

## **INCREASED PROFITS FOR SUSTAINABLY PRODUCED GARLIC**

**ABSTRACT:** Garlic is a profitable crop for small to medium-sized vegetable farmers in the NE. Despite the increasing market for specialty garlies it is remarkable how little is known about the diverse types of garlic available in the U.S. Farmers need to know which garlic types perform well under their growing conditions, and they need reliable descriptors to publicize these types to their customers. In this proposal, NE vegetable farmers will use sustainable practices to perform the first multi-year garlic variety trial. We will determine how 10 garlic types respond to cultural practices across 5 farms in the NE and then recommend types that excel. This is a project that garlic farmers value nationwide. In fact, we have six volunteer garlic growers from other regions in the US who will participate in this project with their expenses defrayed by the Garlic Seed Foundation. This project has one research and three outreach objectives:

**Objective 1)** Correlate the yield and qualities of 10 distinct garlic cultivars with growth environment, inputs, quality, and chemical composition data.

**Objective 2)** Increase public awareness of garlic diversity.

**Objective 3)** Develop name recognition and appreciation for selected varietal garlies.

**Objective 4)** Attract new growers to this profitable niche commodity.

**Performance target:** We will increase the yield, quality and uniformity of garlic produced by small scale farms. In the NE, the number of garlic growers will increase by 10% (60 growers) and profits will increase by 25% for 300 of the current garlic producers. In addition, nationally 100 growers will begin garlic production and 2500 current growers will have increased yields by growing garlies best suited to their regional environments.

## **WHO STANDS TO BENEFIT**

The farmers of small and medium-sized vegetable farms will benefit from this project. Five of these growers will be performing on-farm research using 10 garlic types. In addition, six farmers from other diverse locations within the US will participate in this project (national portion to be funded by the Garlic Seed Foundation). Research has established sustainable production techniques in weed control, soil properties and fertilization, erosion prevention, and rotations (O’Callaghan, 2001). We will publish grower recommendations that will increase yields for more than 2800 existing growers and introduce at least 160 new growers to this profitable crop.

**Case 1.** The Small Farmer looking for a new crop to offer his farmers market customers or CSAs (Community Supported Agriculture) will see our garlic trial results in magazines, outreach presentations, and Appropriate technology transfer for rural areas (ATTRA) publications. He will learn that additional information is available at the project website and can contact the Key Project Leader if more information is needed. He will maximize his investment by selecting garlic varieties that will perform well at his farm.

**Case 2.** The medium sized garlic grower hoping to improve yields will see our results in the “Garlic Press”, magazines, newsletters, and at conference presentations (Garlic is Life Meetings or at the Hudson Valley Garlic Festival). She will learn which varieties perform well under her environmental conditions as well as cultural practices that may significantly improve her garlic crop yields. This information will also be available on the project website for instant access at anytime during the growing season. With this new information, this grower will increase yields by 25% within the first year.

## PERFORMANCE TARGET

Most consumers and many vegetable farmers don't realize that there is more than one type of garlic. Large-scale California growers have greatly reduced their garlic production in recent years. Most garlic available in supermarkets is imported from China and is not produced sustainably. Throughout the U.S., farmers have discovered that the demand for local, fresh market, high quality, sustainably grown varietal garlic far exceeds supply. Income from fresh-market sustainably grown garlic fields can range from \$10,000 to \$30,000 per acre. However, this crop is labor intensive, with more than 20 human interventions during the growing seasons. Such management-intensive production without available labor in the NE means that fresh-market garlic is produced on a limited scale with minimal mechanization. Varietal garlic must be produced on small or diversified farms. Therefore, expansion of this commodity is dependent upon attracting new growers to the garlic farming community. Even though there are more than 5000 garlic farmers in the US, we do not yet know which varieties grow best in each region.

