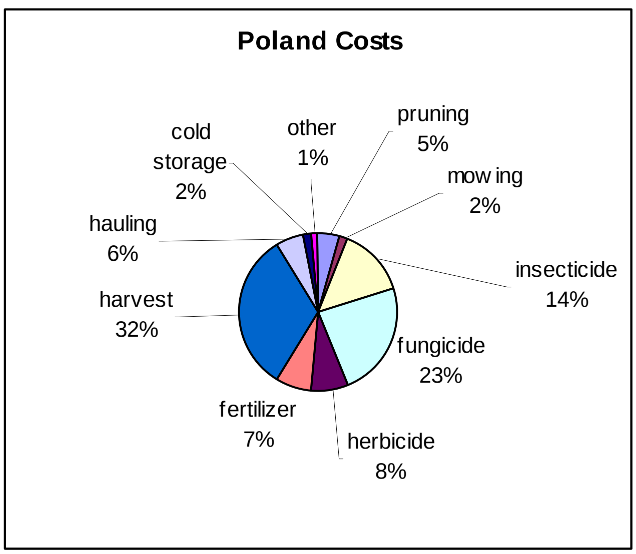
Appendix 4: Michigan and Polish Production Costs



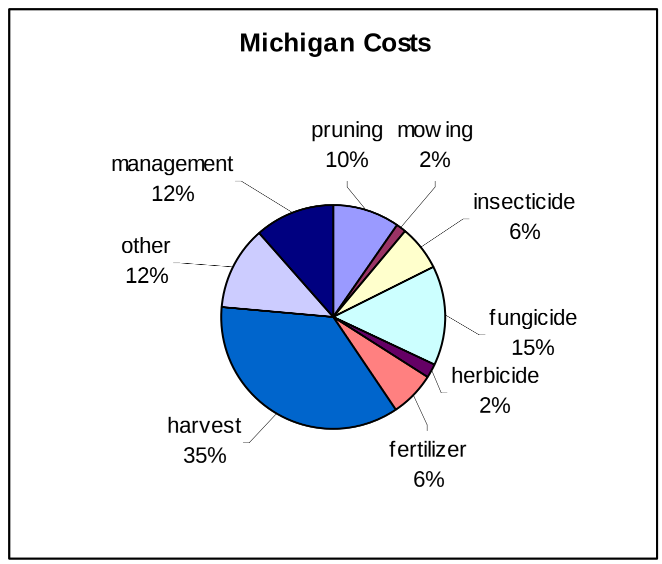
Source: Polish Tart Cherry Survey, 2004 and Author's Calculations



Source: Michigan Tart Cherry Focus Groups, 2004 and Author's Calculations



Source: Polish Tart Cherry Survey, 2004 and Author's Calculations



Source: Michigan Tart Cherry Focus Groups, 2004 and Author's Calculations

Appendix 5: Michigan and Poland Production Regions/ Survey and Focus Group Locations

Proportion of survey responses from each region.

16.7%

11%

5.6%

41.7%

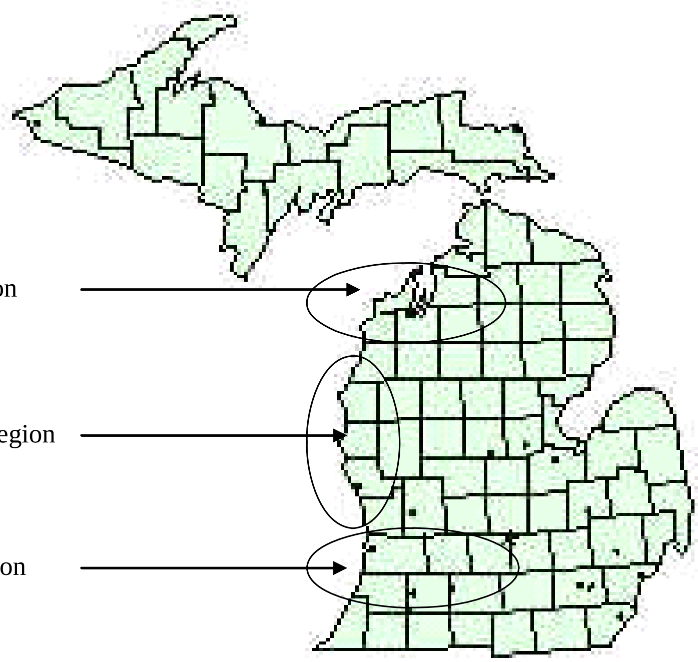
25%

Focus group locations

Northwest region
(2 groups)

West Central Region

Southwest Region



Appendix 6: Polish Historic Price, Yield and Area Planted

Years	Polish yield in metric tons	Polish yield in Mil. Lbs.	Area planted in thousands of hectares	Price zloty/kg	Price $/Lbs
1990	77.0	169.76	23.2	0.5	
1991	80.0	176.37	25.3	0.5	0.22
1992	119.7	263.89	29.4	0.4	0.13
1993	147.0	324.08	31.5	0.2	0.05
1994	122.0	268.96	32.0	0.9	0.18
1995	144.4	318.35	34.8	0.9	0.17
1996	149.4	329.37	38.0	1.2	0.20
1997	136.6	301.15	38.0	2.6	0.36
1998	156.3	344.58	38.0	1.8	0.23
1999	144.5	318.57	39.0	2.2	0.25
2000	140.0	308.65	39.3	1.97	0.21
2001	179.7	396.17	40.0	0.9	0.10
2002	173.0	381.40	39.0	1.96	0.22
2003	191.0	421.08	37.8	1.96	0.23
2004	201	443.13	38	0.8	0.10

Note: The average 2004 exchange rate between Polish Zloty and U.S. Dollars equals 3.65 Zloty to 1 U.S. dollar.
Source: Institute of Rural Economics, Main Statistical Office, 2005, www.oanda.com/convert/fxhistory, 2005.

Appendix 6a: Michigan Historic Price, Yield and Area Planted

Years	Michigan yield in Mil. Lbs.	Area planted in acres	Grower price $/Lbs.
1990	160	32900	18
1991	110	34400	48
1992	245	33900	17
1993	270	33000	11
1994	210	32000	16.7
1995	310	30000	5.2
1996	195	29100	16.1
1997	225	28400	15.9
1998	263	28400	14.5
1999	185	28100	21.8
2000	200	28500	18.4
2001	297	27400	18.3
2002	15	27400	44.3
2003	154	27000	35.8
2004	149	27000	32.9

Source: National Agricultural Statistics Service, Michigan Agricultural Statistics, 2005

Appendix 7: Break-Even Price Calculations Using Historic Yield

Michigan break-even price using historic yields indexed to Beedy's model

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.0																									
year	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0
cost	1300.0	2665.0	871.0	901.0	901.0	901.0	1050.0	1067.0	1100.0	1134.0	1160.0	1180.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1186.0	1172.0	1158.0
yield	0.0	0.0	0.0	0.0	0.0	0.0	994.1	1460.2	3338.7	3091.4	3864.1	4165.8	3200.0	7230.0	8180.0	6560.0	10330.0	6700.0	7920.0	9260.0	6580.0	7020.0	10840.0	495.0	4560.0	3864.0
price	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
inflow	0.0	0.0	0.0	0.0	0.0	0.0	352.9	518.4	1185.3	1097.5	1371.9	1479.0	1136.1	2566.8	2904.1	2329.0	3667.4	2378.7	2811.8	3287.6	2336.1	2492.3	3848.5	175.7	1618.9	1371.8
net cash in	-1300.0	-2665.0	-871.0	-901.0	-901.0	-901.0	-697.1	-548.6	85.3	-36.5	211.9	299.0	-63.9	1366.8	1704.1	1129.0	2467.4	1178.7	1611.8	2087.6	1136.1	1292.3	2648.5	-1010.3	446.9	213.8
discount cash flow	-1300.0	-2550.2	-797.6	-789.5	-755.5	-723.0	-535.3	-403.1	60.0	-24.5	136.4	184.2	-37.7	771.3	920.2	583.4	1220.1	557.7	729.8	904.5	471.1	512.8	1005.6	-367.1	155.4	71.1
npv		0.0																								
Historic Yield	0.0	0.0	0.0	0.0	0.0	0.0	6960.0	5110.0	7790.0	5410.0	5410.0	4860.0	3200.0	7230.0	8180.0	6560.0	10330.0	6700.0	7920.0	9260.0	6580.0	7020.0	10840.0	550.0	5700.0	5520.0
Beedy's Model	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7

