FOOD QUALITY PROTECTION ACT/STRATEGIC AGRICULTURAL INITIATIVE GRANT PROGRAM: REQUEST FOR APPLICATIONS – FY08

EPA-R1-SAI-08

Towards more targeted pesticide application in commercial apple orchards in Massachusetts and New England – a pilot sprayer testing, calibration, and automation project

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Project Duration: March 1, 2008 – March 1, 2010

First Year Funding Request:	$33,010
Second Year Funding Request, if applicable:	$30,375
Total Funding Request (for the entire project):	$63,385

Executive summary

Using an orchard airblast sprayer 'test bench,' selected Massachusetts and New England Eco Apple orchards will be provided with a complete orchard sprayer evaluation to improve targeted application of pesticides. Based on these results, selected orchard sprayers will be outfitted with automation technology to further improve application efficiency and accuracy.

Currently, there is no organized testing of orchard airblast sprayers in New England to determine if they are functioning properly and applying the desired amount of pesticide to the orchard. A significant consequence of improper calibration is under- or over-application of pesticide, resulting in poor pest control or environmental contamination, respectively. The amount of time and effort focused on improving targeted application of pesticides has been negligible compared to other components of Integrated Pest Managment, i.e. monitoring, bio-control, trapping, etc.

Using accepted tools – in this case, the sprayer test bench – and demonstrating sprayer performance adjustments in selected Massachusetts and New England Eco Apple orchards will help address this lack of emphasis on more effective and accurate application of orchard pesticides. In addition, scrutinizing orchard sprayers and orchard architecture will allow decisions to be made on which units could most benefit from automated controls to further improve pesticide application accuracy and efficiency.

As a result of this Project, approximately 20-25 Massachusetts and New England apple orchards, including all Eco Apple growers in New England, will have their orchard sprayers tested and inspected on the described test bench per protocols that ensure they will be applying pesticides in a targeted and rate-appropriate manner. Additionally approximately seven (7) sprayers (including at least 2-3 Eco Apple growers) will be selected and fitted with automation controls and nozzles, these sprayers being the ones most likely to benefit from such retrofitting as identified by testing. It is estimated the sprayer test procedure will directly and immediately impact up to 2,000 acres of New England orchard, and via twilight meetings, nearly 100% of commercial apple growers will have some exposure to the procedure and its benefits. Ultimately, it is expected that an orchard sprayer test bench program and sprayer automation project may reduce pesticide application rates by up to 20% and/or result in much more effective pest control per unit of pesticide application and fruit production.

1. Project title

Towards more targeted pesticide application in commercial apple orchards in Massachusetts and New England – a pilot sprayer testing, calibration, and automation project

2. Objectives

1. Provide a voluntary orchard sprayer inspection/calibration service to selected Massachusetts and New England Eco Apple orchards in 2008 and 2009. *Such an inspection should result in more efficient and accurate application of pesticides to orchards, including reducing drift and the total amount used (including organophosphate insecticides).*

2. Demonstrate orchard sprayer inspection procedure(s) to all Massachusetts orchards in 2008 and 2009 via meetings, newsletters, website, etc. Include other New England orchards/meetings as opportunity arises. *Such outreach will result in education about the importance of sprayer performance testing and monitoring to improve pesticide applications to a New England-wide audience of apple growers.*

3. Outfit 'best-criteria' selected sprayers with automation technology to further improve application accuracy and efficacy. *As the cost of doing this is high, this Project will serve as a catalyst for growers to consider sprayer automation as a way to improve and simplify application control adjusted for block-to-block orchard differences. It will also provide much-needed documentation as to exactly what growers are applying to their orchards.*

These objectives specifically address (at a minimum) the following Goals and Objective of the Strategic Agricultural Initiative Program*:*

- Growers significantly reduce or eliminate the use of organophosphate, carbamate or other pesticides impacted by FQPA.
- Engage/work collaboratively with scientists, farmers, commodity organizations/groups, industry, and local and state and federal partners.
- Utilize demonstration, extension, outreach and/or education on integrated or sustainable agricultural practices in partnership with producers, commodity groups and other agricultural stakeholders by making the best use of expert field consultants, USDA research, EPA's reduced risk substitutes, and university supported technical support on alternatives and pest management practices.

