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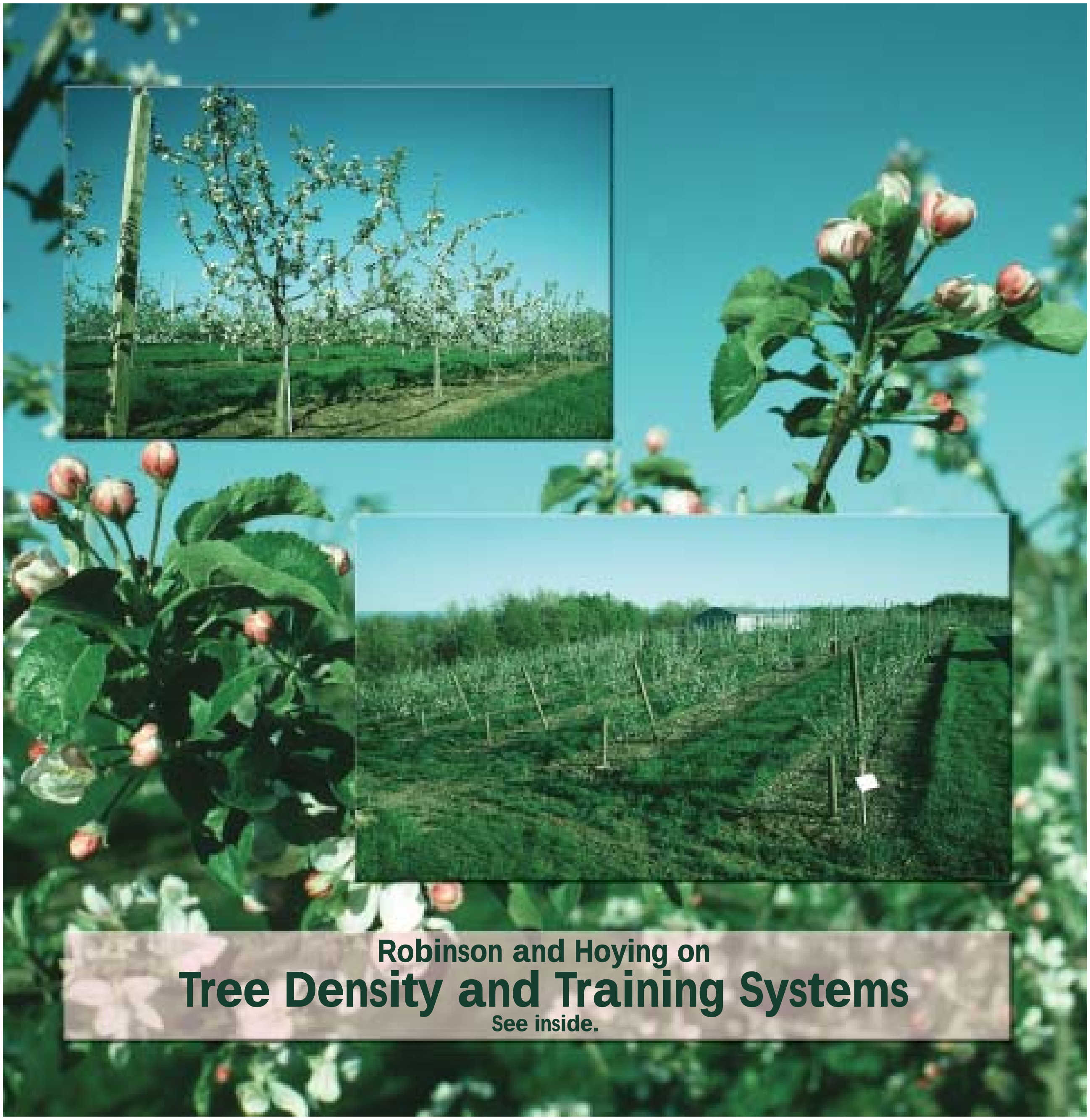

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N E W Y O R K
FRUIT QUARTERLY

Editorial

Can New York Compete in the World Apple Market?

Two years ago a group of Washington growers and researchers met to discuss the future of the Washington apple industry. One of their findings was that they would have to lower the cost of production of high quality apples by 30 percent by 2010!! This was a shock to many growers. The growers asked, "How can our cost of production go down when our expenses are going up?" To answer this question, they are developing the *Technology Roadmap*, which we will hear more about in the future.

The answer to the cost reduction question has two parts. The first obvious answer is that we have to increase our yields. Dividing the expenses per acre by more bushels results in a lower cost per bushel. This led me to take a look at our yield per acre compared to competing production areas. When we compare New York to other eastern areas, we compare quite favorably. We're all in the 500 bushels per acre range. But when we compare ourselves to Washington we're way behind. Depending on which numbers you pick they're probably in the 800 – 900 bushel range, a very significant yield advantage. And when we look at competing countries, we find New Zealand also just above 900 bushels. But the real shocker was discovering that Belgium and The Netherlands are both over 1000 bushels per acre; more than double New York. How can they do that in those maritime climates with less sunlight intensity than we have? One answer could be that being farther north, they have longer daylight in the summer than we do. But the real answer is probably that almost all their orchards are very high density with 1000 or more trees per acre. And their grower technology is arguably better than ours. Doubling our production is a tremendous advantage.

This leads us to the question of why is New York production so low? We have individual growers who average over 1000 bu/acre, but many of their neighbors have trouble making 500. So the answer is not climate, although some parts of the state do average more than others. What is our production potential? Darrel Oakes told me a couple of years ago about an area of Crispin on M9 in one of his orchards that picked 3500 bu/acre. This points out that our yield targets have not been high enough and we need a concerted push to get our yields higher if we are going to be competitive in the future. In the NY Apple Industry Strategic Plan, this area was assigned to Cornell, and hopefully they can continue to help us in this area.

However, even if we get our yields up, it is doubtful if we can decrease our production costs 30 percent using present practices. This leads us back to the Washington group and their Technology Roadmap. They are examining every practice and asking the question "why are we doing this and how can we do it better"? This will lead to a complete reengineering of apple production from the rootstock to the market. This is how computer companies have reduced the cost of a computer from $2000 to $200 in the past 10 years. And if the New York apple industry wants to compete in the world market of the future, it will have to go through the same process.

New York has many advantages. We are within 500 miles of half of the US population and half of Canada's. And that advantage increases daily as fuel costs escalate. But if we want to be successful in the future, we, too, will have to lower the production cost of high quality apples. The problems in the apple business are not all in marketing, as many of us would like to think!

George Lamont
Executive Director, NYS Horticultural Society

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FRONT COVER: The majority of growers are planting apple trees between 1,000 and 2,500 tree/ha. There is also considerable debate about which training system is best: Slender Spindle or Vertical Axis. Photos by Terence Robinson.

BACK COVER: Technology in New York State orchards discussed in this edition of the New York State Fruit Quarterly ranges from pheromone applicators and application rates (left) to weed flamers for tractors (right). The pheromone applicator photos are by Art Agnello. Weed flamer attachment photos are by Kevin Bittner.

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What Tree Density and Training System Should NY Growers Use with New Apple Orchards?

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This work was funded in part by the NY Apple Research and Development Program and the New York Apple Research Association.

Our results show there are no large differences in yield, quality or profitability between different training systems when trees are planted at the same density. Profitability of very high density systems like the Super Spindle system appears to be similar to the Vertical Axis system, but the investment risk is much higher due to the much higher establishment costs.

Fruit growers in New York State continue to plant higher and higher tree densities. However, there is great disparity of opinion on the optimum density. Some growers are using densities above 5,000 trees/ha and some growers on the other extreme plant densities of 500 trees/ha. The majority of growers are planting densities between 1,000 and 2,500 trees/ha. There is also considerable debate about which training system is best. Some favor the Slender Spindle system, others the Vertical Axis system, and others some version of V-systems. Our goal has been to provide research data on the production and economic performance of high density systems to assist growers in making proper planting decisions that will provide them the best return on investment. Our approach has been to compare several of the leading high density planting systems and also to compare them at several densities on growers' farms to determine the optimum density for each system and which systems are the most profitable.

The 1993 High Density Trial

We planted a replicated orchard planting systems field trial in 1993, on the farm of Eric and Bob Brown near Albion, NY. The trial was five acres in size and compared seven training systems each planted at two densities. Tree densities ranged from 1,098 to 5,980 trees/ha (Table 1). Each system had four varieties (Red Cortland, NuRedspur Delicious, Thome Empire and Regal Gala) with solid rows of each variety. Each row was 60 m long and each system was replicated three times. The site previously had been planted to apples and the soil was a sandy loam. Irrigation was applied through a trickle system with in-line emitters. The trees of Gala, Cortland and Empire were feathered at planting but the Delicious trees were whips. Annually, we measured yield, fruit size, fruit color and labor inputs for tree training and pruning.

Horticultural Results

The Super Spindle/M.9 system which had the highest tree density began production in the second year and continued with the highest yield through year 6 (Figure 1). There was almost no difference in yield between the two densities of Super Spindle. The results show that the Super Spindle system can achieve commercially important yields in the second year and maximum yields by year five. Cumulative yield by the end of year five was highest for the Super Spindle system and was related to tree density in essentially a linear manner (Figure 3). In years 7-9, the moderate density systems of Vertical Axis/M.9 and the Slender Spindle/M.9 had similar yields as the very high density Super Spindle/M.9 system. By the end of the ninth year, cumulative yield was highest for the Super Spindle/M.9 system and lowest for the Vertical Axis/M.26 system (Figure 2 and Table 2). The relationship of cumulative yield and tree density at the end of year nine was strongly curvilinear indicating that medium density systems produced essentially the same cumulative yield as

TABLE 1

Planting Systems at Brown's on-farm orchard systems trial[1].