***Performance Target: We will increase the yield, quality and uniformity of garlic produced by market gardeners and small to medium scale farms. In the NE, the number of garlic growers will increase by 10% (60 growers) and profits will increase by 25% for 300 of the current garlic producers. Nationally 100 growers will begin garlic production and 2500 current growers will have increased yields by growing garlic varieties best suited to their regional environments.***

We will know how many growers are affected by this project through follow-up personal communication, surveys, market evaluations and outreach activities.

## **PROJECT NARRATIVE**

### *Experimental Research Method to achieve Objective 1:*

**Objective 1) Correlate the yield of 10 distinct garlic cultivars with location, inputs, quality, and chemical composition data.** The effects of environmental and geographical conditions on garlic bulb yield, quality, and chemical composition will be determined. We will identify consistent, environmentally-independent, descriptive characters that can be used to identify 10 garlic types. Garlic does not produce seed under standard cultivation conditions and it is not amenable to traditional or modern breeding programs. Optimal yield and quality conditions must be determined using existing varieties. Many of the US varietal garlics have recently been fingerprinted using DNA genotyping techniques and we now know that there are at least ten types of varietal garlic (Volk et al., 2004a). We will select one cultivar from each garlic type to represent the spectrum of genetic diversity: Porcelain, Purple stripe, Marble purple stripe, Glazed purple stripe, Rocambole, Silverskin, Creole, Asiatic, Artichoke, and Turban.

**Year 1:** Bulbs of 10 garlic types will be purchased for all five NE growers from a common source. With non-SARE funds, 6 garlic growers from other US regions will also participate in this study. Using sustainable practices, all of the growers will produce 10 varieties in three completely randomized, replicate test plots with 16 plants per plot. Growers will record all amendment applications, human interventions (irrigation events, scape removal methods, weeding and pest control measures), and collect data on leaf architecture, scape emergence, flowering date and description, and harvest date. They will also photograph the plants at specific stages of development, and growers will provide soil, compost, and irrigation water samples at two pre-determined times during

the growing season for soil and water quality tests. Regional weather data will be collected from local weather stations. After the growing season, each participant will ship 12 of the cured garlic bulbs from each replicate plot to the PI for uniform data collection yield (bulb wt, bulb circumference, clove number, clove wt), wrapper color, and storability (rate of shoot elongation within cloves under ambient and  $-3^{\circ}\text{C}$  storage conditions). Sulfur content (CSU plant testing laboratory) and antioxidant levels (Volk laboratory) will be determined for each variety from each location. “Genotype by environment” statistical analyses will be performed to correlate the known genetic variation within and among the chosen accessions with the quantitative data. The distribution of the coefficients of plasticity will be determined for each of the quantitative traits evaluated. Dr. Christopher Richards, Molecular Geneticist USDA-ARS-NCGRP, has offered to serve as a consultant for these analyses. PI and NE growers will attend an annual meeting of participants.

**Year 2:** Bulbs will be purchased for all growers from a common source for one planting and a second planting will be performed using cloves of each of the same 10 varieties harvested from that grower’s field during Year 1 of the project. Data will be collected and analyzed as described for Year 1. Participants will attend a second annual meeting.

***Outreach Method to achieve Objectives 2-4:***

**2) Increase public awareness of garlic diversity.** It is critical that the results of this study are made available to consumers as well as current and new garlic growers.

Consumers have a great interest and curiosity in garlic (40,000 people attended the 2004 Hudson Valley Garlic Festival). Our outreach plan will have high publicity for our research project as well as the NE-SARE program. We will develop a website and digital

press package to illustrate the diversity of high quality garlic to attract consumers and growers to the sustainable, varietal garlic market. Results will be disseminated through gardening and cooking magazines, scientific publications, newsletters (Garlic Press, circ. 1500), ATTRA, e-zines (Garlic Gazette, circ. 10,000), agricultural papers and reports, and outreach presentations at agricultural workshops, conferences and festivals. As an example, the Key Project Leader recently gave presentations to several thousand garlic enthusiasts and growers at the Hudson Valley Garlic Festival in September 2004.

