

Title: State Master Gardeners Knowledge and Behavior Regarding Food Safety and Good Agricultural Practices Recommendations.

Christy Brennan¹, Renee R. Boyer^{1*}, Heather Boyd², David Close³, Joseph D. Eifert¹, and Robert C. Williams¹

Department of Food Science and Technology¹, Virginia Polytechnic Institute & State University, 22 Duck Pond Drive, Blacksburg, VA 24061

Department of Agricultural and Extension Education², Virginia Polytechnic Institute & State University, 111 Hutcheson Hall, Blacksburg, VA 24061

Department of Horticulture³, Virginia Polytechnic Institute & State University, 407 Saunders Hall, Blacksburg, VA 24061

Abstract:

Master Gardener's (MG) are volunteers that dedicate their time and resources to complete advanced training on gardening practices. They are a valuable resource to state Cooperative Extension services, like the one in Virginia (VCE), by volunteering to share gardening knowledge with the public. MG's assist the public in starting and maintaining personal and community fruit and vegetable gardens. Food producing gardens should be treated differently from recreational gardens. Gardening and harvesting practices that will ensure the production of safe and healthy produce need to be taught. The objective of this study is to assess MG's knowledge of good agricultural and food safety practices, with the intent of developing an additional food safety curriculum for this audience. Virginia MG's completed an electronic survey to assess knowledge of safe gardening practices and personal gardening behaviors, as well as to evaluate their perceptions of organic and conventionally grown foods. MG's displayed some gardening practices considered to put foods at risk of being contamination with foodborne pathogens. Eighteen percent top dressed with fresh manure, 44% applied compost material throughout the growing period and 33% used overhead irrigation. Seventy-one and 69% of respondents considered organic foods safer or healthier than conventionally grown foods respectively. The addition of Good Agricultural Practices and food safety best practices to the MG training materials may be beneficial to the MG's to ensure they are providing safe information to the public.

Public concern over food safety is increasing. Recent recalls of raw produce, meats and other food items have initiated a movement to support the federal government instituting new food safety measures (Pew Trusts, 2009). A recent survey reported that fifty-eight percent of registered voters worry at least somewhat about the safety of the food they eat and more than half of these voters have lost confidence in the safety of food (Produce Safety Project, 2008).

Consumers have become increasingly interested in knowing the source of their produce and how it is grown (Conger, 2009). Currently no organization is tracking the exact number of vegetable gardeners in the United States, although an increase in activity in the past couple of years has been reported by gardening organizations and retail establishments specializing in gardening and agriculture (Conger 2009). The numbers of new local farmers markets, Community Supported Agriculture (CSA's) farms and gardens and the interest in personal gardens is on the increase. An annual survey conducted by the Garden Writers Association, questioned consumers on lawn and garden spending. The most popular sectors of lawn and garden have been lawns, annuals, and perennials, with vegetable gardening a distant fourth. In 2008, however, vegetable gardening jumped to No. 2, indicating a marked increase in growing food at home. (Marks, Alexandra & Patrick Jonsson, 2008).

Virginia Cooperative Extension (VCE) and the Master Gardener (MG) program can be a valuable resource for consumers as gardeners. The MG Program in Virginia is composed of volunteers that agree to attend fifty hours of formal training and pledge to volunteer at least fifty hours of community service in the year following the initial training. To remain active, MG's must attend an additional eight hours of continuing education and volunteer at least twenty hours per year. Each summer, MG's may elect to attend the Master Gardener College at Virginia Tech to meet the additional educational requirements.

VCE developed The Master Gardener Handbook as the foundation of the 50 hours of formal training. The MG handbook is comprised of soil and plant science, Integrated Pest Management System (IPM) and recommended science based lawn and gardening practices which promote environmental health and sustainability. Although Master Gardeners have received extensive training in sustainable gardening practices the application of these practices as a direct correlation to food safety may not be evident. The objective of this study was to use a survey to determine MG's knowledge in safe food production practices (as outlined in the Good Agricultural Practices recommendations). The survey specifically addressed knowledge of practices outlined in the MG handbook and specific MG behaviors as they relate to food producing gardens. The results of this survey will assess the need for additional training on the topics of food safety as it relates to certain gardening practices.