Polish break-even price using historic yields indexed to Beedy's model

discount rate	1.0																									
year	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0
cost	583.6	413.3	163.7	1046.4	1093.1	1139.8	1186.5	1233.2	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1279.8	1251.8	1223.8	1195.8
yield	0.0	0.0	0.0	534.5	1223.2	1652.8	2118.8	3340.1	3957.6	4508.1	4719.2	2961.1	2821.1	3632.4	4163.5	3401.4	3702.0	3507.7	3207.1	3669.7	3305.6	3178.2	4008.1	3561.9	3606.5	3303.4
price	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
inflow	0.0	0.0	0.0	230.3	526.9	712.0	912.7	1438.8	1704.8	1941.9	2032.8	1275.5	1215.2	1564.7	1793.5	1465.2	1594.7	1511.0	1381.5	1580.7	1423.9	1369.1	1726.5	1534.3	1553.5	1423.0
net cash in	-583.6	-413.3	-163.7	-816.2	-566.2	-427.8	-273.8	205.6	424.9	662.1	753.0	-4.3	-64.6	284.9	513.6	185.4	314.9	231.1	101.7	300.9	144.1	89.2	446.7	282.5	329.7	227.1
discount cash flow	-583.6	-395.5	-149.9	-715.2	-474.8	-343.3	-210.2	151.1	298.8	445.5	484.9	-2.7	-38.1	160.7	277.4	95.8	155.7	109.4	46.0	130.4	59.8	35.4	169.6	102.6	114.6	75.6
npv		0.0																								
Historic Yield	3401.4	3702.0	3507.7	3207.1	3669.7	3305.6	3178.2	4008.1	3957.6	4508.1	4719.2	2961.1	2821.1	3632.4	4163.5	3401.4	3702.0	3507.7	3207.1	3669.7	3305.6	3178.2	4008.1	3957.6	4508.1	4719.2
Beedy's Model	0.0	0.0	0.0	0.2	0.3	0.5	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7

Note: Costs were developed using Michigan cost of production focus group data and Polish grower survey data. Michigan historic yield was calculated by indexing actual historic yields per acre to Beedy's model in order to simulate an orchard's production cycle. Poland's historic yield was calculated the same way with the exception that it was adjusted because pre-1990 data was not available. Using a discount rate of 4.5%, Michigan historic break-even price is 35.5 cents per pound and Poland's historic break-even price is 43 cents per pound.

Appendix 7a: Break-Even Price Calculations Using Projected Yields

Michigan break-even price using simulated yields indexed to average Michigan yields

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	*average cost during production years*
discount rate	1.045																										
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158	1170.35
yield	0	0	0	0	0	0	1142	2284	3426	4569	5712	6854	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996	7196	6397	5597	
price	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	
inflow	0	0	0	0	0	0	336.4	672.9	1009	1346	1682	2019	2355	2355	2355	2355	2355	2355	2355	2355	2355	2355	2355	2120	1884	1649	
net cash in	-1300	-2665	-871	-901	-901	-901	-714	-394	-90.7	212	522.4	838.8	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	933.7	712.2	490.7	
discount cash flow	-1300	-2550	-798	-790	-756	-723	-548	-290	-63.8	142.6	336.4	516.9	681.2	651.9	623.8	596.9	571.2	546.6	523.1	500.6	479	458.4	438.6	339.3	247.6	163.3	
npv	0.017																										
Beedy's Model	0	0	0	0	0	0	0.143	0.286	0.429	0.571	0.714	0.857	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7	

Polish break-even price using simulated yields indexed to the 2004 Polish yield

discount rate	1.045																										
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
cost	583.6	413.3	163.7	1046	1093	1140	1186	1233	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1252	1224	1196	1242.081
yield	0	0	0	909.1	1818	2727	3636	4545	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	5454	4909	4363	3818	
price	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	
inflow	0	0	0	266.4	532.8	799.2	1066	1332	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1439	1279	1119	
net cash in	-584	-413	-164	-780	-560	-341	-121	98.88	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	186.8	54.94	-76.9	
discount cash flow	-584	-396	-150	-684	-470	-273	-92.8	72.66	224	214.4	205.2	196.3	187.9	179.8	172	164.6	157.5	150.8	144.3	138.1	132.1	126.4	121	67.86	19.1	-25.6	
npv	-0.03																										
Beedy's Model	0	0	0	0.167	0.333	0.5	0.667	0.833	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7	

Note: Costs were developed using Michigan cost of production focus group data and Polish grower survey data. Michigan simulated yields are based on Beedy's model and are indexed to the average historic yield from 1985 to 2004 (6,557 pounds per acre). Average yield, calculated from year 6 to year 25, is 6,556 pounds per acre. At this level, when the discount rate was set at 4.5%, price needed to average 29.45 cents per pound for NPV to equal 0. Polish yields were calculated in the same manner with one exception. Simulated yield was not indexed to Polish historic average due to the radical growth and change that is occurring in Poland. Instead, yields were indexed to Poland's 2004 yield of 4719 pounds per acre. Using a discount rate of 4.5%, prices needed to be at 29.3 cents per pound for NPV to equal 0.

Appendix 7b: Break-Even Price Calculations Using Claimed Yield

Michigan break-even price with simulated yields indexed to claimed average (10,000 lbs per acre)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	1742	3484	5226	6970	8712	10454	12196	12196	12196	12196	12196	12196	12196	12196	12196	12196	12196	10976	9757	8537
price	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193
inflow	0	0	0	0	0	0	336.4	672.9	1009	1346	1682	2019	2355	2355	2355	2355	2355	2355	2355	2355	2355	2355	2355	2120	1884	1649
net cash in	-1300	-2665	-871	-901	-901	-901	-714	-394	-90.7	212	522.4	838.8	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	933.7	712.2	490.7
discount cash flow	-1300	-2550	-798	-790	-756	-723	-548	-290	-63.8	142.6	336.4	516.9	681.2	651.9	623.8	596.9	571.2	546.6	523.1	500.6	479	458.4	438.6	339.3	247.6	163.3
npv	0.006																									
Beedy's Model	0	0	0	0	0	0	0.143	0.286	0.429	0.571	0.714	0.857	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7

Polish break-even price with simulated yields indexed to claimed average (10,950 lbs per acre)

discount rate	1.045				10997																					
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	583.6	413.3	163.7	1046	1093	1140	1186	1233	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1252	1224	1196
yield	0	0	0	2118	4237	6355	8473	10592	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	12710	11439	10168	8897
price	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126
inflow	0	0	0	266.3	532.9	799.2	1066	1332	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1598	1439	1279	1119
net cash in	-584	-413	-164	-780	-560	-341	-121	98.97	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	318.6	186.8	54.95	-76.9
discount cash flow	-584	-396	-150	-684	-470	-273	-92.9	72.73	224	214.4	205.2	196.3	187.9	179.8	172	164.6	157.5	150.8	144.3	138.1	132.1	126.4	121	67.86	19.11	-25.6
npv	0.017																									
Beedy's Model	0	0	0	0.167	0.333	0.5	0.667	0.833	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7

Note: Costs were developed using Michigan cost of production focus group data and Polish grower survey data. Michigan break-even price is near

19 cents per pound when the discount rate is set at 4.5 %. Claimed yields are simulated using Beedy's model and are indexed to the yields that Michigan growers claim that they average (10,000 pounds/acre). Poland Break-Even price is at 12.5 cents per pound when yields are simulated using Beedy's Model and are indexed to Robert Kurlus's claimed yield of about 11,000 pounds per acre.

