1. **Project Name and Contact Information**

Personal Planter – A Self-Propelled Transplanter for Setting 100-1,000 Plants at a Time
FNE05-045

Andy Fellenz
1919 Lester Rd.
Phelps, NY 14532
315 548 6228
Fellenz@fltg.net

2. **Goals**

Build and test a self-propelled transplanter suitable for planting a range of crops including: salad greens, strawberries, tomatoes, peppers, cucurbits and asparagus into both rows and beds out in the field and in high tunnels.

3. **Farm Profile**

The Fellenz Family Farm is a small intensively cropped certified organic fruit and vegetable farm. It has space for growing ~3 acres of vegetables and 2 ½ acres of tree fruit and brambles. Our use of season extension hoophouses has grown from ~2,600 sqft in 2005 to 6,100 sqft in 2006 and a planned 10,000 sqft in 2007. Over the same time period, greenhouse space for the production of transplants has grown from ~300sqft to ~1,000 sqft. Season extension, multiple croppings each season and extensive use of transplants to increase the number of succession plantings/acre each season are critical components of the farm plan.

The farm markets its produce through the UUCC CSA in Canandaigua NY and the Geneva CSA in Geneva NY a farm stand, and to several commercial accounts. Sales are increasing rapidly with ~50% growth in 2005, 25% growth in 2006 and 15% forecast for 2007.

4. **Participants**

David Doktor a craftsman with over 30 years experience in developing custom agricultural implements has closely supported the project. He has provided assistance in the fabrication of the transplanter, developed and tested ideas for the transplanting mechanism, assisted in all aspects of the design process and conducted library research on transplanters at the NYSAES in Geneva NY.

I originally planned to do some work with Elizabeth Henderson an organic farmer with over 20 years growing experience at her farm evaluating her use of a water-wheel transplanter. This work was not done because we were able to find sufficient literature data regarding real world transplanter performance. We had also hoped to do a field trial with the self-propelled transplanter during the summer of 2006, but due to the issues we

ran into with the drive contoller for the ride-on self-propelled transplanter, we were not able to do this trial.

5. Project Activities

From the 2005 Interim Report
We completed the literature research and patent search. 18 relevant patents were identified and reviewed.

Plant placement options were evaluated. A piercing mechanism for placing plants through plastic mulch was trialed and found not to work reliably. We considered designs for an alternate punching mechanism and water-wheel style mechanism for locating the transplants. Components for the water wheel mechanism are on order and should be delivered in early February.

We worked through a range of ergonomics concerns regarding operator position. Ultimately, a kneeling position emerged as the best choice. This position requires less stretching than a seated position and also allows the operator to be located closer to the ground reducing the amount of twisting and bending.

We evaluated several drive/steering options before settling on a zero turn radius/electric drive option. Internal combustion drives (gas & diesel) were ruled out because of the desire to operate within a hoophouse. The zero-turn option provides for greater maneuverability enabling the machine to turn within its own length at the end of the row.

We constructed the transplanter chassis, mounted the wheels, began work on the operator work station and have begun evaluating several possible layouts of planting trays and other equipment which will need to be mounted on the transplanter. Operator ergonomics are a critical concern – we want to ensure that different size operators can adjust the machine to fit them and that reaching/twisting/bending are minimized.

We are evaluating various motor control, operator control location.and transmission options. Concerns are operator ergonomics and the desire to have an operating speed range of 1 – 175fpm. A transplanting speed range of 1 – 25 fpm will enable efficient planting of a crops ranging from 4 across lettuce with 12" spacing to pumpkins at up to 6 ft. A transport speed of 175fpm, walking speed, will allow us to drive the transplater from the shed to the planting location on our small farm in a reasonable amount of time.

Next steps on the project include the following:

- Mount motors, controls and final drives. For the initial testing, we may set up the machine for transplanting speed 1 – 25fpm, only and leave modification of the drive to allow a transport speed of 175fpm for later.
- Complete fabrication and assembly of water wheel style punching mechanism for plant placement. Resolve issues related to powering and timing this mechanism.
- Mount plant trays and other components necessary to trial the machine.

- Test planter for 4 across plant setting.
- Test planter for 1 or 2 across plant setting
- Complete time study of tractor drawn water wheel transplanter and compare to literature values and the rates obtained with the self-propelled transplanter.
- Write up final report and arrange for dissemination of results.