System[2]	Spacing (m) and Tree Density (trees/ha) of Lower Density System		Spacing (m) and Tree Density (trees/ha) of Higher Density Systems	
Vertical Axis/M.26	2.1 X 4.3	(1,098)	1.5 X 4.3	(1,538)
Vertical Axis/M.9	1.8 X 3.7	(1,495)	1.2 X 3.7	(2,242)
Slender Spindle/M.9	1.8 X 3.7	(1,495)	1.2 X 3.7	(2,242)
V-Slender Spindle/M.9	1.8 X 3.7	(1,495)	1.2 X 3.7	(2,242)
Y-Trellis /M.9	1.8 X 3.7	(1,495)	1.2 X 3.7	(2,242)
V-Trellis /M.9	1.2 X 3.7	(2,242)	0.6 X 3.7	(4,485)
Super Spindle/M.9	0.6 X 3.7	(4,485)	0.45 X 3.7	(5,980)

[1]Trial was planted in April 1993.

[2]Each system used 4 varieties: Regal Gala, Thome Empire, Red Cortland and NuRedspur Delicious.

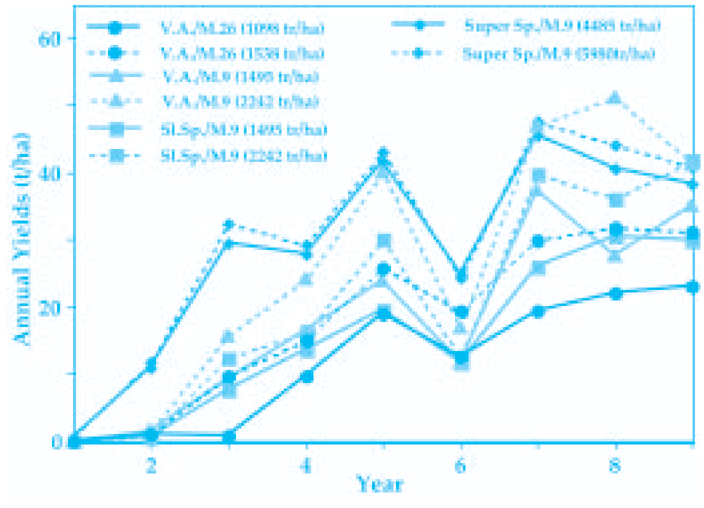

Figure 1. Annual Yields over 9 years of Gala trained to 4 planting systems and 2 spacings at the Brown's Planting Systems Trial.

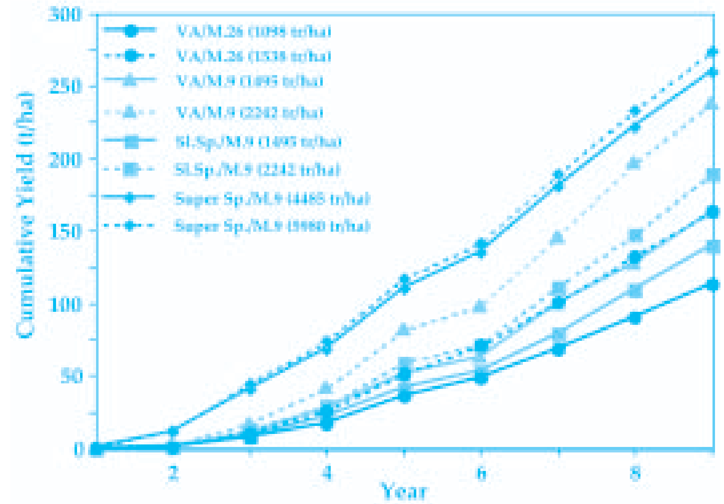

Figure 2. Cumulative yields over 9 years of Gala trained to 4 planting systems and 2 spacings at the Brown's Planting Systems Trial.

the high density system. It is likely that as the orchard ages, the relationship will be even more strongly curvilinear. The changing relationship indicates that the highest density systems have greater advantage in the early years, but, in the later years, the advantage disappears. This means that the very high density systems would have the greatest potential if orchard life is short or if fruit prices are very high in the early years of an orchard life.

In this study, there were no significant differences in cumulative yield among the four systems planted at the same two densities (Vertical Axis. Slender Spindle, Y-trellis, and V-Slender Spindle). Most of the differences in yield in this study were related to planting density. This indicates that the four leading modern training systems can all result in high yields since they all utilize the same principles of minimal pruning and good light distribution.

The largest average fruit size was with the Slender Spindle/M.9, the Vertical Axis/M.9 and the V-Slender Spindle/M.9 systems (Table 2). The V-trellis/M.9, Y-trellis/M.9, and the Vertical Axis/M.26 systems had intermediate fruit size while the Super Spindle/M.9 had the smallest fruit size. To a large extent, the smaller fruit size on the Super Spindle system was likely the result of larger crop.

Fruit red color was greatest with the Vertical Axis/M.26 system (Table 2). There were no differences in average fruit color between all of the other systems. The Vertical Axis/M.26 system had the most space between the trees and the most open canopy which likely resulted in the slightly improved fruit red color; however, all of the systems have good color due to

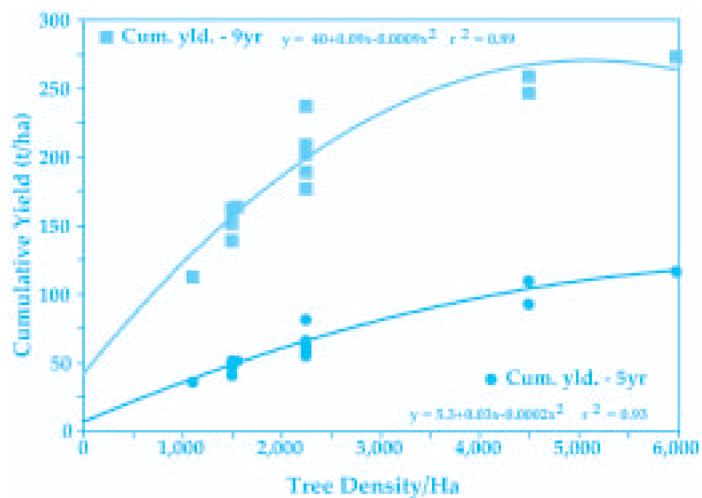

Figure 3. Relationships of cumulative yield and tree density a the end of year 5 and year 9 of Gala trained to 7 planting systems and 2 spacings at the Brown's Planting Systems Trial.

TABLE 2

Yields and fruit quality of 4 apple varieties (Red Cortland, NuRedspur Delicious, Thome Empire, and Regal Gala) trained to 7 orchard planting systems and 2 spacings at Brown's orchard planting systems trial.

System	Tree Spacing m	9 Yr. Cum. Yield (t/ha)	8 Yr. Average Fruit Size (g)	5 Yr. Average Fruit Color (%)
Vertical Axis/M.26	2.1 X 4.3	113	184	52
Vertical Axis/M.26	1.2 X 3.7	151	180	49
Vertical Axis/M.9	1.8 X 3.7	134	196	47
Vertical Axis/M.9)	1.2 X 3.7	179	192	46
Slender Sp./M.9	1.8 X 3.7	132	198	46
Slender Sp./M.9	1.2 X 3.7	164	196	47
V-Slender Sp./M.9	1.8 X 3.7	133	197	47
V-Slender Sp./M.9	1.2 X 3.7	164	190	45
Y-Trellis/M.9	1.8 X 3.7	132	187	46
Y-Trellis/M.9	1.2 X 3.7	164	184	47
V-Trellis/M.9	1.2 X 3.7	146	192	47
V-Trellis/M.9	0.6 X 3.7	191	180	47
Super Spindle/M.9	0.6 X 3.7	234	171	48
Super Spindle/M.9	0.45 X 3.7	262	170	46
LSD $p \leq 0.05$		26	8	3

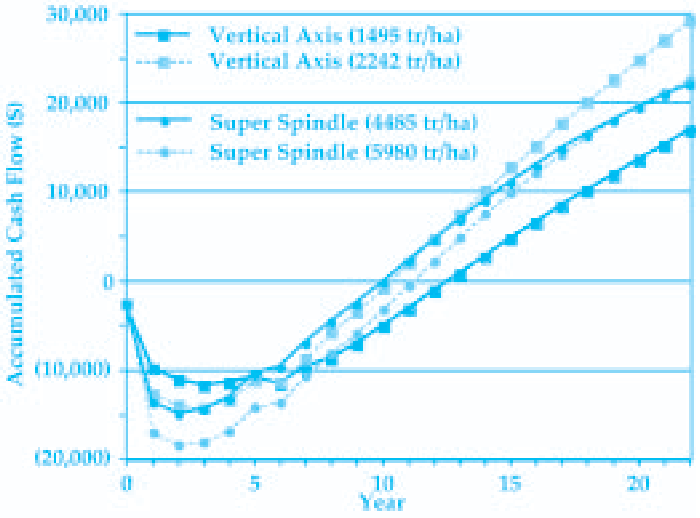

Figure 4. Projected cash flow through year 22 of Gala trained to 2 planting systems and 2 spacings at the Brown's Planting Systems Trial.