Materials and Methods:

Sampling and data collection:

A survey was designed to ask MG's a series of multiple choice questions. The survey was divided into five sections: 1) Frequency of community questions related to food safety 2) perception of what makes food safe and the differences between organic and conventionally grown foods, 3) knowledge of recommended gardening practices included in the MG Handbook, 4) personal gardening practices as they relate to food safety and the MG handbook and 5) purchasing/handling practices of organic and conventionally grown fruit and vegetables. Initially a pilot survey was conducted with ten MG's to judge response, test for bias and to implement revisions accordingly.

There are currently over 5,000 active Master Gardener volunteers in Virginia, 230 attended the 2009 MG College at Virginia Tech. The survey was implemented through the

Virginia Tech electronic survey tool and sent to those members who attended the 2009 MG College.

Results and Discussion:

Forty-five MG's completed the survey for a response rate of 19%. MG's reported being asked questions on organic gardening and food safety during each season of the year. Eighty-seven percent reported that they were asked questions at least 5-10 times during the winter, and between 75-80% were asked organic gardening and food safety questions 1-5 times during each other season(Spring, Summer and Fall) (Table 1). The majority of the questions asked during the winter involved the preparation for the gardening season. Due to the large number of questions MG's field regarding food safety practices, more effectively incorporating good agricultural practices into advanced training and Master Gardner handbook may enable Master Gardeners to more effectively share food safety practices with the community.

Perception and purchasing of Organic versus Conventionally Grown Foods

MG's were asked to define organic and conventionally grown foods using the descriptors: traditional agricultural practices, use of pesticides, use of fertilizer, non-traditional agricultural practices, safe foods, healthy foods and other. The most popular choices for the definition of organic foods were: using non-traditional agricultural practices (58%), safe foods (53%), and healthy foods (47%) (Figure 1). Conventionally grown foods were defined primarily as: using traditional agricultural practices (76%) and the use of pesticides (87%) and fertilizers (78%) (Figure 1). Significantly more respondents used the terms "healthy" and "safe" to describe organically grown produce than conventionally (figure 1). Overall, 71% of MG's either strongly agreed or agreed that organic foods are safer than conventionally grown foods and 69% strongly agreed or agreed that organic foods are healthier (Table 2).

Questions concerning the purchasing choices of organic and conventional foods resulted in: 71% answered that organic foods are safer than conventionally grown foods while 27% strongly disagreed and did not feel that organic foods were safer. 69% felt that organic foods are healthier than conventionally grown foods and 27% disagreed (Table 3).

Seventy-four percent of MG's chose to purchase locally grown foods 20-74% of the time. 53% of MG's chose to purchase organically grown foods less than 25% of the time (Figure 3). The additional cost associated with organic foods may be a reason for purchasing organic foods less than 25% of the time, even though most felt organic foods are safer and healthier than conventionally grown foods (Figure 2).

Recommended Gardening Practices and Practices used by MG's

VA Cooperative Extension (VCE) has developed recommended sustainable gardening practices which are included in the VA Master Gardener Handbook. The handbook is the foundation of the 50 hours of required training for MG's. The survey questioned MG' on their understanding of these recommendations as compared to their actual gardening practices and/or behaviors. Most (78%) MG's strongly agreed or agreed that the Master Gardener Handbook address current food safety concerns, while 4% strongly disagreed and 13% disagreed (data not shown). The same 78% percent of MG's strongly agreed or agreed that the Master Gardener Handbook address current health concerns of foods, while 22% disagreed, 2% strongly disagreed, and 7% had no answer (data not shown).

Water Use:

Water is one of the most common sources of contamination for fresh produce and it is important to consider the source of water used for irrigating the produce garden to prevent contamination. Water sources in relation to food safety are not included in the MG handbook

recommendations, however overhead irrigation is not recommended. Even so 33% of MG's identified overhead irrigation as a practice recommended in the handbook (Table 3A). The Master Gardener Handbook recommends drip irrigation early in the morning to prevent plant disease and rot, and 96% of MG's identified drip irrigation as a source recommended (Table 3A). Drip irrigation is also recommended in the GAP's to reduce contamination onto produce surfaces.