2006 Activities

We trialed the mini-waterwheels for punching/marking plant locations and determined that to ensure proper plant spacing it would be necessary to drive them rather than to have them ground driven. We did some redesign and made modifications to the chassis to better accommodate the 4-across planter layout, added drive to the mini-waterwheels and need for increased vertical travel in the front end to better accommodate uneven ground. I worked through several issues with motor controls and gearing, but ultimately was not successful in developing a drive which would reliably propel the vehicle at the low speeds required to manually set plants in a 4-across fashion.

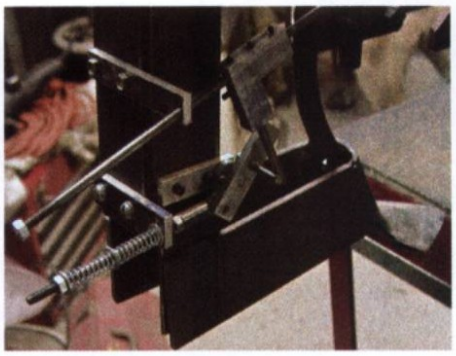
With my increasing use of hoophouses, I was becoming concerned that the ride-on vehicle while much better than a tractor pulled transplanter in a hoophouse might not be as maneuverable as I had hoped. We also were not able to resolve all of the ergonomic issues associated with the knealing position and 4-across planting. The designed operator position was closer to the ground than I liked and still had what I considered to be excessive reaches, especially for a smaller operator. We also ran into problems finding an electronic controller for the vehicle motors. After reviewing what was working and what wasn't, I decided to back-up and start again with a new approach. While I could have continued with the vehicle, I didn't feel that I was going in a direction which would yield a reliable working machine for the 2007 season.

The next step was to try a single-row transplanter built on a Troy-Bilt Pony roto-tiller frame. I completed several trials with the tiller, a furrower, and rudimentary plant placing mechanism before winter closed in and was pleased with the results. Through this winter I have fabricated an improved furrower/plant placer and am now completing the closing mechanism to pack soil about the plant. The tiller has also been rebuilt with a new lower speed drive and power take off to power the plant placer. The PTO can also be used to drive a conveyor to deliver plants to the placer if that turns out to be necessary.

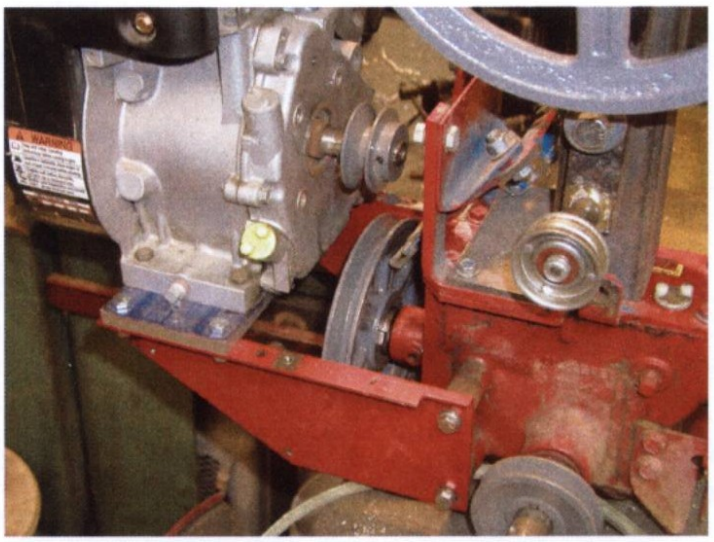
Pictures from the first placement trial

Pictures of plant placement mechanism





Pictures of reduced speed drive for Troy-Bilt Pony roto-tiller



The modified tiller will run at ~20fpm and plant 20 plants/minute for 3-5 minutes before the transplanter needs to be stopped and restocked with plants. Ground trials will begin in April when the first hoophouse is planted with spring greens. Several hundred lettuce and Chinese cabbage were planted in March for this trial.

I have continued to research transplanters and found two 1999 articles in English from the Japanese Institute of Agricultural Machinery, "Development of Fully Automatic Vegetable Transplanter" and "Development of riding-type, fully automatic transplanters" which detailed a well funded development project in which Yanmar, Iseki and Kubota participated to develop fully automatic transplanters which placed up to 60/plants/minute/row. The articles can be found here:

http://www.jircas.affrc.go.jp/english/publication/jarq/34-1/tsuga/34-1(3).htm . I also learned that Iseki markets both ride-on and walk behind automatic transplanters for the Japanese market.
Here is a picture of a walk-behind semi-automatic transplanter Iseki sells in Japan.