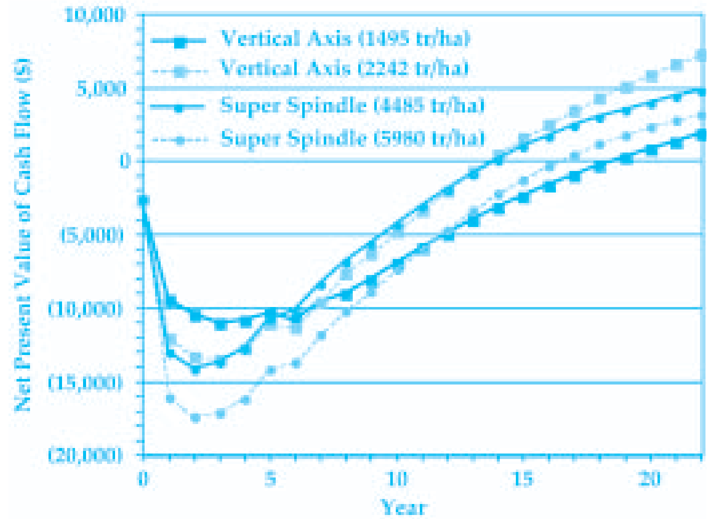

Figure 5. Net Present Value (NPV) of projected cash flow through year 22 of Gala trained to 2 planting systems and 2 spacings at the Brown's Planting Systems Trial.

the small tree size and open canopies.

Among varieties, Cortland was the most productive variety followed by Gala, Empire and then Delicious.

Economic Results

An economic analysis of cash flow and profitability was done using actual yields, fruit quality, material costs and labor inputs through year nine. We added projections of yield, quality and labor for years 10-22 based on average yield for years 7-9. Each of the planting systems was evaluated from an investment perspective by calculating the Net Present Value (NPV) of the investment over 22 years and by calculating the Internal Rate of Return (IRR) of the investment (White and DeMarree, 1992). The Net Present Value of the investment at any year can be determined from the value at that year. Thus, for a planned orchard life span of less than 22 years, the comparisons among systems can be made by the relative ranking of NPV at that year. For simplicity, only the results of Gala with four systems are presented in Figures 4-7.

Comparisons of cumulative cash flow showed that the Super Spindle/M.9 system which had the highest tree density was the most expensive to establish ($16,000/ha in the first year) and had the greatest cumulative negative cash flow in year 2 ($18,000/ha) (Figure 4). The Vertical Axis/M.9 system required $12,000/ha to establish and had a maximum negative cash flow of $14,000/ha in year three. At the end of year 9 none of the systems had a positive cumulative cash flow, but the low density Super Spindle/M.9 (4485 trees/ha) and the high density Vertical Axis/M.9 system (2,242 trees/ha) were the closest to breaking even. Projected to year 22, the greatest cash flow was with the high density Vertical Axis/M.9 system. The low density Vertical Axis system was lower with both densities of Super Spindle/M.9 intermediate.

Among varieties, Gala was the most profitable due to higher fruit prices, although Cortland was the most productive variety. Profitability of Gala was followed by Empire, Cortland, and then Delicious, which was the least productive and not profitable with any system.

Profitability among systems as measured by net present value analysis (NPV)

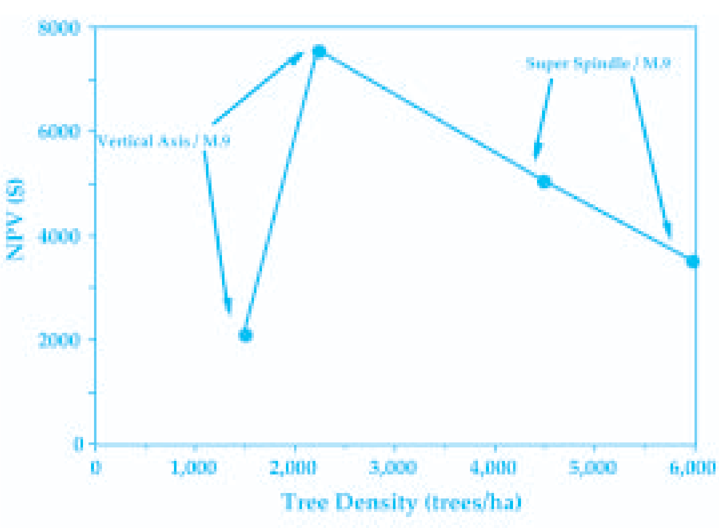

Figure 6. Effect of tree density on Net Present Value (NPV) of projected cash flow of Gala trained to 2 planting systems and 2 spacings at the Brown's Planting Systems Trial.

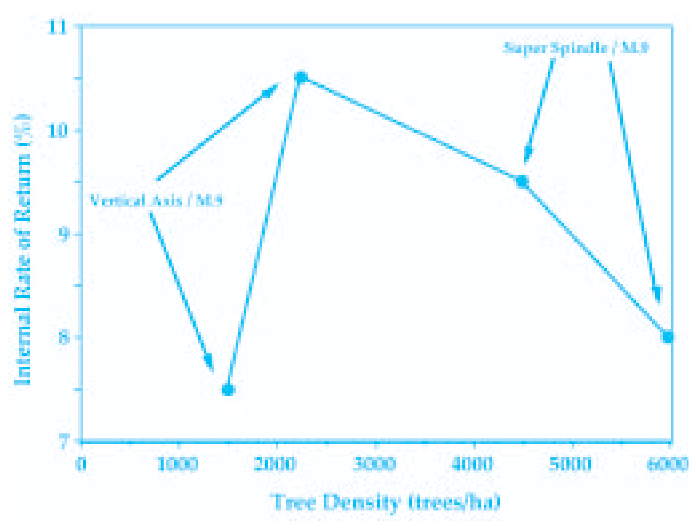

Figure 7. Effect of tree density on Internal Rate of Return (IRR) of investment in different planting systems of Gala (Brown's Planting Systems Trial).

of the investment after 22 years was highest for the high density Vertical Axis/M.9 system (Figure 5). Both the lower density Super Spindle and the higher density Vertical Axis system became profitable in year 10 with the higher density Super Spindle system in year 11 and the lower density Vertical Axis system in year 13. The lower density Super Spindle and the higher density Vertical Axis systems had very similar profitability for orchard life spans of 10-13 years. But for longer orchard life spans, the higher density Vertical Axis was more profitable.

Using a 22-year orchard lifetime, NPV and Internal Rate of Return (IRR) were curvilinearly related to tree density with intermediate densities giving the highest profitability (Figures 6 and 7). These data indicate that for a 22-year orchard life span and with the moderate vigor soil used in this study, there is a clear optimum of orchard planting density between 2,000 and 3,000 trees/ha. With shorter orchard life spans we predict a rather broad optimum planting density between 2,000 and 4,500. However, these data clearly show that, regardless of orchard life span, even the relatively modest density of 2,200 trees per ha can be as profitable as the very high densities.

Our results show that the Super Spindle system can be profitable, but it must have an orchard life of at least 10-11 years. Even at the relatively short orchard life of 10-13 years, the Super Spindle systems were not more profitable than the more moderate density Vertical Axis system. Even though profitability of the Super Spindle system appears to be similar to the Vertical Axis system, the investment risk is much higher due to the much higher establishment costs. From an investment perspective this will require a higher IRR for the Super Spindle to justify planting this system. To improve the profitability of this system and reduce the risk, either the establishment cost must be reduced through less expensive trees or very high fruit prices must be obtained during years 2-6 when the Super Spindle system has the greatest yield.

Conclusions

Long-term orchard planting systems trials such as the one at Brown's farm in New York have provided data which can be used to compare different training systems and to predict for growers which planting density and training system is most profitable. Two important results of this study complement the results of our earlier studies:

1. There were no large differences in yield, quality or profitability between different training systems when they were planted at the same density.
2. Increasing tree planting density results in increased cumulative yield, but with a curvilinear relationship.

In addition, results of this study provide more precise information on profitability and optimum planting density: We conclude that:

1. With replant soils in New York State such as the one used in this study, all densities up to 5,500 trees/ha are manageable and productive.
2. The optimum planting density depends on economic factors, not horticultural limitations.
3. Under New York State conditions, the optimum density for profitability is between 2,200 and 3,000 trees/ha.
4. The super high density systems can be profitable, but with traditional tree prices, they are not more profitable than more moderate densities of around 2,200 trees/ha.
5. The super high density systems require lower establishment costs and higher fruit prices to be the most profitable.
6. The investment risk increases with increased investment costs making the super spindle system riskier from an investment perspective.

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Acknowledgement

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Terence Robinson is a research and extension professor in the department of horticultural sciences who specializes in high density orchard management systems. Steve Hoying is a regional extension educator in the Lake Ontario Fruit Region specializing in orchard management.

Use of 1-MCP on Apples*

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Many processes that occur during apple ripening, such as softening, yellowing, increased respiration, and aroma production, are closely associated with ethylene. Senescence, the irreversible physiological changes that lead to cell death, follows ripening. While many of the ripening-associated processes that occur result in providing an acceptable product to the consumer, the goal of the storage operator is to reduce ethylene responses. Control of the onset and/or continuation of ripening and senescence provides the industry with a mechanism to maintain fruit quality. In fruit storage, cultural techniques used to minimize the effects of ethylene include low O_2, high CO_2, and reduced temperature (Abeles et al., 1992).

The growth regulator, 1-methylcyclopropene (1-MCP), has been shown to have significant promise as an ethylene action inhibitor (Sisler and Blankenship, 1996; Sisler et al., 1996). 1-MCP is classified as a growth regulator by the Environmental Protection Agency. In the US, it is approved for use in ornamentals under the trade name EthylBloc®, and under the commercial name, SmartFresh™, for application on apples and several other fruit. 1-MCP also is being extensively evaluated for use on many other crops.

Apple responses to 1-MCP

A single exposure to 1-MCP can temporarily render apple fruit insensitive to ethylene. 1-MCP delays the onset of the rise in ethylene production and similarly delays the rise in respiration, aroma production, and softening. A single postharvest application could prevent ripening for an extended period (> 30 days) at ambient (24°C or 75°F) temperature relative to non-treated controls (Fan et al., 1999; Mir et al., 2001). 1-MCP also dramatically inhibits aroma production in apple (Fan et al., 1999; Rupasinghe et al., 2000) and can reduce the incidence of superficial scald (Rupasinghe et al., 2000; Watkins et al., 2000).