**3) Develop name recognition for selected varietal garlics.** Product recognition (such as with Vidalia onions) occurs when there is a critical mass of growers producing an appealing variety. With this, demand for product increases dramatically. With name recognition, regional cultivar recommendations can be provided to growers. We will prepare press materials to aid in the advertisement of regional varietal garlics.

**4) Attract new growers to this profitable niche commodity.** U.S. consumption of garlic has increased 6-fold in the past 15 years. When available, local, fresh-market sustainably grown garlic easily outsells industrially produced, imported garlic. Garlic is a crop that can be successfully grown in both rural communities and urban gardens. It requires no elaborate equipment to produce a quality crop. Most varieties of garlic can be successfully stored for at least five months after harvest at room temperature, which extends marketing options. When diverse family farms remain intact, local community businesses that depend on their support will survive. The social impact of family farms in America is critical to maintaining viable rural communities.

New growers will be encouraged to contact the Key Project Leader to discuss marketing and cultural strategies. The number and success of new garlic growers that are

attracted to this field as a result of this project will be recorded. Growers that contact the Key Project Leader during the granting period will be interviewed (by phone) and records will be kept as to what they grew and marketed. A link at the project website will let people e-mail feedback to the Key Project Leader regarding adoption of new techniques and their successes (and failures). Feedback will also be encouraged during discussion groups to be held at various locations in the NE. A survey will be conducted within the NE garlic growing community during the final season of this project for feedback on the outcomes of this project.

**National Impact:** As we have discussed this research project with members of the garlic community, numerous people have asked to be included in this research project as participants without compensation. They will grow the same garlic varieties on their farms and compare their results with those funded by NE-SARE. The Garlic Seed Foundation has agreed to provide funds to defray costs for the national project participants. By including these participants in our research trials, we have significantly broadened the impact of our proposed studies. These nationwide participants will be invited to participate in our grower meetings without compensation for their expenses.

Nationwide participants include:

Dr. Walt Lyons	Yucca Ridge Farm, Ft. Collins, CO
Joel Girardin	Girardin Gourmet Gardens, Cannon Falls, MN
Jean Pitchers, Leo Keene	Blue Moon Farm, Richmond, KY
Dr. Angela O'Callaghan	Univ. Las Vegas, Las Vegas, NV
Janet Buchmann	NCAT-ATTRA, Fayetteville, AR
Frank Parente	Gourmet Organics Inc., Freeland, WA

Dr. David Holm  
Program Manager, SARE Northeast Region  
217 Hills Bldg.  
105 Carrigan Drive  
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Burlington, VT 05405-0082

Dear Dr. Holm:

Administrative approval is granted for Dr. Gayle Volk, USDA-ARS Research Scientists at the National Center for Genetic Resources Preservation in Ft. Collins, CO, to submit the proposed grant "Increased profits for sustainably produced garlic." The proposal will be submitted to NE-SARE Research and Education Program. I fully support Dr. Volk's efforts on this proposal.

I understand that Dr. Volk will be collaborating with Mr. David Stern, Garlic Seed Foundation, for all the outreach activities proposed. She has also established collaborations with 4 additional NE garlic/vegetable growers who will be performing the on-farm research. Dr. Volk is the PI on the project and will be responsible for performing antioxidant assays, collecting phenotypic data, performing statistical analyses, and publishing the results in a scientific journal. These results will give us a better understanding of the environmental effects on garlic phenotypes, data which will be valuable for our research programs that aim to preserve genetic diversity in germplasm collections.