Appendix 7c: Break-Even Yield Calculations Using Historic Prices

Michigan break-even price using historic prices

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189	9189
price	0.445	0.486	0.202	0.464	0.135	0.491	0.248	0.217	0.197	0.074	0.178	0.145	0.18	0.48	0.17	0.11	0.167	0.052	0.161	0.159	0.145	0.218	0.184	0.183	0.443	0.358
inflow	0	0	0	0	0	0	2279	1994	1810	680	1636	1332	1654	4411	1562	1011	1535	477.8	1479	1461	1332	2003	1691	1682	4071	3290
net cash in	-1300	-2665	-871	-901	-901	-901	1229	926.9	710.2	-454	475.6	152.4	454	3211	362.1	-189	334.5	-722	279.4	261	132.4	803.1	490.7	495.5	2899	2132
discount cash flow	-1300	-2550	-798	-790	-756	-723	943.6	681.1	499.4	-306	306.2	93.88	267.7	1812	195.5	-97.8	165.4	-342	126.5	113.1	54.88	318.7	186.3	180	1008	709.2
npv	-0																									

Polish break-even price using historic prices

discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	583.6	413.3	163.7	1046	1093	1140	1186	1233	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1252	1224	1196
yield	0	0	0	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582	6582
price	0.055	0.178	0.165	0.202	0.36	0.23	0.251	0.205	0.1	0.218	0.229	0.099	0.203	0.117	0.055	0.178	0.165	0.202	0.36	0.23	0.251	0.205	0.1	0.218	0.229	0.099
inflow	0	0	0	1327	2366	1514	1654	1352	656.9	1434	1504	654.3	1336	768.3	362.9	1170	1086	1327	2366	1514	1654	1352	656.9	1434	1504	654.3
net cash in	-584	-413	-164	280.4	1273	374.3	467.9	118.8	-623	154.3	224.4	-626	56.48	-512	-917	-109	-194	47	1087	234.2	374.5	72.16	-623	182.3	280.4	-541
discount cash flow	-584	-396	-150	245.7	1068	300.3	359.3	87.33	-438	103.8	144.5	-385	33.3	-289	-495	-56.5	-96	22.24	492	101.5	155.3	28.63	-237	66.24	97.49	-180
npv	8E-04																									
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	0.055	0.178	0.165	0.202	0.36	0.23	0.251	0.205	0.1	0.218	0.229	0.099														

Note: Costs were developed using Michigan cost of production focus group data and Polish grower survey data. The source of Michigan price data is National Agricultural Statistics Service (N.A.S.S.), Michigan Agricultural Statistics. The source of Polish price data is the Institute for Rural Economics. The Institute of Rural Economics does not publish pre-1990 price data. In order to compensate, 1993 to 2004 price was substituted for 1979-1989. The discount rate was set at 4.5% for both Pland and Michigan growers. Under these conditions, Michigan had to average 9188 pounds per acre and Poland had to average 6581 pounds per acre in order to break even.

Appendix 7d: Break-Even Yield Calculations Using Projected Prices Indexed to Historic Average

Michigan break-even price using projected prices

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351	8351
price	0	0	0	0	0	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.27	0.27	0.27	0.27	0.23	0.23	0.23	0.23	0.23	0.23	0.17	0.17	0.17
inflow	0	0	0	0	0	0	1670	1670	1670	1670	1670	1670	1670	2255	2255	2255	2255	1921	1921	1921	1921	1921	1921	1420	1420	1420
net cash in	-1300	-2665	-871	-901	-901	-901	620.1	603.1	570.1	536.1	510.1	490.1	470.1	1055	1055	1055	1055	720.7	720.7	720.7	720.7	720.7	720.7	233.6	247.6	261.6
discount cash flow	-1300	-2550	-798	-790	-756	-723	476.2	443.2	400.9	360.8	328.5	302	277.2	595.1	569.5	545	521.5	341	326.3	312.3	298.8	285.9	273.6	84.88	86.1	87.05
npv	-0.01																									

Polish break-even price using projected prices

discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	583.6	413.3	163.7	1046	1093	1140	1186	1233	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1280	1252	1224	1196
yield	0	0	0	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043	7043
price	0	0	0	0.166	0.166	0.166	0.166	0.166	0.166	0.224	0.224	0.224	0.224	0.224	0.224	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.141	0.141	0.141
inflow	0	0	0	1169	1169	1169	1169	1169	1169	1578	1578	1578	1578	1578	1578	1345	1345	1345	1345	1345	1345	1345	1345	993.8	993.8	993.8
net cash in	-584	-413	-164	122.7	76.08	29.36	-17.3	-64	-111	298.5	298.5	298.5	298.5	298.5	298.5	64.71	64.71	64.71	64.71	64.71	64.71	64.71	64.71	-258	-230	-202
discount cash flow	-584	-396	-150	107.6	63.79	23.56	-13.3	-47	-77.8	200.9	192.2	184	176	168.5	161.2	33.43	31.99	30.62	29.3	28.04	26.83	25.67	24.57	-93.8	-80	-67.2
npv	0.009																									

Note: Costs were developed using Michigan cost of production focus group data and Polish grower survey data. Michigan price data is indexed to historic averages published by National Agricultural Statistics Service (N.A.S.S.), Michigan Agricultural Statistics. Polish price data is indexed to historic averages published by the Institute for Rural Economics. The discount rate was set at 4.5% for both Poland and Michigan growers.

Under these conditions, Michigan had to average 8350 pounds per acre and Poland had to average 7043 pounds per acre in order to break even.

Appendix 8: Economic Valuation Calculations Using Historic Yield and Price

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Michigan Historic Yield and Price																										
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	6960	5110	7790	5410	5410	4860	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	550	5700	5520
price	0.486	0.202	0.464	0.135	0.491	0.248	0.217	0.197	0.074	0.178	0.145	0.180	0.480	0.170	0.110	0.167	0.052	0.161	0.159	0.145	0.218	0.184	0.183	0.443	0.358	0.329
inflow	0	0	0	0	0	0	1510.3	1006.7	576.46	962.98	784.45	874.8	1536	1229.1	899.8	1095.5	537.16	1078.7	1259.3	1342.7	1434.4	1291.7	1983.7	243.65	2040.6	1816.1
net cash in	-1300	-2665	-871	-901	-901	-901	460	-60	-524	-171	-376	-305	336	29	-300	-104	-663	-121	59	143	234	92	784	-942	869	658
discount cash flow	-1300	-2550	-797.6	-789.5	-755.5	-723	353.48	-44.33	-368.1	-115.1	-241.8	-188.1	198.13	16.42	-162.1	-53.99	-327.8	-57.4	26.842	61.832	97.209	36.377	297.58	-342.4	302.02	218.96
npv	-7208																									
npv assuming farmers are indifferent (ie discount rate = 0)							-7442																			

Note: Cost information was developed from Michigan cost of production focus groups. Historic yield and price information is provided by the National Agricultural Statistics Service, Michigan Agricultural Statistics. The discount rate was set at 4.5 %. Under these conditions, NPV was -$7208 per acre. Assuming farmers are indifferent (discount rate = 0), this value drops to -$7442 dollars per acre.