The response of apple fruit to 1-MCP depends upon a number of variables. These variables include application technique, the exposure environment, the storage environment (if different from the exposure environment), cultivar sensitivity, and the physiological status of the crop. Control of these variables will be needed to achieve a consistent response of fruit to 1-MCP.

Application Technique

Application technique refers to the concentration, duration and frequency of application. 1-MCP concentrations required to saturate binding sites, and the extent and longevity of 1-MCP action, are influenced greatly by species, organ, tissue, and mode of ethylene biosynthesis induction. A 'time x concentration' effect is apparent, and the longer the exposure, the lower the required concentration.

Although 1-MCP binding is essentially irreversible, inhibition of ethylene action may be overcome by the production of new receptors (Sisler et al., 1996). For apple, it appears that the concentration of 1-MCP needed to be effective is between 0.25 and 1 ppm in the airspace around the fruit. The concentration needed to achieve maximum benefits may be slightly higher at higher treatment/storage temperatures. The time needed for effective treatment appears to be relatively short and is between 12 and 16 hours. It is thought that the treatment time needed to achieve maximum benefits decreases as treatment temperature increases. Repeated treatment of apple fruit with 1- MCP can improve the effectiveness of the material, especially at elevated temperatures (Mir and Beaudry, 2001). A weekly application of 1-MCP prevented the softening of 'Redchief Delicious' apple fruit for over 120 days at 20°C (68 °F). However, decay, while reduced relative to untreated fruit, is not inhibited by 1-MCP and can be a significant problem for fruit held at elevated temperatures. Furthermore, titratable acids are lost rapidly at elevated temperature.

This is the first year 1-MCP (SmartFresh™) has been available to the US apple industry. New York storage operators, through impressive efforts by the industry and NY State DEC, were able to use SmartFresh commercially for the first time in 2002. Although CA storage rooms have just begun operating, the quality of treated fruit has been outstanding, especially after non-refrigerated post-storage periods. Clearly, this compound represents a revolution in our ability to provide higher quality fruit to the consumer.

Since it is a gas, 1-MCP is applied in the air of the storage room, so air containing the 1- MCP has to be physically moved by blowers or existing fans. Air movement should be sufficient to rapidly and evenly distribute the gas.

Physiological Status. The physiological status of the apple fruit is affected by a number of environmental, chemical and physiological factors. It appears that apple fruit tend to respond best when they are treated early in the ripening process (Watkins et al., 2000; Mir et al., 2001) in much the same way that less mature fruit tend to respond more favorably to CA application relative to more mature fruit. There is some evidence to suggest that the elevated levels of ethylene found during

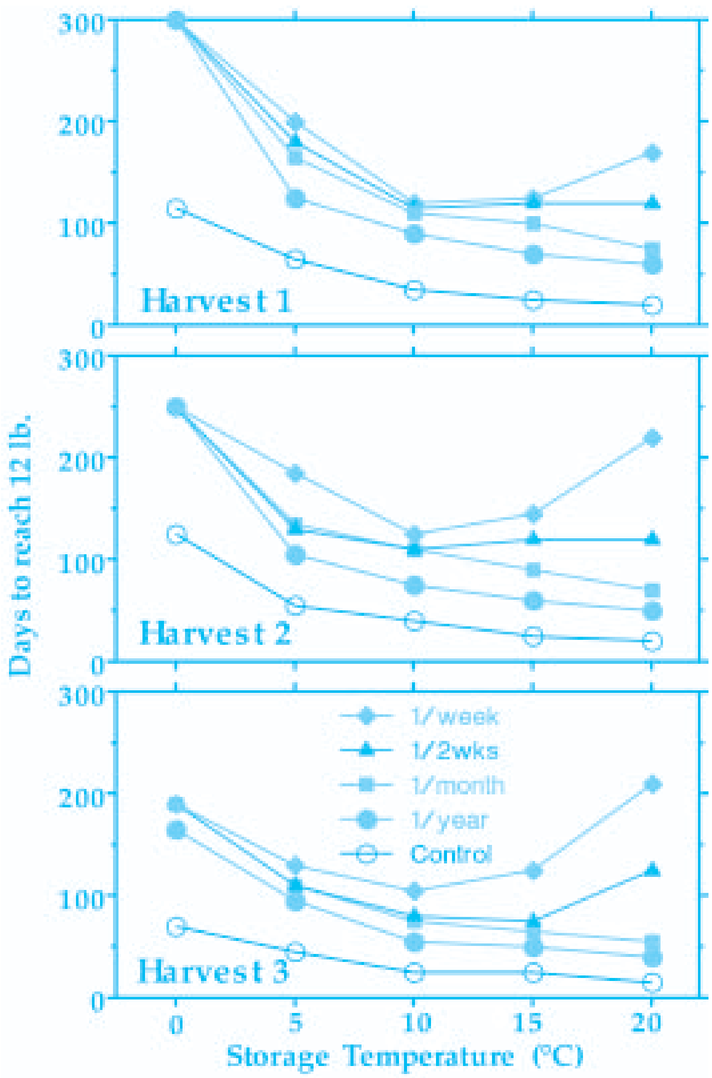

Figure 1. Estimates of days from harvest at which fruit would be expected to reach 53.5N (12 lb.) firmness based on linear regressions of time-dependent softening for 'Red Delicious' fruit harvested at weekly intervals (harvest 2 coincided with the onset of the ethylene climacteric) and given 1-MCP treatments on a once-per week (1/week), once-per-two-weeks (1/2wks), once-per-month (1/month), and once-per-year (1/year) basis and stored at 0, 5, 10, 15, and 20 °C

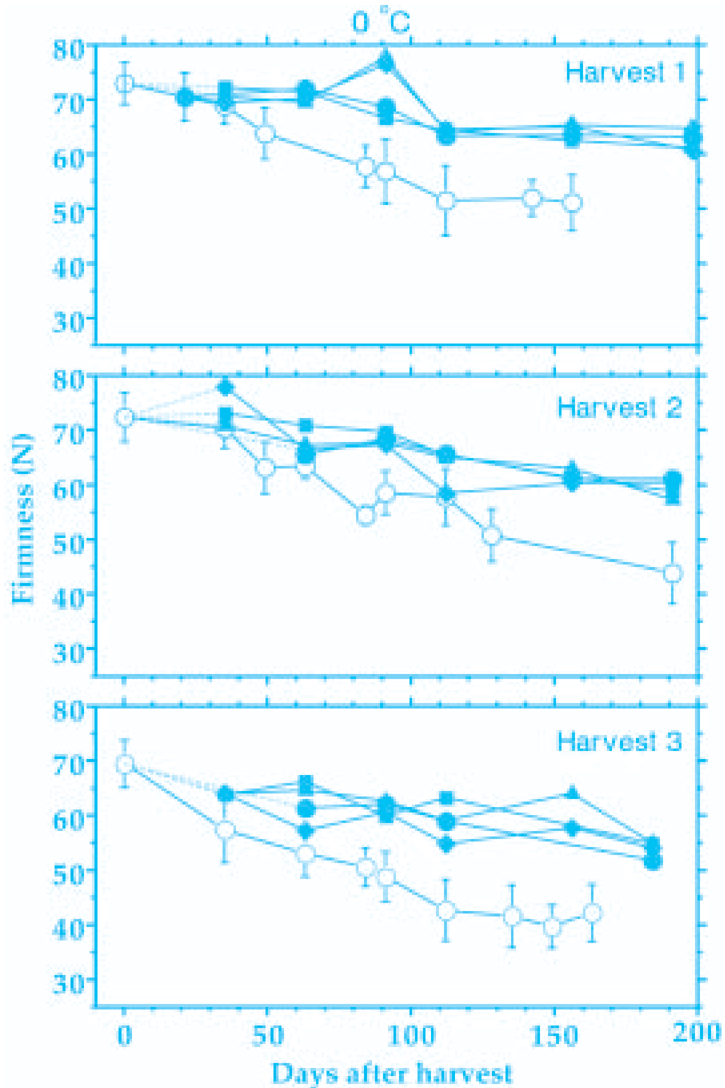

Figure. 2. Effect of 1-MCP on firmness loss of 'Redchief Delicious' apple fruit harvested 23 Sept. (harvest 1), 30 Sept. (harvest 2), and 6 Oct. (harvest 3) 1999 and stored continuously in air at 0°C. Treated fruit (closed symbols) were initially exposed to 0.7 L•L^{-1} 1-MCP for 16 h at room temperature and subsequently given weekly (1/week), bi-weekly (1/2 weeks), monthly (1/month) or no (1/year) additional treatments. Nontreated fruit (open symbols) were not exposed to 1-MCP. Each symbol represents 10 fruit, five from each of two replicate treatments. Vertical bars represent ±1 SD; bars are shown only for nontreated fruit for clarity, variation for treated fruit was similar.

ripening in some fruit varieties, such as 'McIntosh', may be sufficient to reduce the effectiveness of 1-MCP (Watkins et al., 2000). Therefore, those factors that enable treatment of the fruit with 1-MCP at an earlier stage of development should improve or enhance the response of the fruit. For instance, cultural practices that enhance red color development relative to other maturity parameters (e.g., good light penetration into the canopy, application of ethylene synthesis inhibitors such as ReTain™, and cultivar selection) for red colored cultivars, should provide growers with the potential to harvest at a less mature stage of fruit development.

If fruit are held in storage for a period prior to application of 1-MCP, the effectiveness of the gas declines. This is likely due to the fact that the fruit are at a relatively advanced stage of ripening at the time of 1-MCP application. However, depending on variety, fruit may still respond to 1-MCP even after several months if they are maintained in a relatively 'young' condition by CA storage.