Sincerely,

W.H. Blackburn

cc: w/o enclosure  
Henry Shands, CD  
Christina Walters, RL  
Gayle Volk, Res. Scientist

## **MILESTONES**

- 1) September 2004: PI and Key Project Leader met with garlic growers in Geneva, NY to discuss project proposal and determine priority research areas.
- 2) Summer 2006: Garlic growers participating in the NE SARE grant harvest their first year experimental crop and data is tabulated.
- 3) Fall 2006: Public views the website that lists growth protocols detailed for each grower. Preliminary results are presented at outreach forums (Garlic Seed Foundation sponsored events (>50 attendees), Garlic Festivals (>4000 attendees), Garlic is Life Symposium (>50 attendees) and through written documents (Garlic Press, circ. 1200).
- 4) Summer 2007: Garlic growers harvest second year crop and data is tabulated.
- 5) Fall 2007: Garlic enthusiasts find out results from the first multi-location, multi-variety garlic research trial in the Garlic Press (circ. 1200), a scientific journal (such as HortScience, available at libraries worldwide), and through press releases distributed to newspapers, gardening magazines, farm newsletters, as well as posted on the website. Results are presented at scientific meetings as well as a minimum of six public outreach forums throughout the northeast (>5000 attendees).
- 6) Summer 2008: Follow-up conversations with new growers that have contacted project personnel as well as survey of garlic growers.
- 7) The number of garlic growers will increase by 10% (60 growers) and profits will increase by 25% for 50% of the current garlic producers. In addition, nationally 100 growers will begin garlic production and 2500 current growers will have increased yields by growing garlic varieties best suited to their regional environments.

## **KEY INDIVIDUALS**

**Principle Investigator:** Gayle Volk, Ph.D. Dr. Volk has recently published a paper describing the genetic relationships among 212 garlic accessions available in the U.S. This work has been cited by the NY Times and Chicago Tribune. She is particularly interested in the influence of growth environment on bulb phenotype (appearance, sulfur content, antioxidant level, storability). She will receive bulbs from growers, collect data, perform antioxidant assays, and analyze data using appropriate statistical techniques. Her participation in this project will ensure that valuable data will be published in the scientific community in addition to presentation in grower outreach programs.

**Key Project Leader and Garlic Grower 1:** David Stern. Mr. Stern has been Director of the Garlic Seed Foundation for more than 15 years and has published many volumes of the “Garlic Press”. His long-term dedication to this crop has earned him much respect in the garlic growing community. He has participated in SARE and Cornell University research and education involving garlic. He has played a leadership role in this proposal by assembling the unique group of people that will participate in this research endeavor. As the owner of Rose Valley Farm in Rose, N.Y. (certified organic), he will also participate as a grower in the proposed studies. David will coordinate all outreach and follow-up portions of this proposal.

### **Garlic Grower 2:**

Shane LaBrake, Org. Non-certified, Organic Garlic/Vegetable Farmer  
EcoSystem Farm, Accokeek, MD

### **Garlic Grower 3:**

Seth Kroeck, Certified Organic Garlic/Vegetable Farmer  
Crystal Spring Community Farm, Brunswick, Maine

### **Garlic Grower 4:**

Noah Gress, Non-certified, Organic Garlic/Vegetable Farmer  
Pete’s Produce, West Chester, Pennsylvania

### **Garlic Grower 5:**

Eugenie Doyle, Certified Organic Garlic/Vegetable/Crop Farmer  
The Last Resort Farm, Bristol, Vermont

## LITERATURE REVIEW

Garlic is a profitable crop for organic/sustainable farmers nationwide.

Approximately 50% of the fresh market operations (100% of CSA farms) in the NE grow at least one variety of garlic. Quality garlic crops can demand high prices at market and sell out quickly. Most extension publications provide advice about planting time, fertilization, harvest options, and recommend procedures for curing the bulbs before marketing; however, cultivar recommendations are lacking.

(<http://www.extension.umn.edu/distribution/cropsystems /DC7317.html>;

[http://oregonstate.edu/Dept/NWREC/garlic\\_planting.html](http://oregonstate.edu/Dept/NWREC/garlic_planting.html);

<http://www.hort.cornell.edu/extension/commercial/vegetables/pubs/Garlicvc387.PDF>).