Forty-four percent of MG's use water from municipal systems (Table 4A) which is considered the best possible source of water for the produce garden according to GAP's recommendations. Municipal water sources are frequently monitored by federal regulation concerning purity and quality, minimizing the chance of bacteriological contamination. Thirty-eight percent of MG's use well water for irrigation and 60% use rain collection systems for watering (Table 4A). VCE has started the Well Owners Program to educate well owners on the proper placement and maintenance for wells in Virginia; many MG's have participated in this program. This training will be helpful in their volunteer work.

Animal Exclusion:

Pets and wildlife can expose produce gardens to pathogens. Animals are known sources of pathogens, especially in their fecal matter. The contamination can come from the animals tracking dirt/feces into the garden on their bodies, or from the animals defecating in the areas where fruits and vegetables are grown. The Master Gardener handbook addresses animal exclusion methods to protect the ornamental garden and prized plants, as a source of potential food contamination is not presented. Most (78%) Master Gardeners tried to eliminate animals from the garden, although 16 % did not and 7% allowed pets in the garden (Figure 3).

Soil Preparation and Compost/ Manure Application:

Soil preparation is usually considered the first step when planning a vegetable garden. Gardening practices described in the MG Handbook recommend obtaining a soil test to determine the exact nutritional needs of the soil to create a healthier environment for gardening, 96% of MG's performed a soil test as recommended (Table 3B).

The MG Handbook recommends adding composted materials to improve soil compaction and add nutrients into the soil, 80% of MG's identified this as a recommendation (Table 3B). The USDA National Organic Program (NOP) recommends tilling compost deeply into the soil at least 90 days prior to harvest to decrease the possibility of bacteriological contamination. This recommendation should be included in the MG handbook to prevent the possibility of bacteriological contamination.

Seventy-three percent of MG's identified the handbook recommendation of using cover crops to increase soil nutrients and prevent soil erosion (Table 3B). Using cover crops also provides weed control, increases soil microorganisms, and serves as a habitat for beneficial insects which help to sustain the garden.

Natural amendments such as manure are recommended to increase nutrients and reduce soil compaction. The use of fresh manure as a soil amendment, top dressing or fertilizer during the growing season can expose produce to high levels of bacteria. Fresh manure may contain human pathogens which are able to persist in the environment for several weeks and in some studies several months. Fifty-one percent of MG's top-dress the produce garden prior to planting, 33% when planting and 44% top-dress throughout the growing season, and 9 % recommended top dressing with manure (Table 4B). This risky practice is not addressed in the handbook. Inclusion of the potential food safety risks of pathogen contamination from top dressing should be included in the MG handbook and training in the future.

Fertilizer and Pesticide Usage:

Master Gardeners receive in-depth training concerning plant health and disease prevention, these practices can help to assure food safety. The MG handbook advises use of pesticides and fertilizers according to the label of the particular product, but no recommendations as to application location. Most MG's (93%) correctly identified that application location depended on the label (Table 3C). There are no recommendations regarding quality of water used to mix these chemical, which should be included in food safety recommendations.

Most MG's use a combination of synthetic (in-organic) fertilizers and natural composted materials to add nutrients to produce gardens. Sixty-two percent applied the fertilizer prior to planting and 51% applied them throughout the growing season (Table 4C). Natural composted materials may include: compost and/or manure, "teas" made from these sources and bio-solids. The use of manure, compost teas and bio-solids are not recommended by GAP's as fertilizer or a pest treatment for produce due to the high microbial population.

IPM (Integrated Pest Management System) is a main portion of the Master Gardener Handbook. IPM consists of using information about pests and pest control methods to manage pest damage with the least possible hazard to people, property, and the environment. The survey results indicated; 71% of Master Gardeners used manual removal of pest, 44% used natural organic chemicals, 33% used inorganic and 31% used homemade remedies such as pepper sprays (Table 4C).

Conclusion:

Basic food safety procedures can be implemented when growing, handling and preparing both organic and conventionally grown produce to prevent food borne illnesses. The MG's defined organic and conventionally grown foods by several gardening practices and were able to

relate the recommended gardening, pre-harvesting and post harvesting practices to safe and healthy foods. Although most MG's felt that organically grown foods are safer and healthier than conventionally grown foods, the survey results showed a preference to purchasing locally grown foods more than organically grown foods. This may be due to the higher cost associated with organically produced foods during tough economic times.