The storage environment influences the physiology of the apple fruit and so, too, affects the response to 1-MCP. As temperature increases, the duration of the effectiveness of a single pre- storage application of 1-MCP declines (Mir et al., 2001). Ripening is delayed by roughly 30 to 40 days at room temperature, but the delay in ripening can be more than 100 to 200 days at 0 °C (32°F) (Mir et al., 2001).

Although variety greatly influences responses of apple fruit to 1-MCP (Fan et al., 1999a; Rupasinghe et al., 2000; Watkins et al., 2000), the response of most varieties to 1-MCP is an immediate and relatively long-lived inhibition of ripening and other ethylene responses.

Physiological disorders of apple fruit (superficial scald, soft scald, coreflush, greasiness, and senescent breakdown) can be reduced by 1-MCP application (Fan et al., 1999b; Rupasinghe et al., 2000; Watkins et al., 2000). 1-MCP application has also been associated with the development of some forms of superficial lesions or disorders occasionally on some apple fruit cultivars. One concern is reports of increased susceptibility of 1-MCP-treated fruit to carbon dioxide injury.

Beneficial or detrimental effects of 1-MCP presumably depend on whether ethylene production, and associated ripening and senescence, is required for disorder development, e.g. scald and senescent breakdown, or whether normal ripening is required to prevent disorder development.

Factors to Consider Prior to Use

Ethylene is a natural hormone for the plant and, like other hormones, is required for or participates in a number of physiological processes. Apart from inducing ripening-related changes in flavor and texture in climacteric crops such as apple, ethylene is known to play a role in pigment formation, chlorophyll degradation, decay resistance, phenolic metabolism, and other processes in many tissues. These facts provide some indication of the potential to achieve desirable as well as undesirable responses from apple fruit.

While some aspects of ripening are nearly completely arrested by timely application of 1- MCP, others not under complete control of ethylene may continue to change. The effect of 1- MCP on ripening parameters such as starch degradation, sugar accumulation, and preservation of titratable acidity, is not as dramatic as its effect on firmness (Fan et al., 1999; Watkins et al., 2000; Mir et al., 2001). This may have important implications on fruit quality. In the case of apple, acidity contributes a significant portion of taste quality. It is possible that 1-MCP treated fruit, despite their firmness, may not maintain the tartness typical of some cultivars after extended storage. The impact of 1-MCP on aroma has been measured (Rupasinghe et al., 2000). The compound induces a profound reduction in aroma production at concentrations greater than 1 ppm. Flavor may be reduced by 1-MCP application, but many of these volatiles are undesirable in any case, being associated with over-ripening.

In addition to the problem posed by acidity loss, extensive decay has been encountered in 1-MCP treatments at elevated temperatures. While there is no published literature that suggests that apple fruit in particular may be more susceptible to decay in response to the suppression of ethylene action by 1-MCP, other plant species have exhibited increased susceptibility to some disease and decay causing pathogens. Some caution with regard to decay prevention is probably warranted even at the low temperatures of typical air or CA storage.

The advent of 1-MCP as a commercial tool has tremendous potential to help fruit industries maintain fruit quality. However, the effects of 1-MCP described thus far indicate that much remains to be learned before commercial use can be optimized.

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Multi-Species Pheromone Disruption in Orchards Under a Selective Pesticide Program

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This multi-site and multi-year research project is examining pest control programs that use only selective and reduced-risk pest control tactics. Among the approaches that are being used in these plots are selective (soft) insecticides, mating disruption, conservation of natural enemies, and cultural practices. This work will help evaluate recently registered selective insecticides to demonstrate their efficacy and, more importantly, their weak points when used in a seasonal program over a range of growing conditions.

Recent regulatory changes threaten to restrict or eliminate certain pes ticides that are currently instrumental in New York apple pest management systems, such as organophosphates (e.g., Guthion, Imidan) and carbamates (e.g., Sevin, Lannate, Vydate). Such restrictions could possibly lead to situations that may eliminate or greatly reduce apple production in some regions. Newer pesticides could eventually replace the older products, but little work has been done on these recently registered insecticides to demonstrate their efficacy and, more importantly, their weak points when used in a seasonal program over a range of growing conditions.

New York is a participant in a multi-state USDA-RAMP (Risk Avoidance and Mitigation Program) project that is examining pest control programs that use only selective reduced-risk pest control tactics on multiple farms throughout the state over a four-year period, to determine the best use of these tactics and any changes in the biological systems that may result from their use. Among the approaches that are being used in these programs, which are designed for fresh market apple production, are selective (soft) insecticides, mating disruption, conservation of natural enemies, and cultural practices. These tactics are being integrated into specific pest management programs designed to be most appropriate for each major production region within the state. This article reports the results of the mating disruption component of the project during the first season of the study (2002).

The RAMP Project in NY

Research sites were set up in all the major apple growing areas of New York: Western NY (Appleton, Oak Orchard, Lyndonville, Waterport; Sodus, Phelps); Central NY region (Lafayette); Hudson Valley (Milton, Stone Ridge, Gardiner); Capital District (Burnt Hills, Granville); and Champlain Valley (Chazy, Valcour). Each research site was a "split-plot design" in which the entire 10-acre block received a program of soft insecticides, and a five-acre portion of the block was additionally treated with pheromones for mating disruption of the later summer generations of codling moth (CM), oriental fruit moth (OFM), and lesser appleworm (LAW). A comparison block, which had the same varieties and planting style, was also monitored at each site. These blocks all contained at least one fresh fruit variety such as 'Empire' that might be selected for marketing in Europe or some other market outlet that could eventually require IPM protocols for market access.

Private crop consultants played a leading role in the interactions with growers within a region, being responsible for general communication with cooperating growers, and in ensuring that recommended insecticide sprays were applied to the plots. In growing areas where there were insufficient numbers of private crop consultants, the leading role for grower selection and appropriate seasonal interactions was taken by the Cornell researchers or field extension personnel. Materials used in the blocks receiving the soft pesticide program included: Apollo or dormant oil plus Pyramite (as needed in summer) for mites, Avaunt for early season pests (including spotted tentiform leafminer, plum curculio and tarnished plant bug) and apple maggot plus internal Lepidoptera, and Confirm and SpinTor for leafrollers. All sprays were applied by the grower.

From April 16–30, Trécé Pherocon IIB pheromone traps were hung in all the plots at each commercial orchard site as follows: a CM , OFM, and an LAW trap group was placed at head height and arranged around the canopy of each of three trees in a middle row (one at each end, and one in the center) of the Soft Pesticides, Pheromone+Soft Pesticides, and Comparison blocks at each site. Also, additional CM and OFM trap groups were placed in two trees situated halfway between each end tree and the center tree in the Pheromone+Soft Pesticides block, to make a total of five trapping stations for this treatment. All traps were checked and cleaned weekly until mid-August, and lures were changed during the first two weeks of July. From June 21–July 9, polyethylene pheromone tie dispensers were hung in the Pheromone+Soft Pesticides blocks at each site, using two products to disrupt two separate moth species: Isomate C+ at 400 ties/A for codling moth, and Isomate M-100 at 100 ties/A for oriental fruit moth. Ties were hung in the upper

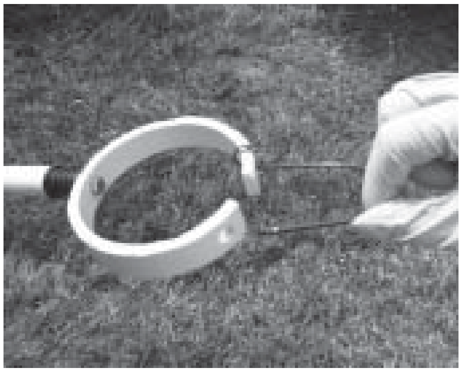

Figure 1. Attaching pheromone tie to hoop applicator.

Figure 2. Placing hoop with tie over foliar shoot.

Figure 3. Tie affixed to shoot after twisting pole.

Figure 4. Application of pheromone ties to larger trees using pole+hoop method.

third of the tree canopy by hand for dwarf trees, and using a pole+hoop applicator (Figs. 1-4) for trees taller than 7 ft. Time requirements for deploying the pheromone ties (500 per acre total) were as follows:

Hand-applied: 1.6 hr/A/person (or 0.6 A/hr/person); 306 ties/hr/person

Pole+hoop: 3.9 hr/A/person (or 0.3 A/hr/person); 128 ties/hr/person

From July 22–26, fruit was examined for internal larval feeding damage in each block by inspecting 20 random fruits on each of 30 trees along the edges and near hedgerows where pressure from immigrating moths was expected to be most severe. Shortly before the respective harvest date in each orchard, 20 fruits were picked from each of 35 trees in each plot: 6 trees grouped in the center of the block, 12 trees from the mid-interior region (a few rows in from each of the four edges), and 12 trees from the outside edges + 5 extra along one edge designated as being at high risk for apple maggot injury. All fruits were inspected for damage caused by diseases and insects, including the three internal Lepidoptera species.

Results for 2002

Pheromone trap catches from around the state revealed unanticipated population patterns for the different species. Catches from some representative orchards are shown in Figs. 5 and 6. As seen in the numbers from all four orchards presented here, codling moth levels were fairly moderate throughout the season in all the blocks, with catches rarely exceeding 10 moths per trap per week, and, in many cases, considerably fewer than five per trap. Abundance of the remaining two species, however, was highly variable, and dependent on geographical location. In most western sites (e.g., Fig. 5), lesser appleworm levels tended to be modest, but oriental fruit moth pressure was sometimes severe, with numbers exceeding 100 per trap per week in one instance. In the eastern orchards (e.g., Fig. 6), the opposite trend was seen, with OFM scarcely present, particularly during the latter half of the season, and LAW at reasonably high levels in most of these blocks, particularly toward the end of the season and beyond harvest. In all cases, however, the application of pheromone ties appeared to suppress trap catches of not only the two target species (CM and OFM), but also LAW, at levels at or near zero for the remainder of the season. The suppression of LAW is presumed to have occurred because of the similarity of its pheromone blend (98:2 of Z:E-8 12-OAc) to that of OFM (92:8 of Z:E-8 12-OAc).