Appendix 8a: Economic Valuation Calculations Using Historic Price with Yield Adjusted for an Orchard Production Cycle (Indexed to Beedy's Model)

discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	994	1460	3339	3091	3864	4166	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	495	4560	3864
price	0.486	0.202	0.464	0.135	0.491	0.248	0.217	0.197	0.074	0.178	0.145	0.180	0.480	0.170	0.110	0.167	0.052	0.161	0.159	0.145	0.218	0.184	0.183	0.443	0.358	0.329
inflow	0	0	0	0	0	0	215.72	287.66	247.06	550.26	560.29	749.85	1536	1229.1	899.8	1095.5	537.16	1078.7	1259.3	1342.7	1434.4	1291.7	1983.7	219.29	1632.5	1271.3
net cash in	-1300	-2665	-871	-901	-901	-901	-834	-779	-853	-584	-600	-430	336	29	-300	-104	-663	-121	59	143	234	92	784	-967	460	113
discount cash flow	-1300	-2550	-797.6	-789.5	-755.5	-723	-640.6	-572.7	-599.8	-392.8	-386.2	-265.1	198.13	16.42	-162.1	-53.99	-327.8	-57.4	26.842	61.832	97.209	36.377	297.58	-351.3	160.11	37.684
npv	-9793																									
npv assuming farmers are indifferent (ie discount rate = 0)							-11524																			
yield	0	0	0	0	0	0	6960	5110	7790	5410	5410	4860	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	550	5700	5520
Beedy's model		0	0	0	0	0	0.1428	0.2858	0.4286	0.5714	0.7143	0.8572	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7

Note: Appendix 8a is identical to Appendix 8 with the exception that historic yield is indexed to Beedy's Model. Results show that at a discount rate of 4.5%, NPV = -$9793 per acre and -$11524 per acre if growers are indifferent.

Appendix 8b: Economic Valuation Using Historic Price, Historic Yield Indexed to Beedy's Model and Production Costs Decreased by 2.5%

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	701.2	1473	493.6	523.4	536.4	549.9	656.8	684.1	722.9	763.9	800.9	835.1	870.5	892.3	914.6	937.4	960.9	984.9	1010	1035	1061	1087	1114	1129	1143	1158
yield	0	0	0	0	0	0	994.1	1460	3339	3091	3864	4166	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	495	4560	3864
price	0.486	0.202	0.464	0.135	0.491	0.248	0.217	0.197	0.074	0.178	0.145	0.18	0.48	0.17	0.11	0.167	0.052	0.161	0.159	0.145	0.218	0.184	0.183	0.443	0.358	0.329
inflow	0	0	0	0	0	0	215.7	287.7	247.1	550.3	560.3	749.8	1536	1229	899.8	1096	537.2	1079	1259	1343	1434	1292	1984	219.3	1632	1271
net cash in	-701.2	-1473	-493.6	-523.4	-536.4	-549.9	-441.1	-396.5	-475.9	-213.6	-240.6	-85.27	665.5	336.8	-14.77	158.1	-423.7	93.8	249.8	307.9	373.8	204.5	869.4	-909.6	489.1	113.3
discount cash flow	-701.2	-1410	-452	-458.6	-449.8	-441.2	-338.7	-291.3	-334.6	-143.8	-155	-52.54	392.4	190.1	-7.977	81.68	-209.5	44.39	113.1	133.4	155	81.16	330.1	-330.5	170	37.68
npv	-4048																									
npv assuming farmers are indifferent (ie discount rate = 0)								-3617																		

Note: Appendix 8b uses the same yield and price information as Appendix 8a. Cost data is derived by depreciating reported 2004 costs by 2.5%. 2.5% represents typical annual cost increases that Michigan growers reported during the cost of production focus groups. With a Discount rate of 4.5%, NPV = -$4048 per acre. If growers are indifferent, NPV = -$3617 per acre.

Appendix 8c: Economic Valuation Using Historic Yield Indexed to Beedy's Model and Inflation Adjusted Historic Price

discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	994.1	1460	3339	3091	3864	4166	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	495	4560	3864
price	0.602	0.242	0.544	0.166	0.591	0.29	0.281	0.261	0.096	0.209	0.161	0.198	0.56	0.202	0.127	0.194	0.06	0.162	0.174	0.171	0.273	0.228	0.217	0.552	0.396	0.329
inflow	0	0	0	0	0	0	497.2	678.7	567.1	1150	1107	1465	3185	2601	1842	2259	1096	1932	2445	2814	3195	2846	4189	485.5	3209	2260
net cash in	-1300	-2665	-871	-901	-901	-901	-553	-388	-533	15.81	-52.6	284.9	1985	1401	641.6	1059	-104	731.7	1245	1614	1995	1646	2989	-700	2037	1102
discount cash flow	-1300	-2550	-798	-790	-756	-723	-424	-285	-375	10.64	-33.9	175.6	1171	790.3	346.4	547.2	-51.3	346.2	563.7	699.2	827.4	652.9	1135	-255	708.4	366.7
npv	-8333																									
npv assuming farmers are indifferent (ie discount rate = 0)									-8545																	

Note: Appendix 8c uses 2004 costs and historic yields indexed to Beedy's model as in Appendix 8a. Historic price is adjusted using the Producer Price Index to reflect 2004 dollars. When the discount rate is set at 4.5%, NPV = -$8333 dollars per acre. If growers are indifferent, NPV = -$8545 per acre.

Appendix 8d: Calculation of Historic Yield Increase Required for NPV to = 0

	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	0	0	0	1767	2596	5935	5496	6869	7406	5689	12853	14542	11662	18364	11911	14080	16462	11698	12480	19271	880	8106	6869
price	0.602	0.242	0.544	0.166	0.591	0.29	0.281	0.261	0.096	0.209	0.161	0.198	0.56	0.202	0.127	0.194	0.06	0.162	0.174	0.171	0.273	0.228	0.217	0.552	0.396	0.329
inflow	0	0	0	0	0	0	497.2	678.7	567.1	1150	1107	1465	3185	2601	1842	2259	1096	1932	2445	2814	3195	2846	4189	485.5	3209	2260
net cash in	-1300	-2665	-871	-901	-901	-901	-553	-388	-533	15.81	-52.6	284.9	1985	1401	641.6	1059	-104	731.7	1245	1614	1995	1646	2989	-700	2037	1102
discount cash	-1300	-2550	-798	-790	-756	-723	-424	-285	-375	10.64	-33.9	175.6	1171	790.3	346.4	547.2	-51.3	346.2	563.7	699.2	827.4	652.9	1135	-255	708.4	366.7
npv	0.003																									
npv assuming farmers are indifferent (ie discount rate = 0)							8877																			
yield	0	0	0	0	0	0	994.1	1460	3339	3091	3864	4166	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	495	4560	3864
yield Increased by 1.778			0	0	0	0	1767	2596	5935	5496	6869	7406	5689	12853	14542	11662	18364	11911	14080	16462	11698	12480	19271	880	8106	6869
net present value assuming farmers are indifferent (ie discount rate = 0)										8877																
Yield Increased by this rate in order for NPV to equal 0										1.778																

Note: Appenix 8d shows how much yield in Appendix 8c would have to increase in order for NPV = 0. Historic yields that have been indexed to Beedy's model will have to increase by 77.8% in order for NPV = 0 when the discount rate = 4.5%. When farmers are indifferent, NPV - $8777 per acre.