Here is a picture of a ride-on automatic transplanter developed by Kubota for the Japanese Institute of Agricultural Machinery.

Two more ride-on automatic transplanters from Japan

The Japanese machines, especially the ride-on machines are designed to plant up to 6 acres/day and would not be cost-effective at the 100-1,000 plant scale of this project, they are neat examples of what can be achieved with a compact single operator transplanter.

We also did some work with manual transplanting methods in 2006 and were able to make changes in our procedures which improved transplanting efficiency so that we could set >100 plants/man hour with lettuces and other greens and upwards of 220/man hour for alliums and root crops. The changes here were cutting full row furrows to place plants in, laying multiple plants in the furrow and then coming back

to close the furrow around the transplant. These changes have increased our manual transplanting efficiency by ~50%.

6. Results

The first design iteration – a ride-on 4 row transplanter ran into problems and was abandoned. A second design – a walk behind single row transplanter showed promise through initial trials in November and December 2006 and will be ready for field trials in April. More detail on the results achieved is included in section 5.

7. Conditions

Time available to work on the project through the 2006 growing season was less than I originally forecast due to the growth of the farm business and health problems which resulted in a short hospital stay and fairly extensive cardiac testing through the summer of 2006. While I caught up on the shop side this winter, my field testing will not be completed within the grant's timeframe.

8. Economics

I cannot report cost data yet, but am confident that the machine will lead to significant improvements in labor utilization. If the machine operates at 50% efficiency it will reduce my transplanting labor by at least a factor of three, saving over a thousand dollars in labor each year. At least as important as the labor savings, will be the smoothing in labor requirements so that labor requirements do not spike in the spring when most transplanting is done.

9. Assessment

I continue to be excited by the project. I think that the new direction I began moving in last Fall with the change from a multi-row ride-on machine to a single row walk-behind machine was the right choice. The single row machine is much more flexible than the multi-row machine, can be used more easily in a hoophouse or on hilly terrain and is much less costly to build.

Next steps for me with the transplanter will be field trials in 2007. Assuming some level of success in the field trials, I will be looking at ways to improve the machine's performance in the field and to determine what modifications will be necessary to use it as a potato planter, garlic planter and leek/onion planter. I will also be looking to see if I can use it to plant transplants grown from 1020 style trays or ellepots in addition to plants grown using the Jiffy Strip system..

10. Adoption

I will continue to work on development of the transplanter in 2007. In addition to using the machine for transplanting, I am planning a trial for potato planting and am

starting to work on a modification which will enable me to use it as a garlic planter in the fall. Devices like the transplanter are essential to my success on the farm. The area I am located in does not support super-premium pricing so my opportunities for profit improvement are primarily in the areas of cost reduction.

11. Outreach

I presented preliminary project results in a Cornell University/Cooperative Extension statewide video-conference call this fall. A page describing the project and its status can be found on my website: www.FellenzFamilyFarm.com . I have responded to every email or phone call inquiry I have received regarding the project. Following the initial planting trials this spring, I plan to submit press releases about the project to the NOFA-NY newsletter, Growing for Market, New Farm website and Farm Show magazine.

12. Report Summary

The project goal was to develop a self-propelled transplanter suitable for transplanting 100 to 1,000 plants at a time. The original design concept of a ride-on transplanter was abandoned after encountering several problems and a second approach of a walk-behind transplanter was taken up. Initial testing of components for the walk-behind transplanter has been successful. The critical components of the walk-behind transplanter have been machined and fabricated and final assembly of the transplanter will be complete in early April. Through literature research, I have learned of several commercially available Japanese walk-behind and ride-on transplanters suitable for planting up to 6 acres/day. Unfortunately, there do not appear to be any plans to export these machines to the US. Outreach through Cornell Cooperative Extension was successful and generated interest in the project at the NOFA-NY winter conference in January 2007. While I did not accomplish all of the goals set for the project within the timeframe of the project, I am confident that I will see results from the project this growing season.

Andy Fellenz
March 20, 2007