Fruit damage at harvest caused by internal Lepidoptera was uniformly low across all blocks and treatments (Table 1), with no statistically significant differences between the soft pesticide blocks, with or without pheromones, and the grower standards. Some distinct differences did occur among the stratified samples taken within respective blocks, so that for instance, localized damage of up to 8–13 percent was noted along a specific orchard edge in two cases. Subsequent analyses will be conducted on these data to establish any correlations between location of damage incidence and the treatment regimens.

The orchards used in this trial were assumed to be relatively clean at the initiation of this multi-year project. If the selective pesticide program tested here does exhibit any shortcomings in the control of CM, OFM, or LAW, we would expect to see evidence of this over time as local populations are given the chance to increase beyond levels that are economically acceptable.

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TABLE 1

RAMP plots 2002, summary of internal Lepidoptera fruit damage

	Mean % fruit damage by internal-feeding Lepidoptera	
Treatment	July 22-26	Harvest
Pheromones+Soft Pesticides	0.17 a	0.40 a
Soft Pesticides	0.40 a	0.25 a
Grower Standard	0.16 a	0.33 a

Means followed by the same letter not significantly different (P = 0.05, Fisher's Protected LSD test). Values transformed by arcsine-square root before analysis.

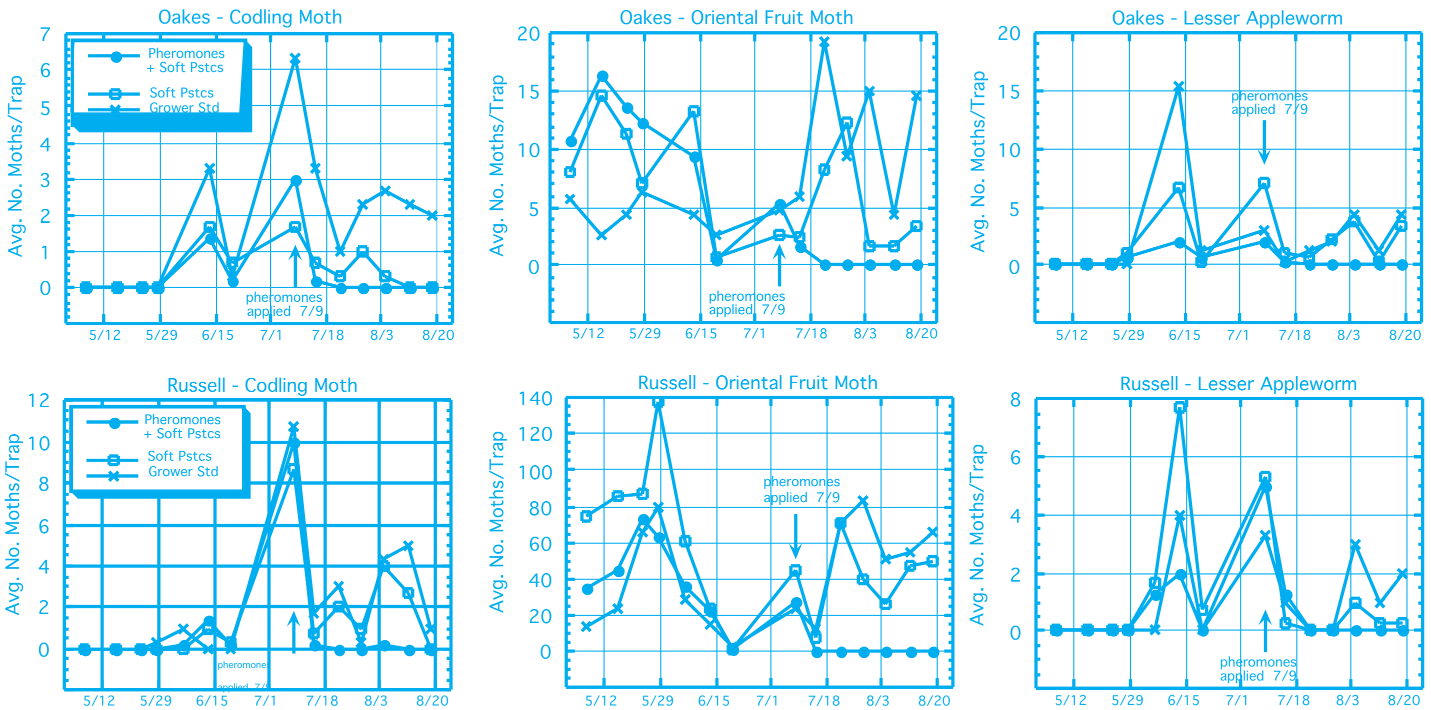

Figure 5. Pheromone trap catches of internal Lepidoptera moth pests in Western N.Y. apple orchards receiving a program of pheromones plus soft pesticides, soft pesticides only, or under the grower's standard management program. 2002

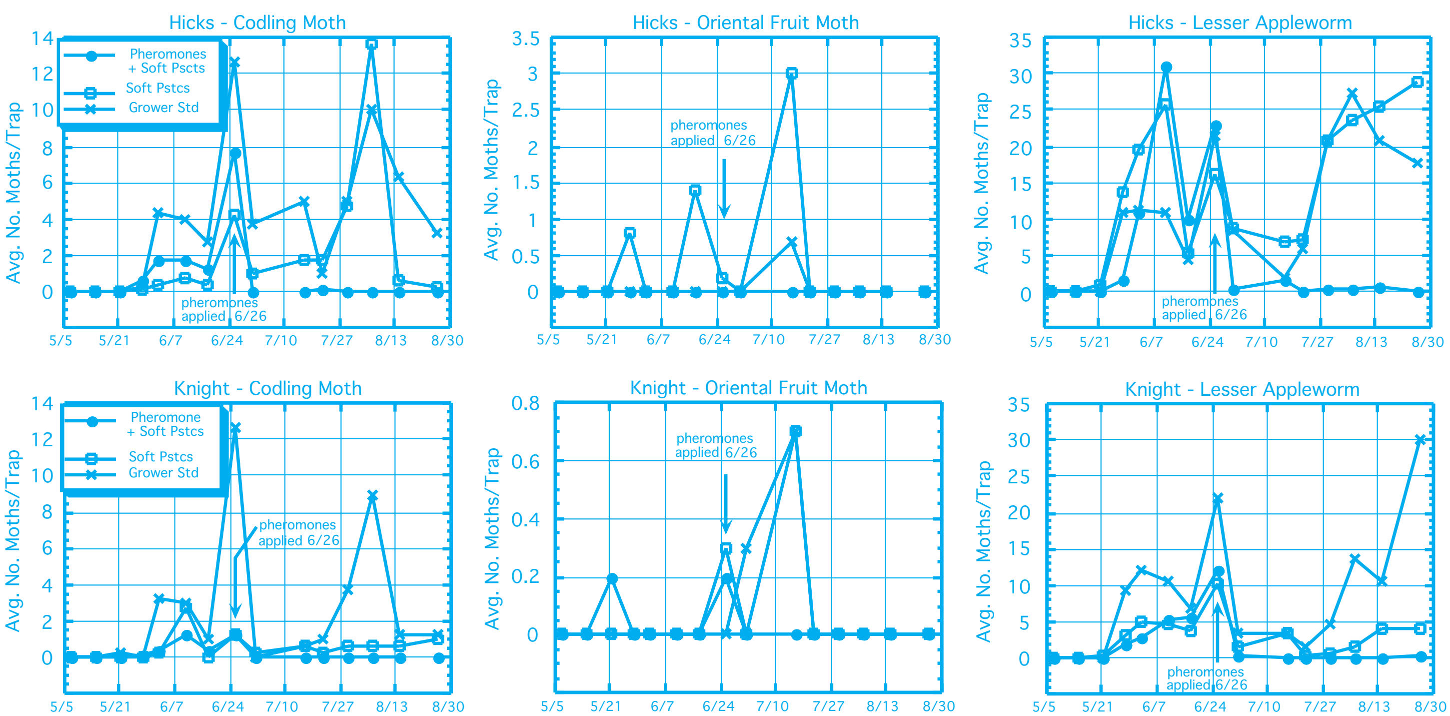

Figure 6. Pheromone trap catches of internal Lepidoptera moth pests in Eastern N.Y. apple orchards receiving a program of pheromones plus soft pesticides, soft pesticides only, or under the grower's standard management program. 2002

Reed, P. Russell, R. Schoonmaker, K. Trammel, and D. Wilson), consultants (P. Babcock, J. Eve, J. Misiti, and R. Paddock), and fruit agents (D. Breth and K. Iungerman) participating in this trial, without whom this study could not have taken place. We also thank our Technical Field Assistants, Emily Fitzgibbons, Laura Gillespie, Bruce Wadhams, Rachel Mussack, David Whelan, Peter Jentsch, Tim Mallet and Rebecca Habernig. We are grateful for the support and material received from CBC America Corp., Dow AgroSciences and Makhteshim Agan.

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Development and Testing of a Shrouded Flame Weeder for Non-Chemical Weed Control

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Propane "flamers" may be useful to control weeds in situations where herbicides are not desirable. The model tested here was affordable with operating and material costs similar to that of a typical burn down herbicide application but without the soil or water residues. This technique could be particularly valuable in organic fruit production where herbicide use is prohibited.