They also best fit the SAI Transition Gradient #2., described as *"Reduced risk pest management practices have been initiated at grower level on a pilot basis; growers at early stages of implementation."*

3. Justification

Massachusetts and New England tree fruit growers have traditionally relied on Extension and or vendor/manufacturer representatives to ensure that they are using their orchard airblast sprayers to apply pesticides to the target (trees and pests) per label and/or pest control recommendations. There is no argument that application of pesticides to a three-dimensional target (i.e. orchard tree rows) per the recommended rate or dose is a challenge to get right. Many factors affect the 'spray application equation,' include canopy size (tree row volume), tree variability, environmental (weather) conditions, rate descriptions (per 100 gallons vs. per acre), and equipment maintenance and performance (testing and calibration) as well as operator savvy. All play a role in determining how much pesticide is actually applied, and whether enough is applied to control the target pest(s), or too much is applied, possibly resulting in excess environmental contamination.

Sprayer performance has been an under-looked component of the orchard spray application equation in Massachusetts and New England. Upon purchase of a new sprayer initial setup and calibration is provided by the vendor(s), but growers are typically left on their own afterwards. As already mentioned, Extension and equipment vendor(s) have played some role in educating tree fruit growers about procedures related to calibration, i.e. tractor speed, calculation of tree-row-volume, application rate, and avoiding drift. But there is a broad range of implementation and understanding, resulting in lack of proper pest control (observed) and over-application, resulting in both increased costs to the grower and greater chance of negative environmental effects.

Recent developments in sprayer testing tools and automation technology make the premise of testing and tuning orchard sprayers for better-targeted applications in Massachusetts and New England both feasible and very desirable if trying to maximize pesticide efficacy while reducing waste and excess environmental contamination. Nozzle flow rate, pressure gauge test, and spray pattern determination tools can be assembled into a test bench for airblast sprayers. (APPENDIX A.) New York has used the equipment to reduce spray drift and improve targeted application in 60 orchards and reduced pesticide use (by up to 20%) and improved pesticide application to the target. (Landers and Farooq, 2004.). European producers must already submit to mandatory sprayer testing for various certifications (IPM, GAP, etc.)

In addition, recent advances in automation controls have made adjusting sprayer output with minimal manual intervention and based on changes in orchard architecture possible. For example, a computerized, tractor cab-mounted sprayer control in combination with various valves, flow sensors, and manifold designs can change spray volumes/pesticide rates with up-front information-based programming. This is far more desirable than manual, 'seat-of the-pants' changes to orchard sprayer output based on changes manually observed in the orchard canopy volume or architecture while spraying.

More specifically, justification(s) for each objective follows:

➢ *For Objective 1. "Provide a voluntary orchard sprayer inspection service to selected Massachusetts and New England Eco Apple orchards."*

As already mentioned, there is no organized testing of orchard airblast sprayers in Massachusetts to determine if they are functioning properly and applying the desired amount of pesticide to the orchard. A significant consequence of improper calibration is under- or over-application of pesticide, resulting in poor pest control or environmental contamination, respectively. Drift control is also an issue where, for example, orchard sprayers are not configured properly to hit the target (trees and pest) and spray over the tree canopy.

In Europe, a mandatory sprayer test program has become a requirement for integrated fruit production (IFP) certification. Recommendations for an equipment test bench and testing procedures have been developed. In New York, such equipment and sprayer testing have been successful in reducing spray drift and improving targeted pesticide applications to orchards (Landers et al.). Unfortunately, the equipment and program are too expensive and require significant learning for growers to do themselves. Hence the need for a sprayer testing and demonstration service in Massachusetts and New England.

➢ *For Objective 2. "Demonstrate orchard sprayer inspection procedure(s) to all Massachusetts orchards via meetings, newsletters, website, etc. Include other New England orchards/meetings as opportunity arises."*

Although most Massachusetts and New England tree fruit growers receive some information on orchard sprayer calibration and application rates, there is a wide range of proper adoption and implementation, and thus large potential for waste and/or misuse of pesticides. Few growers, if any, properly inspect and calibrate their orchard sprayers on an annual basis, due to lack of incentive and/or education. By demonstrating orchard sprayer calibration and performance testing, growers will have an exaqmple by which to become more interested and capable of performing sprayer maintenance and calibration which should result in more targeted and effective pesticide applications to apple orchards New England-wide. The Project will be a model for grower involvement, and it is hoped more widespread and annual sprayer inspections and calibration will become commonplace in Massachusetts and New England.