In July 2004, the first genetic characterization of garlic varieties using commercially available types in the US was published. This paper revealed, as many growers suspected, that there are many uniquely named garlic cultivars that are genetically identical (Volk et al., 2004a). The phenotypic garlic types, as described by Ron Engeland (Engeland 1991; Engeland 1995) were also distinct genetically. NE farmers frequently criticize the phenotypic descriptions of garlic that were published by Engeland since most of the bulb characteristics he described are not valid if a variety is grown in a location other than Okanogan, WA (the site of his former farm). A formal, multi-site, two year project with avid growers familiar with research procedures as proposed here will address the genotype x environment variation question and will allow growers nationwide to recognize the major types of garlic based on phenotypic characters.

Garlic and other Alliums are unusually rich in sulfur. Sulfur compounds are also a source of garlic's cancer preventative, anti-bacterial, platelet aggregation inhibitory

activity, and antithrombotic properties, which make garlic very desirable to the nutraceutical market (Randle and Lancaster, 2002; Keusgen 2002). The sulfur content of garlic is close to 1% of its dry weight (Lawson, 1996). Biochemically active compounds such as alliin, allicin, and  $\gamma$ -glutamylcysteines constitute about 86% of the total sulfur in garlic cloves (Lawson, 1996). Total sulfur measurements are economical (\$15 vs \$100 a test for allicin) and serve as valid predictors of the alliin potential in garlic cloves (Larry Lawson, personal comm.). Future in-depth studies with allicin quantitation could be targeted toward varieties or environmental conditions that yield bulbs that are particularly high in sulfur. Sulfur determinations are performed on dried garlic using inductively coupled plasma-atomic emission spectroscopy (ICP-AES) instrumentation at Colorado State University. In a two-year study at a single location using 69 garlic cultivars, Lawson (1996) documented that alliin potential was higher in hardneck than softneck garlic varieties. In addition, hot and dry conditions resulted in higher alliin potential than cold, wet conditions (Lawson 1996).

Garlic compounds provide antioxidative effects in the form of decreased lipid peroxidation, increased free radical scavenging, and increased glutathione (Banerjee et al., 2003). While many nutrition programs are researching the human health benefits of garlic, few have recognized that certain garlic varieties may be preferable for the nutraceutical market. Antioxidant, or free radical scavenging ability can be measured using activity assays such as the ABTS (2,2'-azino-bis(3-ethylbenz-thiazoline-6-sulfonic acid) antioxidant activity assay (Cox et al., 2003). This assay can be performed using a 96 well format spectrophotometer in the lab of the PI. Expertise is available at the Colorado State University campus (Dr. Cecil Stushnoff, personal comm.).

Understanding the dependence of the health benefits of garlic (S compounds, antioxidants) on variety and growth location is important to determine potential new outlets for garlic bulbs. Companies are willing to pay a premium for American, organic/sustainable garlic with high sulfur and antioxidant levels (Stern, personal comm.).

The sustainable garlic market is dependent upon a farmer's ability to produce a high quality product. The growers included in this study produce some of the highest quality garlic available nationwide. These growers have agreed to make their production practices public and help new growers become established. Garlic growers realize that there is far more demand than supply for garlic at this time. Since garlic can be successfully cold-stored (Volk et al. 2004b) for up to 9 months without a discernable loss in quality for consumption purposes, it is entirely possible to make a quality product available to consumers year round. Currently, growers sell out of their garlic soon after harvest, so the potential for increased marketing of high quality, sustainably produced garlic is enormous.

This proposal addresses the most enigmatic aspects of garlic production. How dependent are the phenotypes of garlic cultivars on environmental conditions? Our Objective 1 will determine how the plant growth characteristics, yield, quality, and chemical composition of 10 garlic cultivars vary with environmental conditions. Our Objectives 2, 3 and 4 are aimed at increasing markets for regional garlic varieties. Through our outreach program, we will increase the public awareness of the diversity between different types of garlic, develop name recognition for selected garlics, and attract new growers to this profitable niche commodity.

## References

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## REFERENCES

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