The first use of a flamer for agricultural purposes was in 1938 by Price McLemore who used a kerosene flamer for cultivation of his corn and cotton. In the early 1940s, Louisiana State University began testing the concept, and, by the middle of the decade, there were many flamers in use in Mississippi for desiccation of cotton. The flaming concept expanded from there through constant testing and experimenting with new uses and designs. Today, there are many applications on a variety of crops throughout the world that utilize this concept (Flame Engineering 2003).

Examples include weed control in strawberries and potatoes (Ivens, 1966), alfalfa, corn (Sullivan, 2001), and cotton (Seifert, S. and Snipes, 1998), seedbed sterilization, and pest control. Colorado potato beetles are easily controlled on young plants by using a flamer that kills the beetles without seriously damaging the plants (Cornell University, 2002).

Weed control is the primary use of flamers. Weeds are not completely burned by this technique. Rather, travel speed is adjusted so that surface vegetation is merely scorched, and essential enzymes are denatured, disabling the plants' metabolism. Weeds then wither and succumb over a period of several hours. If done properly, weeds will appear normal immediately after flaming, remaining green and still standing. It takes from a few minutes to a few hours until they start to wilt and die (Hickey, 2000).

Flaming conserves plant residues as organic matter and mulch for the soil. The key to effective weed control with flaming is that weeds must be shorter and more tender than the crop you are protecting. Flaming weeds at the same level of maturity as the crop plants may damage the crop. As crop plants mature, they develop a hard outer coating on the stems.

Extreme caution should be exercised when flaming around tender crops such as potatoes, strawberries, and young grapevines and fruit trees. Even young trees and bushes can be harmed since they do not yet have a protective layer, and flaming can burn the cambium, xylem and phloem in the base of the plant. Flamers have also been known to ignite and burn mulches or other flammable materials, and may best be used following rain, or when there is dew on the surface vegetation to impede combustion of weeds (Young, et al., 1990). Engle, et al. (1988) concluded that flame weeding is comparable to contact herbicides in efficacy.

One of the advantages of flaming is that the soil is not disturbed and buried weed seeds are not brought to the surface where they can break dormancy and germinate (Hickey, 2000). Tillage often results in serious weed problems reoccurring in just a few weeks. Problematic orchard weeds like pigweed (*Amaranthus* spp.) and lambsquarter (*Chenopodium album*) are especially prone to regenerate after tillage since these weed seeds can remain dormant in the soil for decades (Sullivan, 2001).

Flaming works relatively well for controlling annual weeds, but perennials such as quackgrass (*Agropyron repens*) may grow back rapidly after flaming or mechanical tillage (Williams and Peachey, 2001). Similar problems with weed regrowth can also occur with non-residual herbicides such as paraquat.

Propane flamers are potentially important pest control devices for organic farmers, providing a non-chemical method of controlling weeds and insect pests (Young, et al.,1990). Some commercial literature suggests that propane may also be more economical than the alternative herbicides (Flame Engineering, 2003) with no indirect farm worker hazard, reentry period, or necessity for pesticide applicators certification.

Types of Flamers

There are many different types of flamers currently available. They vary in size from the small handheld burner wands found in gardening catalogs, to tractor and truck mounted burners handling four rows of corn at a time. Red Dragon Company Inc. makes several of these including orchard, row crop and field or alfalfa flamers (Flame Engineering, 2003).

The orchard and vineyard flamers advertised on their website are trailer mounted and available in either single or double row models. The row crop burners range from two to eight rows. They are sold in fully assembled three point mounted machines or in kits to build your own machine. The kits include the burners, valves and regulators. Typically, the burners are set 30-60 degrees below horizontal. This directs them below the crop foliage and at the ground where short weeds are. Theoretically, the crop is only warmed slightly while weeds are scorched. The alfalfa flamers are meant to burn everything in an alfalfa field or other open fields to control pests and weeds. This allows the alfalfa to re-grow without competition from weeds. Red Dragon Co. also markets a 12-foot unit to drag behind

Figure 1. Shroud around burners.

Figure 2. Propane tank and carrier on forklift.

Figure 3. Flamer mounted on front of tractor.

Figure 4. Front view of unit on tractor. For scale, the tractor is 50 inches wide.

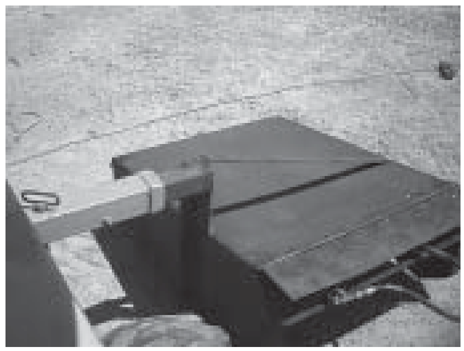

Figure 5. Operator's view of mounted flame weeder from cab of tractor

Figure 6. Flamer raised for easy transport and repairs or adjustments.

a trailer-mounted tank, as well as handheld burners. The cost of these flamers ranges from the $50 handheld unit to $11,000 for tractor mounted units.

Flaming speeds vary greatly depending on the application. Speeds are affected by the type of flamer, application rate, and atmospheric temperatures. On cold days, the flamer must travel more slowly to achieve the necessary minimum temperatures for weed control. It is more difficult to flame after a rain, because heat goes into evaporating the water before it can affect weeds or pests. However, the risk of combustion in weed residues, and smoke generation are also reduced in wet conditions.

The position of burners is also crucial. If directed too far apart, the flame will not cover all the treatment area. If positioned or directed too close together, the flames will overlap, wasting fuel and increasing the likelihood of undesirable combustion of plant residues (Flame Engineering, 2003). Proper spacing is essential for proper economical flaming.

Once the flamer setup is operational, it should work with any sized tank that is large enough to supply it for the length of time desired. In larger applications such as row crops and alfalfa, the only limit is the size and weight of liquid fuel tanks. Most tanks have gas coming out of the valve, while some flamers use liquid feed to the torch, and have the evaporator located in the burner. This eliminates having the tank ice up when large quantities of propane are being used. It also allows smaller hoses and valves to be used. The only difference between these tanks is a standpipe to draw liquid off of the bottom, instead of gas off the top of the reservoir.

The intent of this project was to refine and test a prototype shrouded flame weeder custom designed and built specifically for orchards and vineyards by Ian Merwin. The flamer is unique in that the flame torches are enshrouded within a metal casing that concentrates the heat, reduces the amount of propane required, and protects the trees, vines and irrigation lines from heat damage. We attempted to determine the best operating speed and pressure for this machine with and without shrouding. The research was conducted at Singer Farms, operated by the Bittner family in Barker, NY, from January to September 2001.

Flamer Setup and Modifications

The initial components were the tank, valve assembly, two burners, control solenoids, and a skid mounted steel shroud (Fig. 1). A plate was welded to a set of rear pallet forks for the tank to sit on (Fig. 2). The forks with the tank went on the back of the tractor while the burners went on the front of the tractor. The burner unit was mounted on a mounting bracket for a Muller rototiller and brush sweeper. This allowed the burners to float freely over the ground surface. A frame was then built near the balance point of the shroud to support it from two points, one on each side (Fig. 3). This was welded to a square tube that fits the Muller bracket. The bracket has its own single action hydraulics for lifting and allows the shroud to float over clumps of sod and groundhog holes (Figs. 4-6). This bracket arrangement also allowed a width adjustment for different orchard or vineyard row spacings. Alternatively, the burner unit could be mounted on the end of a weed sprayer bar that fits on the forks of a tractor with a front mounted lift mast or front-end loader.

The burners were bolted to the back of the shroud facing inward. A hinge previously welded onto the shroud allowed the burners to be adjusted for angle. Roundstock skids were then made up to assist the shroud in floating over any rough areas as well as to provide replaceable wear points. For use on larger trees, the right side of the shroud can be unbolted and the burners can be angled towards the trees, enabling control of weeds in between the trees. As long as the flamer was traveling fast enough there was no damage to established trees.

TABLE 1

Percentage of groundcover killed using various tractor speeds and operating propane pressures.

Weed Control Treatment	Tractor Speed (mph)	Propane Pressure (psi)	Percentage of Groundcover Killed
1 qt Paraquat/Acre (Chemical Standard)			95
Shrouded Flamer	**2**	**20**	**60**
Shrouded Flamer	2	40	90
Shrouded Flamer	4	20	40
Shrouded Flamer	4	40	50
Unshrouded flamer	**2**	**20**	**30**
Unshrouded flamer	2	40	40
Unshrouded flamer	4	20	2
Unshrouded flamer	4	40	20

A hose was routed along the hood of the tractor connected the tank in the back with the burner unit in the front. All the electronics and valves were relocated inside the cab of a tractor, to protect them from the weather and tree branches. Protecting these components may help extend the life of the machine. If located outside the cab they should be protected.

Weed Control Trials

January through May 2001, we operated the machine in empty lots to ensure proper operation. On July 11, 2001, we tested the flamer under field conditions in a uniform 10-acre block of Montmorency tart cherries on Mahaleb rootstock, spaced 22 by 20 ft. In previous years, the block had had rotating paraquat and glyphosate herbicide applications with excellent control of established weeds. Prior to the flame weeder treatments, the ground cover was mowed to three inches in height.

Treatments included: 1) One quart paraquat/acre; 2) Shrouded flamer at 2 mph and 20 psi; 3) Shrouded flamer at 2 mph and 40 psi; 4) Shrouded flamer at 4 mph and 20 psi; 5) Shrouded flamer at 4 mph and 40 psi; 6) Unshrouded flamer at 2 mph and 20 psi; 7) Unshrouded flamer at 2 mph and 40 psi; 8) Unshrouded flamer at 4 mph and 20 psi; and 9) Unshrouded flamer at 4 mph and 40 psi. Effectiveness was measured by assessing ground cover height before and after each application, making a visual estimation of percentage of treated ground cover affected by flaming, and by observing the types of weeds that recovered the quickest.