Appendix 9: Incentive to Adopt Overhead Harvesters in Michigan

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
discount rate	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	2665	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	1605	1033	3500	4640	4258	7790	5410	5410	4860	3200	7230	8180	6560	10330	6700	7920	9260	6580	7020	10840	495	4560	3864
price	0.602	0.242	0.544	0.166	0.591	0.290	0.281	0.261	0.096	0.209	0.161	0.198	0.560	0.202	0.127	0.194	0.060	0.162	0.174	0.171	0.273	0.228	0.217	0.552	0.396	0.329
inflow	0	0	0	267.2	610.9	1014	1305	1113	744.3	1132	872.2	961.3	1792	1463	1036	1271	616.7	1087	1375	1583	1797	1601	2356.4	273.1	1805	1271
net cash in	-1300	-2665	-871	-634	-290	113	255	46	-356	-2	-288	-219	592	263	-164	71	-583	-113	175	383	597	401	1156	-913	633	113
discounted cash	-1300	-2550	-798	-555	-243	91.04	196.2	34.1	-250	-1.42	-185	-135	348.9	148.3	-88.6	36.54	-288.4	-53.6	79.37	165.8	247.7	159	439.08	-332	220.2	37.68
npv	-4577																									
Beedy's Model		0	0	0.167	0.333	0.5	0.667	0.833	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.9	0.8	0.7

Note: This valuation measures the incentive of Michigan growers to adopt overhead harvesters by calculating the NPV of an orchard that is harvested starting at year three. Cost is based on Michigan focus group responses but are adapted to reflect the higher number of trees planted by adding $7.50 per tree to year 1. Historic price has been adjusted for inflation using the Producer Price Index. Historic yield has been indexed to Beedy's model. The valuation above shows the NPV of an orchard with 120 trees, first harvested at year three, with no yield increases in order to make NPV = 0. The result shows that in this scenario NPV= -$4577, as described in table 4.3. The same valuation is used to calculate Table 4.3a by increasing the year 1 cost as tree density increases and by varying yield in order to measure the point at which NPV = 0.

Appendix 9a: Economic Valuation with Ascending Revenue Flow using Historic Yield and Producer Price Index Adjusted Historic Price

	1.045																									
year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
cost	1300	11140	871	901	901	901	1050	1067	1100	1134	1160	1180	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1186	1172	1158
yield	0	0	0	3205	988.3	2063	20625	15554	10802	9703	6988	16332	13377	8502	10802	13098	7714.9	9264	15813	14435	18489	14016	6389.12	13138	9104	21643
price	0.602	0.242	0.544	0.166	0.552	0.591	0.06	0.096	0.161	0.198	0.29	0.127	0.162	0.261	0.209	0.194	0.329	0.281	0.174	0.202	0.171	0.228	0.55992	0.273	0.396	0.217
inflow	0	0	0	533.4	545.3	1220	1231	1486	1741	1919	2025	2068	2170	2223	2260	2537	2538.2	2606	2746	2921	3160	3196	3577.42	3589	3604	4705
net cash in	-1300	-11140	-871	-367.6	-355.7	318.8	181.3	419	641.4	785.4	865.4	888.3	969.6	1023	1060	1337	1338.2	1406	1546	1721	1960	1996	2377.42	2403	2432	3547
discount cash	-1300	-10660	-797.6	-322.1	-298.3	255.8	139.2	307.9	451	528.5	557.3	547.4	571.7	577.3	572.3	690.9	661.69	665.5	700	745.6	812.7	791.9	902.71	873	845.7	1180
npv	-4E-04																									
net present value assuming farmers are indifferent (ie discount rate = 0)										15181																

Note: Appendix 9a shows how the NPV of Appendix 9 is influenced when inflows are organized in ascending order. Appendix 9a uses the same inputs as Appendix 9, with the exception that inflow was arranged from smallest to largest. In the valuation shown, year one costs have been increased by $7.50 per tree for 1,250 trees. Yield was then inceased by 99.66% in order for NPV =0. All the results of this valuation are shown in Table 4.3b.

Appendix 10: Northwest Michigan Small-Scale Growers Enterprise Budget

MSU Agricultural Economics
Cost Per Acre to Produce Tart Cherries

Cash and Labor Costs per acre									
Operation	Time (Hrs/A)	Labor Cash ($/hour)	Materials Cash ($/acre)	Equipment Cash ($/Hour)	Equipment Non-cash	Total Cash ($/Acre)	Non-cash	Total Cash ($/Acre)	Non-cash
Cultural								$83.47	$6.93
-Pruning-Pole Saw	5	$12.25			$0.25	$61.25	$0.25		
-Brush Disposal-75 HP Tractor	0.42	$16.15		$4.14	$3.58	$10.92	$3.58		
-Flail Chopper	0.42			$11.30	$3.10	$11.30	$3.10		
Mowing						$0.00	$0.00	$14.83	$2.31
-60 HP used Tractor	0.45	$12.25		$8.90	$0.75	$14.41	$0.75		
-Rotary Motor	0.45			$0.42	$1.56	$0.42	$1.56		
Crop Protection						$0.00	$0.00	$275.15	$15.25
-75 HP Tractor	0.98			$9.74	$5.80	$9.74	$5.80		
-Orchard Sprayer	0.98			$3.83	$9.45	$3.83	$9.45		
-Total Insecticide (exclude Borer control)			$47.45			$47.45	$0.00		
-Total Fungicide			$182.59			$182.59	$0.00		
-Total Pro-Gibb			8.45			$8.45	$0.00		
-Total Spray Labor (exclude Borer control)	1.43	$16.15				$23.09	$0.00		
Borer Control						$0.00	$0.00	$1.24	$1.00
-75 HP Tractor	0.03			$0.30	$0.38	$0.30	$0.38		
-Orchard Sprayer	0.03			$0.12	$0.62	$0.12	$0.62		
-Total labor	0.04	$8.91	$0.47			$0.82	$0.00		
Herbicide						$0.00	$0.00	$29.27	$3.09
-60 HP Used Tractor	0.36			$7.12	$0.78	$7.12	$0.78		
-Weed Sprayer	0.36			$0.55	$2.31	$0.55	$2.31		
-Total Herbicide			12.88			$12.88	$0.00		
-Total labor	0.54	$16.15				$8.72	$0.00		
Fertilizer						$0.00	$0.00	$79.02	$0.58
-Nitrogen-60 HP Used Tractor	0.3	$12.25	$31.56	$5.93	$0.50	$41.17	$0.50		
-Leased Spreader	0.3			$0.70	$0.00	$0.70	$0.00		
-Potassium-60 HP Used Tractor	0.05	$12.25	$5.75	$0.99	$0.08	$7.35	$0.08		
-Leased Spreader	0.05			$0.40	$0.00	$0.40	$0.00		
-Foliar Nutrients			$20.00			$20.00	$0.00		
-Lime (2 Ton/Acre @ Each 5th Year)			$9.40			$9.40	$0.00		
Bee Rental (1 Hive/3 Acres)			$15.00			$15.00	$0.00	$15.00	$0.00
Pest Management Service			$38.50			$38.50	$0.00	$38.50	$0.00
Pickup-Half Ton	4			$18.60	$17.20	$18.60	$17.20	$18.60	$17.20
TOTAL OPERATING COSTS						$555.09	$46.36	$555.09	$46.36
Harvest									
-Double Incline Shaker	2	$24.50		$66.88	$54.84	$115.88	$54.84		
-75 HP Tractor/Forklift	2	$12.25		$19.88	$17.18	$44.38	$17.18		
-60 HP used Tractor/Forklift	2	$12.25		$39.56	$3.33	$64.06	$3.33		
-Skimmer (or Miscellaneous Labor)	2	$8.91				$17.82	$0.00		
-Shipping (.0066 $/lb)						$46.20	$0.00		
-Cooling Pad Operation ($.005/lb)						$35.00	$0.00		
-Tart Cherry Assessment ($.005/lb)						$35.00	$0.00		
-Ethryl Application			$4.99			$4.99	$0.00		
TOTAL HARVEST COSTS*						$363.33	$75.35	$363.33	$75.35
Management and Labor Supervision	8	$28.83				$230.64		$230.64	
Interest on operating capital @ 8%						$73.47		$73.47	
Property Taxes						$25.00		$25.00	
TOTAL PRODUCTION COSTS/ACRE						$1,247.53	$121.71	$1,247.53	$121.71