➢ *For Objective 3. "Outfit best-criteria selected sprayers with automation technology to further improve application accuracy and efficacy."*

One of the biggest obstacles towards more effective and targeted airblast spray applications to orchards is the inherent variability in individual orchard architecture, meaning tree size and age, canopy shape, and tree/row spacing. Growers are instructed to use the tree-row-volume technique to apply water volume (the pesticide carrier) and pesticide rate/acre so that small trees are not sprayed the same as big trees (low canopy volume vs. high canopy volume). This makes sense, however, when actual applications are made to the orchard, it is too difficult, too time-intensive, or too knowledge-heavy to make adjustments for each orchard block, particularly when there are many orchard configurations. Using new automation technology, sprayers can be adjusted on-the-fly from the tractor cab to take into account orchard tree-row-volume, travel

speed, spray pressure and volume, and pesticide rate to make accurate applications to all blocks of different configurations and systems. The process is simply too time consuming and complex to do manually, however, new technology including computerized controls and valves makes it much easier to adjust spray output to match every orchard condition. This could result in significant savings in pesticide applied per acre and/or improved pest control. Computerized automatic controls also provide a method to accurately and easily document actual application rates via computer interface.

4. Project narrative/work plan

The project narrative/work plan will be broken down into what's necessary to accomplish each objective:

➢ Objective 1. – The components for an orchard sprayer test bench will be purchased. (See Appendix A.) After initial set up and testing, appointments will be made with selected Massachusetts apple growers (up to 10 for 2008, 10-15 more in 2009, approximately 50% of Massachusetts commercial apple growers representing app. ¾ of the total acreage) to perform the sprayer test/inspection. Sprayers will be adjusted and/or parts replaced/modified and retested to make sure they are conforming to specifications and match orchard architecture. In addition to the Massachusetts apple growers, all Eco Apple growers in New England (seven at this time, including Connecticut, Vermont, and New Hampshire) will be included in the sprayer test bench/inspection program.

➢ Objective 2. – During regularly scheduled Extension 'twilight' meetings and other grower meetings, the sprayer test bench will be demonstrated. Dr. Andrew Landers from Cornell University will be invited to speak and demonstrate how to modify the airblast sprayer based on results of a sprayer inspection. Note that the UMass Extension Fruit Program has a long history of successful outreach to Massachusetts tree fruit growers. Through a combination of twilight meetings, Newsletters ('Healthy Fruit'), research publications ('Fruit Notes'), web site ('UMass Fruit Advisor'), and one-on-one contacts (grower visits, etc.), IPM innovations and implementation strategies have been well communicated to tree fruit growers.

It is expected that a similar, multi-faceted outreach strategy will be used to communicate the results of this Project and the benefits to tree fruit growers. Very specific and advertised demonstrations will attract growers to learn more about sprayer calibration and testing. Written publications as the Project progresses will be produced and disseminated by multiple means. More recently, the use of Internet video as a learning tool has been adopted by the UMass Fruit Program, and will undoubtedly be used for this Project.

There is no doubt the Project would become an important IPM outreach component of the UMass Fruit Program, which has a history of outstanding information dissemination and adoption by Massachusetts tree fruit growers. In addition, it will serve as a model for other New England states to adopt or borrow for their own use in better managing pesticide application to commercial orchards.

➢ Objective 3. – Based on the results of the sprayer test bench/inspection process, and a survey of individual orchard architecture, up to seven orchard sprayers will be chosen to install automatic controls. (These will include two to three Eco Apple growers.) These sprayers and orchards will have been identified as the result of the sprayer test bench/inspection procedure, as well as individual orchard architecture/design that will most benefit from sprayer automation. Details of what specific pieces of equipment needed to automate the sprayer will vary, but can be assumed to include some form of computerized controller (Appendix B.) combined with automated valves, sensors, and sprayer manifold modification(s). Note that the controller includes PC output to provide documentation on how it is performing. The cost of retrofitting sprayers will be a combination of parts and labor to perform the modification(s). Such automation/modification of sprayers will allow pre-programming of application rates and spray patterns to automatically select the appropriate combination of spray volume and pesticide rate to *exactly* match changing orchard canopy conditions without onerous – and often now neglected – manual modifications by the spray operator/applicator. The potential to minimize over-application of pesticides is huge, as well as possibly improving pest control in some cases.