Results and Discussion

Paraquat was the best treatment with 95 percent of the groundcover area treated killed (Table 1). The next best treatment was the shrouded flamer at 2 mph and 40 psi resulting in 90 percent of treated foliage killed. The shrouded treatment at 4 mph and 20 psi was roughly equivalent to the unshrouded treatment at 2 mph and 40 psi with 60 percent and 40 percent respectively of the ground cover treated killed. The unshrouded flamer operated at 20 psi and 4 mph was ineffective. The effect of shrouding was significant since the shroud appeared to nearly double the effectiveness of the flamer at equivalent speeds and pressures.

Although only one replication was run on the Singer farm, the results were encouraging. The economics of this flamer are affordable and the cost of propane was comparable to that for herbicides. It takes the same number of operator-hours per acre, but the propane does not create a chemical soil or water residue. This technique would be particularly valuable in organic fruit production where herbicide use is prohibited.

On our farm, we found that it was desirable to wait a few hours after rain before flame treatments, depending on wind and sun conditions. One of the advantages of flaming relative to tillage is that flaming is possible when soils are too wet for effective cultivation. The addition of a shroud around a burner reduced the amount of fuel necessary, since it contained the heat so that the wind did not dissipate the heat energy. Inside the shroud the heat is also more uniform and constant.

Besides weed control, flaming weeds in orchard crops may also have other positive side effects in pest management resulting in economic benefit for farmers. Secondary pests such as Tarnished Plant Bug and Lygus may be killed (Seifert and Snipes, 1996). In contrast, when weeds are mowed or sprayed with herbicides, insect and mite pests typically move up into the canopy.

Flaming may have many uses in agriculture. It could provide an economically sound and environmentally friendly way of controlling certain pests and weeds on farms where crops are grown organically. But it may also be useful in conventional farming due to its environmental and economical benefits.

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This research was conducted as an independent research project by Kevin Bittner, an undergraduate student in the Plant Science major at Cornell's College of Agriculture and Life Sciences. Ian Merwin advised this project and is an associate professor of horticulture at Cornell University who specializes in orchard ground cover management.

The Orchard Ergonomics Pilot Study: New Attachment for an Apple Picking Bucket Aimed at Reducing Worker Discomfort and Injury Due to Strain

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A new improvement that can easily be attached to an existing apple harvesting bucket & harness system is currently being tested at NYCAMH. Preliminary results indicate improved comfort, and possible strain reduction. This article includes background on the project and also demonstrates the importance of working together towards the common goal of worker safety.

Thanks to collaborative efforts between apple growers, apple harvesters and industry specialists, NYCAMH recently launched a research initiative focusing on improving apple harvesting equipment. The aim of this project is to reduce injuries due to sprains and strains and to improve picking comfort, while maintaining or improving harvesting efficiency.

Prior research from NYCAMH has indicated that sprains and strains of the back, neck and shoulders are common among apple harvest workers. Although these types of injuries result in lost work time and medical visits by farmworkers, there is little data available on equipment changes that might alleviate this problem (Earle-Richardson et al., 2003). For this reason, NYCAMH was awarded a grant from NIOSH to develop and test ergonomically improved apple harvesting equipment.

You may have heard the term "ergonomics" used in talking about office improvements (like better computer keyboards). The purpose of ergonomics is to design the work environment to fit the worker. In agriculture, the work environment is much different, posing a real challenge for preventing muscle strain injuries. Although agricultural workers are frequently moving rather than sitting, designing comfortable and safe equipment is equally important.

The first step in improving agricultural ergonomics is to analyze the job tasks. For apple harvesting, this was accomplished in 1999 when Scott Fulmer, an ergonomist from the University of Massachusetts at Lowell, and researchers from NYCAMH conducted field observations at 12 orchards in New York and Pennsylvania. Based on these observations, Fulmer identified the ergonomic risk factors to the harvesters, such as reaching with arms over shoulder height (increases pressure to the shoulder), and bending down (back muscles must counter the load from the upper body). He then developed a list of potentially effective ergonomic improvements (Fulmer et al., 2002).

Two advisory teams, made up of orchard owners, apple pickers, industry experts and researchers, were charged with narrowing down the list of ergonomic improvement options into two viable improvements. There were several considerations to keep in mind during this process: the improvements had to have the potential to reduce strain, be accepted by the worker, not show a negative effect on harvesting efficiency, and be economically feasible to produce. The discussion covered possible changes to the apple bin, changes to the ladder, and changes to the bucket/harness system. In Western New York, the team members were Cliff Demay, Gary Fitch, and a crew leader from Singer Farms. In the Hudson Valley, team members were Mike Fargione, Warren Smith and James O'Barr.

An important part of the success of this project was the involvement of those who "know apples"—the growers and the workers. While the research team could suggest a "perfect-in-the-lab" ergonomic solution, without the employers' and workers' insight about how it is likely to work in the field, the idea could fall flat. Jim Bittner, managing partner of Singer Farms in Appleton, NY, agrees: "The fact that you're working directly with the workers is huge. If the worker doesn't like it, it's not going to be used—no matter how good, how improved."

By mid-summer, two promising equipment changes were selected for testing. Both focused upon ways to reduce the force applied to the shoulders and back by the standard apple bucket. Models of each improvement were constructed, and then taken out into the orchards for informal testing. These models were revised three times, based on farmworker comments, before the formal trials in the test orchards began. Estimated cost for each set of models is approximately $ 65. However, this cost is expected to be greatly reduced by using wholesale materials for the next phase of construction.

In late September 2002, tests of the improvements were done in the selected orchards. Workers were observed using each improvement separately, using their own equipment, and then using both improvements combined. Researchers made a series of observations of body posture, work task, and equipment usage every 45 seconds over 90-minute periods. This observation pattern was repeated at each orchard for a total of eight sessions per orchard.

According to Chuck Mead, co-owner of Mead Orchards in Tivoli, NY, it was not a problem for the researchers to "invade" the orchard during work in progress. "Information gathering takes time. There may have been some minor disruptions, but from what the workers told me, they were impressed," Mead said.

The goal of this data collection was to determine the proportion of work time spent in each of several stances. This information is currently being combined with laboratory data that will indicate how much weight and/or pressure reduction the improvements bring about in each stance

In addition, each worker was interviewed after each 90-minute period to obtain worker satisfaction information. Translators who could speak fluent Spanish accompanied the research team where appropriate, so that each worker could be interviewed in his or her native language. Overall, workers found the improvements comfortable and would use them if available. All of the respondents at one test orchard said that their shoulder/neck felt differently after using the improvements, as compared to when they use their regular picking equipment. According to Bittner, improving worker comfort is important. In fact, informal comments as to the comfort of the new system were highly favorable at both of the test orchards, and in the preliminary orchard focus groups.

Field observations and lab data are currently being analyzed, and are expected to be complete by early 2003. In response to suggestions made by the farmworkers, minor adjustments to the design of these improvements are under serious consideration. If proven to be effective, these improvements will be made available to apple orchards throughout the state.

The value of this project becomes apparent when you think about the significant contribution manual laborers make to food production in the United States, apple harvesting included. "If you can find ways for workers to avoid injury, discomfort, or strain, everyone benefits—workers, and employers," said Bittner. Another benefit mentioned by Mead is that "the bucket improvements have good potential to improve harvest efficiency and reduce fatigue."

An improved apple harvesting system that helps to reduce potential for injury, provide comfort to the worker, and aid in an efficient, quality harvest will undoubtedly be beneficial to both apple growers and apple workers. Ultimately all will benefit, as we continue to enjoy the fruits of the New York orchards.

Acknowledgments

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Earle-Richardson G. et al. 2003. Occupational Injury and illness among migrant and seasonal farmworkers in New York State and Pennsylvania; 1997-1999: Pilot study of a new surveillance method, *Am J. Indust. Med.* (Accepted for publication).

Fulmer et al. 2002. Ergonomic Exposures in Apple Harvesting: Preliminary Observations, *Am J. Indust. Med.* 2002; Aug. suppl:3-9.

The New York Center for Agricultural Medicine and Health (NYCAMH) was established by the New York State Legislature in 1988 to research the causes and prevention of agricultural injury and illness, and to educate the farm community and professionals serving the farm community about prevention activities. NYCAMH is also charged with providing clinical help for farm-related health problems.

SPRING 2003
CALENDAR of EVENTS

Workshops to Manage Outbreaks of Worms in Fruit (OFM/CM)
March 19, 8:30-11:00 am
Niagara Co. Farm and Home Center
Rt 78, Lockport, NY.
March 19, 1:30-4:00 pm
Wayne Co. CCE
Rt 88, Newark, NY
2.5 NYSDEC Recertification Training Credits.

Stone Fruit School
March 20, 2003
Highland, NY
Contact Steve McKay.
518-828-3346;
sam44@cornell.edu

Apple Mineral Nutrition School
March 25
Ballston Spa
March 27
Albion, NY.
Contact Max Welcome.
607-255-5439
mw45@cornell.edu

Pest Handlers Training
March 26, 9:00 am-12 noon
Hudson, NY
Contact Steve McKay.
518-828-3346;
sam44@cornell.edu

Berry Processing Meeting
March 29
Contact Steve McKay.
518-828-3346;
sam44@cornell.edu

DEC Special Permit Training Session for non-certified pesticide applicators
April 2
Wayne Co CCE, Newark, NY

DEC Special Permit Tng Session for non-certified pesticide applicators
April 3
Orleans Co. CCE Fairgrounds
On Rt 31, between Albion and Medina.

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