* at 7000 lb/acre yield

Appendix 10a: Northwest Michigan Large-Scale Growers Enterprise Budget

MSU Agricultural Economics
Cost Per Acre to Produce Tart Cherries

Cash and Labor Costs per acre										
	Time	Labor	Materials	Equipment		Total		Total	
Operation	*(Hrs/A)	Cash ($/hour)	Cash ($/acre)	Cash ($/Hour)	Non-cash	Cash ($/Acre)	Non-cash ($/Acre)	Cash ($/Acre)	Non-cash ($/Acre)
Pruning, tipping, and brush disposal								$106.71	$8.90
-Pruning-Chain Saw	6	$10.41		$1.80		$64.26	$0.00		
-Brush Disposal-85 HP Tractor	0.6	$23.36		$6.23	$5.25	$20.25	$3.15		
-Flail Chopper	0.6			$2.52	$2.57	$2.52	$1.54		
-Summer Tipping-85 HP Tractor	0.5	$23.36		$5.19	$4.37	$16.87	$2.19		
-Summer Tipping-Sickle Bar	0.5			$2.81	$4.04	$2.81	$2.02		
Mowing								6.3349	1.4582
-85 HP Tractor	0.23	11.63		2.43	2.05	$5.10	$0.47		
-Rotary Motor	0.23			$1.23	$4.29	$1.23	$0.99		
Crop Protection								237.8848	19.0218
-85 HP Tractor	0.98			$7.01	$5.90	$7.01	$5.78		
-Orchard Sprayer	0.98			$10.30	$13.51	$10.30	$13.24		
-Total Insecticide (exclude Borer control)			44.76			$44.76	$0.00		
-Total Fungicide			$133.90			$133.90	$0.00		
-Total Pro Gibb			8.51			$8.51	$0.00		
-Total Spray Labor (exclude Borer control)	1.43	$23.36				$33.40	$0.00		
Borer Control								1.5139	0.2799
-85 HP Tractor	0.03			$0.31	$8.74	$0.31	$0.26		
-Orchard Sprayer	0.03			$0.32	$0.59	$0.32	$0.02		
-Labor	0.04	10.41	0.4675			$0.88	$0.00		
Herbicide								24.8632	0.6096
-60 HP Used Tractor	0.24			3.06	1.37	$3.06	$0.33		
-Weed Sprayer	0.24			$0.28	$1.17	$0.28	$0.28		
-Total Herbicide			12.88			$12.88	$0.00		
-Total labor	0.37	$23.36				$8.64	$0.00		
Fertilizer								77.496	0.98
-Nitrogen-60 HP Used Tractor	0.3	$23.36	$31.36	$3.83	$1.70	$42.20	$0.51		
-Spin Spreader	0.3			$0.29	$0.62	$0.29	$0.19		
-Potassium-60 HP Used Tractor	0.05	$23.36	$5.75	$0.64	$5.68	$7.56	$0.28		
-Spin Spreader				$0.05	$0.10	$0.05	$0.00		
-Foliar Nutrients			$18.00			$18.00	$0.00		
-Lime (2 Ton/Acre @ Each 5th Year)			$9.40			$9.40	$0.00		
Bee Rental (1 Hive/3 Acres)			$15.00			$15.00	$0.00	$15.00	
Pest Management Service			27.5			$27.50	$0.00	$27.50	
Pickup-Half Ton	2.25			$12.75	$6.44	$12.75	$14.49	12.75	14.49
TOTAL OPERATING COSTS						$510.05	$45.74	510.0488	45.7365
Harvest									
-Double Incline Shaker	1.8	$34.99		$42.19	$29.90	$105.17	$53.81		
-85 HP Tractor/Forklift	1.8	$11.63		$18.70	$8.74	$39.63	$15.74		
-60 HP used Tractor/Forklift	1.8	$11.63		$22.95	$5.68	$43.88	$10.22		
-Skimmer (or Miscellaneous Labor)	1.8	$10.41				$18.74	$0.00		
-Shipping (.01 $/lb)						$70.00	$0.00		
-Cooling Pad Operation ($.005/lb*Avg Yield)						$35.00	$0.00		
-Tart Cherry Assessment ($.005/lb*Avg Yield)						$35.00	$0.00		
-Ethryl Application			$4.60			$4.60	$0.00		
TOTAL HARVEST COSTS*						$352.03	$79.77	$352.03	$79.77
Management and Labor Supervision	6	$25.00				$150.00	$0.00	$150.00	
Interest on operating capital @ 8%						$40.80		$40.80	
Property Taxes						$25.00		$25.00	
TOTAL PRODUCTION COSTS						$1,077.88	$125.51	1077.882	125.5076