For all objectives, detailed record-keeping forms will be developed to document pre-Project spray conditions vs. post-Project spray output/performance. This includes an expectation that participating growers will keep detailed pesticide application records, using a computerized recordkeeping application such as Trac-apple (http://www.nysipm.cornell.edu/trac/). In addition, the outfitting of sprayers with computerized controls that interface with a PC will allow accurate reporting details and documentation as to what and how much is being applied to individual orchard blocks. Such data simply does not exist now in any usable form.

5. Performance measures and expected outcomes/outputs

As suggested previously, there is much room for improvement in targeted application of pesticides to Massachusetts orchards. Advances in IPM techniques are not fully realized unless the pesticide application component (where necessary) is accurate and part of an overall IPM/'reduced risk' crop management program.

The amount of time and effort focused on improving targeted application of pesticides in Massachusetts orchards has been negligible compared to other components of IPM, i.e. monitoring, biological control, trapping, etc. Understanding of tree-row-volume and pesticide application rates by growers varies widely, and annual sprayer inspection/tune-up/calibration efforts are self-addressed and likely to be minimal given the state-of-knowledge and/or lack of understanding by tree fruit growers.

Using accepted tools – in this case, the sprayer test bench – and demonstrating sprayer performance adjustments in selected Massachusetts orchards will help address this lack of emphasis on targeted, more effective application of orchard pesticides. Otherwise, it is safe to say that the actual application of pesticides to the orchard is a weak point in most orchard IPM programs, particularly when it comes to over-application and/or lack of adequate pest control.

As a result of this Project, approximately one-half (or more) of Massachusetts commercial apple orchards will have their orchard sprayers tested and inspected on the described test bench per protocols that ensure they will be applying pesticides in a targeted and rate-appropriate manner. During the orchard sprayer calibration/testing procedure, neighboring growers will be invited to participate in the process. At least three grower twilight meetings will be held in which the orchard sprayer test bench will be demonstrated. It is estimated the sprayer test procedure will directly and immediately impact 50% of Massachusetts orchard acreage (app. 1,700 of the 3,400 total acres), and via twilight meetings, nearly 100% of commercial apple growers will have some exposure to the procedure and its benefits. Ultimately, it is expected that an orchard sprayer test bench program may reduce pesticide application rates by up to 20% and/or result in more effective pest control per unit of pesticide application. Environmental benefits are difficult to measure directly but will be significant.

Upon finalization of this Project, it is expected Massachusetts tree fruit growers will have a greater understanding and appreciation for orchard sprayer calibration and testing. They will know how sprayer calibration and testing will result in more targeted pesticide application to their orchard, resulting in cost saving, better pest control, and reduced environmental contamination.

In addition seven Massachusetts and New England orchard airblast sprayers will be outfitted with automation technology to make it feasible to reliably match spray volume and pesticide application rate to specific orchard conditions (tree row volume specifically). Such technology will allow accurate recordkeeping of actual pesticide applications, likely an improvement over the current state. All Eco Apple growers in New England will be included in the sprayer performance testing/calibration procedure, and those that benefit or show an interest will be outfitted with sprayer automation technology. Because Eco Apple is a premier and successful IPM certification program that relies on documentation of practices and implementation to attain certification, orchard sprayer inspection/testing and calibration is a logical component of the certification program.

6. Environmental results past performance

The Massachusetts Fruit Growers' Association (MFGA) has been successful in obtaining funding from the State of Massachusetts for various marketing projects and has been an active collaborator with significant USDA funded research at UMass Amherst. Individual MFGA grower members have donated parts of their orchard(s) for on-farm IPM research funded by USDA SARE (Sustainable Agriculture Research & Education), CAR (Crops at Risk) and other federally and state funded IPM research/outreach projects at UMass Amherst.

7. Programmatic capability

Not specifically applicable to the Project Coordinator, however, the UMass Amherst Fruit Program has a proven record of grant performance, re. USDA, SARE, CAR, etc. See Major Participants for more information on individual contribution(s) to programmatic capability.

8. Major participants

The following personnel have both the technical expertise and a proven record of grower education and implementation to make the proposed Project a success:

- Jon Clements, Extension Educator and Project coordinator, UMass Amherst. Overall Project coordinator, technical spray test/calibration expert, Extension contact, and educator on Project results and benefits. Will supervise sprayer test/calibration procedures and retrofitting of sprayers with automated controls. Will provide time and management/technical expertise. (See APPENDIX C.)