* at 7000 lb./acre yield

Appendix 10b: West-Central Michigan Growers Enterprise Budget

MSU Agricultural Economics
Cost Per Acre to Produce Tart Cherries

Cash and Labor Costs per acre									
	Time	Labor	Materials	Equipment		Total		Total	
Operation	*(Hrs/A)	Cash	Cash	Cash	Non-cash	Cash	Non-cash	Cash	Non-cash
		($/hour)	($/acre)	($/hour)		($/Acre)		($/Acre)	
Cultural								$92.97	$22.44
-Pruning-Tower and Saw	5.5	$10.15		$3.92	$1.48	$77.39	$8.14		
-Brush Disposal-85 HP Tractor	0.5	$10.15		$10.10	$8.00	$10.13	$4.00		
-Flail Chopper	0.5			$3.52	$8.23	$1.76	$4.12		
-Summer Tipping-85 HP Tractor	0.1	$19.37		$10.10	$8.00	$2.95	$0.80		
-Summer Tipping-Sickle Bar	0.1			$7.49	$53.88	$0.75	$5.39		
Mowing								$6.92	$4.50
-85 HP Tractor	0.27	$10.15		$10.10	$8.00	$5.47	$2.16		
-Rotary Motor	0.27			$5.38	$8.65	$1.45	$2.34		
Crop Protection								$222.84	$13.11
-85 HP Tractor	0.744			$10.10	$8.00	$7.51	$5.95		
-Orchard Sprayer	0.744			$2.81	$9.62	$2.09	$7.16		
-Total Insecticide (exclude Borer control)			$47.04			$47.04	$0.00		
-Total Fungicide			$134.13			$134.13	$0.00		
-Total Pro Gibb			$8.70			$8.70	$0.00		
-Total Spray Labor (exclude Borer control)	1.206	$19.37				$23.36	$0.00		
Borer Control								$3.61	$1.09
-85 HP Tractor	0.062			$10.10	$8.00	$0.63	$0.50		
-Orchard Sprayer (hand held)	0.062			$2.81	$9.62	$0.17	$0.60		
-Labor	0.093	$10.15	$1.87			$2.81	$0.00		
Herbicide								$20.37	$2.23
-60 HP Tractor	0.24			$6.67	$7.99	$1.60	$1.92		
-Weed Sprayer	0.24			$6.46	$1.32	$1.55	$0.32		
-Total Herbicide			10.25			$10.25	$0.00		
-Total labor	0.36	$19.37				$6.97	$0.00		
Fertilizer								$83.51	$3.27
-Nitrogen-60 HP Tractor	0.175	$10.15	$31.30	$6.67	$7.99	$34.24	$1.40		
-Spin Spreader	0.175			$0.99	$3.36	$0.17	$0.59		
-Potassium-60 HP Tractor	0.113	$10.15	$15.33	$6.67	$7.99	$17.23	$0.90		
-Spin Spreader	0.113			$0.99	$3.36	$0.11	$0.38		
-Foliar Nutrients			$20.00			$20.00	$0.00		
-Lime (2 Ton/Acre @ Each 4th Year)			$11.75			$11.75	$0.00		
Bee Rental (1 Hive/3 Acres)			$11.67			$11.67	$0.00	$11.67	
Pest Management Service			$30.00			$30.00	$0.00	$30.00	
Pickup-Half Ton					$2.50	$20.38	$9.00	$20.38	$9.00
TOTAL OPERATING COSTS						$492.27	$55.64	$492.27	$55.64
Harvest									
-Used One Man Shaker	2	$19.37		$45.96	$48.40	$130.66	$96.80		
-85 HP Tractor/Forklift	2	$10.15		$10.01	$8.00	$40.32	$16.00		
-60 HP used Tractor/Forklift	2	$10.15		$4.83	$1.81	$29.96	$3.62		
-Skimmer (or Miscellaneous Labor)	2	$8.06				$16.12	$0.00		
-Shipping (.01 cent/pound*average yeild)						$0.00	$0.00		
-Cooling Pad Operation ($.005/lb*Avg Yield)						$0.00	$0.00		
-Tart Cherry Assessment ($.005/lb*Avg Yield)						$0.00	$0.00		
-Ethryl Application		$19.37	$4.50			$4.50	$0.00		
TOTAL HARVEST COSTS						$221.56	$116.42	$221.56	$116.42
Management and Labor Supervision	3.6	$25.00				$90.00	$0.00	$90.00	
Interest on operating capital @ 8%						$39.38	$0.00	$39.38	
Property Taxes						$25.00	$0.00	$25.00	
Total Production Costs						$868.21	$172.06		

Appendix 10c: South West Michigan Growers Enterprise Budget

MSU Agricultural Economics
Cost Per Acre to Produce Tart Cherries

Cash and Labor Costs per acre									
	Time	Labor	Materials	Equipment		Total		Total	
Operation	(Hrs/A)	Cash	Cash	Cash	Non-cash	Cash	Non-cash	Cash	Non-cash
		($/hour)	($/acre)	($/hour)		($/Acre)		($/Acre)	
Cultural								$103.40	$28.24
-Pruning-Tower and Saw	6	$9.40		$4.23	$2.26	$81.78	$13.56		
-Brush Disposal-60 HP Tractor	1	$9.40		$7.85	$5.21	$17.25	$5.21		
-Brush Rake	1			$0.43	$1.65	$0.43	$1.65		
-Summer Tipping-85 HP Tractor	0.133	$14.09		$9.23	$17.32	$3.10	$2.30		
-Summer Tipping-Sickle Bar	0.133			$6.30	$41.44	$0.84	$5.51		
Disking								$29.57	$8.08
-60 HP Tractor	1.32	$14.09		$7.85	$5.21	$28.96	$6.88		
-10 FT Disc	1.32			$0.46	$0.91	$0.61	$1.20		
Crop Protection								$197.69	$21.58
-85 HP Tractor	0.806			$9.23	$17.32	$7.44	$13.96		
-Orchard Sprayer	0.806			$2.81	$9.46	$2.26	$7.62		
-Total Insecticide (exclude Borer control)			$35.97			$35.97	$0.00		
-Total Fungicide			$123.77			$123.77	$0.00		
-Total Pro Gibb			$11.25			$11.25	$0.00		
-Total Spray Labor (exclude Borer control)	1.206	$14.09				$16.99	$0.00		
Borer Control								$1.53	$0.80
-85 HP Tractor	0.03			$9.23	$17.32	$0.28	$0.52		
-Orchard Sprayer	0.03			$2.81	$9.46	$0.08	$0.28		
-Labor	0.124	$9.40	$0.00			$1.17	$0.00		
Herbicide								$11.61	$3.67
-60 HP Tractor	0.28			$7.85	$5.21	$2.20	$1.46		
-Weed Sprayer	0.28			$1.44	$7.88	$0.40	$2.21		
-Total Herbicide			5.06			$5.06	$0.00		
-Total labor	0.42	$9.40				$3.95	$0.00		
Fertilizer								$55.40	$1.75
-Nitrogen-60 HP Tractor	0.1	$9.40	$31.30	$7.85	$5.21	$33.03	$0.52		
-Spin Spreader	0.1			$1.22	$6.46	$0.12	$0.65		
-Potassium-60 HP Tractor	0.05	$9.40	$9.58	$7.85	$5.21	$10.44	$0.26		
-Spin Spreader	0.05			$1.22	$6.46	$0.06	$0.32		
-Foliar Nutrients			$0.00			$0.00	$0.00		
-Lime (2 Ton/Acre @ Each 4th Year)			$11.75			$11.75	$0.00		
Bee Rental (1 Hive/2 Acres)			$17.50			$17.50	$0.00	$17.50	
Pest Management Service			$0.00			$0.00	$0.00		
Pickup-Half Ton						$14.37	$9.00	$14.37	$9.00
TOTAL OPERATING COSTS								$431.06	$73.12
Harvest									
-Double Incline Shaker	2	$28.18		$68.13	$68.55	$192.62	$137.10		
-60 HP Tractor/Forklift	2	$9.40		$9.22	$17.32	$37.24	$34.64		
-60 HP used Tractor/Forklift	2	$9.40		$21.89	$2.40	$62.58	$4.80		
-Skimmer (or Miscellaneous Labor)	2	$7.05				$14.10	$0.00		
-Shipping (.01 cent/pound*average yeild)						$0.00	$0.00		
-Cooling Pad Operation ($.005/lb*Avg Yield)						$0.00	$0.00		
-Tart Cherry Assessment ($.005/lb*Avg Yield)						$0.00	$0.00		
-Ethryl Application		$14.09	$4.50			$4.50	$0.00		
TOTAL HARVEST COSTS								$311.04	$176.54
Management and Labor Supervision	3	$25.00				$75.00	$0.00	$75.00	
Interest on operating capital @ 8%						$0.00	$0.00	$0.00	
Property Taxes						$25.00	$0.00	$25.00	
TOTAL CULTURAL COSTS								$842.10	$249.66

Appendix 10d: All Growers and Regions Cost to Establish Tart Cherries

Operation	Cost/acre ($)
Year 0--Site Preparation & Fallow:	
Orchard removal & clean-up	$600.00
Plowing and Cover crop	$300.00
Total Site Prep. Costs	$900.00
Year 1--Planting Costs:	
Plowing	$22.23
Nematicide	$150.00
Surveying	$24.10
Trees:	$906.00
Planting,	$56.25
Mulch (1/2 bale straw/ tree)	$200.00
Total Planting Costs	$1,358.58
Cultural Costs:	
Permanent seeding	$37.91
Pest Control (4x)	$58.29
Herbicide	$28.22
Mouse baiting	$10.22
Fertilizer	$26.35
Deer Control @ $.50/tree	$62.50
Management	$40.00
Property tax	$25.00
Total Cultural Costs	$288.49
Total- Year 1	$1,647.07
Year 2--Growing costs:	
Pruning (1 hr/ac)	$13.53
Tree replacement (1%)	$179.97
Herbicide	$30.19
Pest Control--5x	$72.86
Mowing--2x	$14.56
Mouse control	$10.22
Fertilizer-labor & equip.	$11.34
Fertilizer-material (1 lb./tree)	$15.00
Deer control ($0.50/tree)	$62.50
Management (1.5 hr/ac)	$30.00
Property tax	$25.00
Total- Year 2	$465.16

Year 3--Growing costs:	
Pruning (3 hr/ac)	$40.59
Tree replacement (0.5%)	$89.99
Herbicide	$30.19
Pest Control--5x	$89.11
Mowing--3x	$21.84
Mouse control	$10.22
Fertilizer-labor & equip.	$11.34
Fertilizer-material (2 lb./tree)	$30.00
Deer control ($0.50/tree)	$37.50
Management (1.5 hr/ac)	$30.00
Property tax	$25.00
Total- Year 3	$415.78
Year 4--Growing costs:	
Pruning (4 hr/ac)	$54.12
Herbicide	$30.19
Pest Control--5x	$107.74
Mowing--3x	$21.84
Mouse control	$10.22
Fertilizer-labor & equip.	$11.34
Fertilizer-material (3 lb./tree)	$45.00
Management (2 hr/ac)	$40.00
Property tax	$25.00
Total- Year 4	$345.45
Year 5--Growing costs:	
Pruning (5 hr/ac)	$67.65
Herbicide	$30.19
Pest Control--5x	$129.11
Mowing--3x	$21.84
Mouse control	$10.22
Fertilizer-labor & equip.	$12.75
Fertilizer-material (4 lb./tree)	$60.00
Management (3 hr/ac)	$60.00
Property tax	$25.00
Total- Year 5	$416.76
Total Establishment costs	$3,290.22

Appendix 11: Poland All Growing Regions Cost to Produce Tart Cherries

	zloty per hectare	zloty per acre	$ per acre
pruning	532.9139	215.6673	59.08694
mowing	208.6944	84.45746	23.13903
insecticide	1620.538	655.8228	179.6775
fungicide	2661.67	1077.163	295.1131
herbicide	869.5359	351.8963	96.40996
fertilizer	841.9612	340.737	93.35261
harvest	3808.24	1541.174	422.2394
hauling	669.967	271.1319	74.28272
cold storage	191.0013	77.29717	21.17731
other	145.8856	59.0391	16.1751
Totals	11550.41	4674.386	1280.654

Appendix 11a: Poland All Growing Regions Cost to Establish Tart Cherries

note: Establishment costs are estimates. Estimates are based on Michigan costs and are adjusted for Polish materials, labor and machinery costs.

Operation	Cost/acre ($)
Year 0--Site Preparation & Fallow:	
Orchard removal & clean-up	$494.72
Plowing and Cover crop	$88.92
total	$583.64
Year 1--Planting Costs:	
Plowing	$22.23
Nematicide	$150.00
Trees:	100
Planting,	12
Cultural Costs:	
Pest Control (4x)	$58.29
Herbicide	$28.22
Mouse baiting	$10.22
Fertilizer	$26.35
Management	$6.00
total	$413.31
Year 2--Growing costs:	
Tree replacement (1%)	$1.00
Herbicide	$30.19
Pest Control--5x	$72.86
Mowing--2x	$14.56
Mouse control	$10.22
Fertilizer-labor & equip.	$11.34
Fertilizer-material (1 lb./tree)	$15.00
Management (1.5 hr/ac)	$4.50
total	$159.66

Year 0

1) **Plowing and Cover Crop**: Assume 4 hours plowing at $22.23 per hour.

Year 1

1) **Plowing**: Assume 120 labor hours for 5 acres, labor costs $2 per hour and that machinery. costs $18.53 per hour.
2) **Trees**: assume 200 trees at $.50 per tree.
3) **Planting**: Assume 6 hours per acre at $2 per hour.
4) **Management**: Assume 3 hours at $2 per hour.

Year 2

1) **Tree Replacement**: 1% of 200 trees at $.50 per tree.
2) **Management**: Assume 3 hours.

Appendix 12: Example Polish Survey Questionnaire

Global Produce Markets: Poland Growers Survey

Section I. Demographic information

	1) Head of Household	**2) Spouse**	**3)**	**4)**
Male				
Female				
Age				
Years of formal education				
Works on the farm				
Works outside the farm				

Section II. General information regarding the farm operation

2.1 How many total hectares do you have planted to all crops?

Owned land	
Rented land	

2.2 How many hectares of tart cherries do you have planted by variety?

Variety	**Land (ha)**	
	Owned land	**Rented land**

2.3 What is the density of tart cherry planting?

Variety	**Lutowka**	**Lutowka, Nefris**	**Lutowka**	**Nefris**
Number of trees per hectare				
Average age of trees				

Section III. Cost of Production

3.1 In 2003, what was your cost of growing tart cherries?

3.1A Operation Costs

Operation	**Measure (e.g., hectare)**	**Frequency (during the year or every time you do it)**	**Cost**			
			Labor	**Benefits**	**Machinery**	**Other (ex: fuel)**
Trimming						
Weed Control						
Mowing						
Summer tipping						

3.1B Pest Control

Operation	**Name of product used**	**Measure**	**Frequency (during the year or every time you do it)**	**Cost**			
				Labor	**Benefits**	**Machinery**	**Other (ex: chemical cost)**
Insecticide							
Fungicide							
Herbicide							
Nematicide							
Ethrel Spray							
Fertilizers							
Other							

3.2 In 2003, what were the costs of harvesting tart cherries?

Harvesting	**Measure**	**Cost**				
		Labor	**Benefits**	**Machinery**	**Container**	**Other**
Picking Cherries						
Transportation to processing facility						
Hauling						
Other Cold storage						

3.3 During harvest, how difficult or easy is it to find workers?

____

____

____

3.4 In 2003, what were your fixed costs?

Land value:
Interest on land:
Property taxes:
3.5A Do you normally borrow money for annual farm operation?

If YES, how much is the annual interest rate?

3.5B Do you normally borrow money for long-term farm expansion or improvements?

If YES, how much is the annual interest rate?___________________________

Section IV. Quality characteristic requirements

4.1 How do you market or utilize your tart cherries? [Percentages should sum to 100]

	%
Sell directly to individual users	
Sell through broker, intermediary	
Sell to a processor	
Home use	
Discard	
Other	
TOTAL	**100%**

4.2 Has the way you market or utilize tart cherries changed over the last 5 years?

If YES, how have they changed?

____

____

____

4.3 What are the main quality characteristics that your buyers request when you sell tart cherries?

1.
2.
3.
4.

4.4 Have the quality characteristics requested changed over the last 5 years?

If YES, how have they changed?

____

____

____

____

____

Section V. Uncertainties and Risk Management

5.1 Looking ahead, do you think that tart cherries have a good market in the future?

____

____

____

____

5.2 Looking ahead, what product forms do you expect to dominate tart cherry markets in the future?

____

____

____

5.3 What are your planting plans for the next 5 years?

____

____

Section VI. Any Other Comments

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