- Wesley Autio, Professor, UMass Amherst. Will be a technical expert, serve as publication editor and Extension dissemination coordinator. Will provide input and expertise. (See APPENDIX D.)

- James Krupa, Technical Assistant II, UMass Cold Spring Orchard. Will provide mechanical/technical expertise and assist with sprayer test/calibration procedures. Will provide technical expertise.

- OESCO, Inc., Conway, Massachusetts. Provider of orchard sprayer and equipment sales; will provide technical and demonstration support (verbal agreement).

- Maurice Tougas, Northboro, Ma. fruit grower and Massachusetts Fruit Growers' Association representative. Tougas with his family run a diversified retail/pick-your own orchard and small fruit farm of about 90 acres (http://www.tougasfarm.com). He has been a leader in planting intensive apple orchards, and has many age orchards of different architecture and configuration, hence the interest and need for precision application of orchard pesticides. Tougas will be a mentor and technical resource on sprayer calibration and adjustment to achieve better spray applications.

- Red Tomato Eco-Apples (http://www.redtomato.org/ecoapples.html) a coordinated marketing and IPM certification program that has had much success recently in helping participating orchards adopt a standardized IPM program while helping them sell their Eco Apples at premium prices. From the Eco Apple website "Eco Apple farmers use a combination of old agricultural methods and leading edge technologies to minimize spraying and other environmentally disruptive practices. They're pioneers in what is known as IPM, which stands for integrated pest management." Red Tomato and Eco Apple growers will provide record keeping advice and services as needed, in addition to the growers being active participants in the Project.

9. Budget

Project period from March 1, 2008 – March 1, 2010

Category	Grant funding	Other funding*	Total funding**
Personnel	**$9,250**	**($9,250)**	**$18,500**
Clements	*6,750*	*(6,750)*	-
Tech support	*2,500*	*(2,500)*	-
Fringe benefits	-	-	-
Travel	**$7,100**	**-**	**$7,100**
Mileage	*5,850*	-	-
Meals, lodging	*1,250*	-	-
Equipment	**$42,135**	**($10,500)**	**$52,635**
Sprayer test bench	*14,135*	-	-
Sprayer automation	*28,000*	*(10,500)*	-
Supplies	**$900**	**-**	**$900**
Contractual	**$4,000**	**($3,500)**	**$7,500**
Andrew Landers	*500*	-	-
Eco Apple	*3,500*	*(3,500)*	-
Indirect cost	-	-	-
Other	-	-	-
TOTAL	**$63,385**	**($23,250)**	**$86,635**

** dollars in ( ) represent estimated in-kind amounts*

*** includes estimated in-kind amounts*

***Budget narrative**:*

Some breakdown of the proposed budget is in the Budget table above. Further discussion below:

- Personnel – Grant funding request is for Project Coordinator (Clements), 112.5 hours per year (times 2 years) @ $30/hour = $6,750 (split evenly between both Project years). Other funding is in-kind donation of time and benefits from UMass salary; Tech support is for UMass technician to help with project, same for other funding as above. Again, split evenly over two years of the Project.
- Travel – Mileage is estimated at 6,500 miles per year (13,000 total) @ $0.45/mile. Meals, lodging for out-of-state travel to work with Eco apple growers. Split evenly over two years of the Project.
- Equipment – Purchase of three pieces that comprise sprayer test bench = $14,135 (these have to be imported from Europe, purchase in year 1 of the Project). Sprayer automation figured at $4,000 per sprayer (up to 7) for parts, including controller, valves, sensors, etc. all high pressure (these will be retrofitted at the rate of 2 during the first year of the Project, 5 in the second year; other funding ($10,500) is figured as grower in-kind donation of labor to retrofit sprayers with controller, manifold modification, etc. at $1,500 each

- Contractual – $500 to bring Andrew Landers from Cornell for at least one meeting (year 1); $3,500 to Eco Apple for recordkeeping services (Seven orchards @ $500/each [$250/year], split over both years of the Project.)

References

Landers, A. and Muhammad Farooq, 2004. Reducing spray drift from orchards – a successful case study. New York Fruit Quarterly, Vol. 12 (3): 23-26.