The MG's that participated in the survey have indicated that the current training system is effective and that they are practicing the VCE gardening practices learned through advanced training. The survey results have shown that there are some opportunities where training could be enhanced by relating the choice of certain gardening practices to food safety. Fresh fruits and vegetables can become contaminated with bacteria through various sources in the environment. Specific references to pathogenic bacteria which may be found in soil and water where produce is grown can be included with the VCE recommended gardening practices to increase the awareness of Master Gardeners.

It can be very difficult to control pathogen contamination in the produce garden from environmental sources. Including the sources and routes of contamination in the required training and the Master Gardener Handbook will help to explain how gardening practices can directly influence the safety of the fruits and vegetables grown. The survey responses indicate there is public interest in gardening and food safety during each season. As Master Gardeners learn to implement food safety practices (GAPs) into gardening practices, they will be able to educate Virginia residents on the safety of home fruit and vegetable gardens as they volunteer throughout community.

References:

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Tables:

Table 1. Frequency of organic gardening & food safety questions receive by Master Gardeners from the public according to season.

Organic Gardening questions	1-5 times	6-10 times	More than 10 times	No Answer
Summer	64%	16%	18%	2%
Fall	67%	11%	11%	11%
Winter	82%	9%	0%	9%
Spring	71%	9%	20%	0%

Food Safety Questions	1-5 times	6-10 times	More than 10 times	No Answer
Summer	71%	16%	4%	9%
Fall	76%	11%	2%	11%
Winter	87%	2%	0%	11%
Spring	73%	11%	4%	11%

Table 2. Master Gardener’s perception of the health and safety of organic versus conventionally grown foods:

Responses	Organic foods are healthier than conventionally grown foods	Organic foods are safer than conventionally grown foods.
Strongly Agree	4%	9%
Agree	69%	60%
Disagree	0%	27%
Strongly Disagree	27%	4%
No answer	0%	0%

Table 3 (A-C). Master Gardener’s knowledge of best gardening practices related to water usage (A), soil preparation (B) and pest control/fertilizer application (C) as recommended in the Virginia Master Gardening (MG) Handbook.

A) Water Usage

Question	Selection	Responses	Virginia MG Handbook Recommendations
Water Source as recommended in the MG handbook	Overhead Irrigation	33%	No
	Drip Irrigation	96%	Yes
	Recycled gray water	22%	Yes
	None of these	4%	

B) Soil Preparation: Compost & Manure Application

Question	Selection	Responses	Virginia MG Handbook Recommendations
Recommended Soil Preparation MG Handbook Practices includes	Soil Testing	96%	Yes
	Tilling in Compost	80%	Yes
	Top dressing with fresh manure	18%	No
	Application of synthetic nutrients (10.10.10)	42%	Yes ,if recommended after soil test results
	Use of Cover Crops	73%	Yes
	None of these	0%	
	Other	11%	
Recommended Application of Top Dressing in the MG handbook includes	Prior to planting	51%	Yes
	When planting	33%	No
	Throughout the growing season	44%	No
	Prior to harvesting	2%	No
	None of these	9%	
	Other	7%	

C) Pest Control and Fertilizer Usage

Question	Application location	Responses	MG Handbook Recommendations
			Use the VCE Pest Management Guide
Pest Control Application recommended by the MG handbook includes:	Foliar	16%	According to label of recommended pesticide/fungicide
	Soil/Surface	93%	
	Depends on product label	93%	
	Leaf/ Fruit	13%	According to label of recommended pesticide/fungicide
	None of these	0%	Warning to read label when to eat fruits & vegetables after treatment
	Other	4%	

Table 4 (A-C). Master Gardener’s personal gardening practices related to water usage (A), soil preparation (B), and pest control/fertilizer application (C).

A) Water usage

Question	Water source	Response
What type of water source do you use for the vegetable garden	(Potable drinking quality water) municipal systems	44%
	(Potable drinking quality water) well	38%
	Use of natural surface water (creek, stream)	4%
	Rain and rain collection systems (rain barrels)	60%
	Recycled gray water	7%
	None of the above	2%
What type of irrigation do you use on your fruit /vegetable garden	Overhead irrigation	16%
	Drip Irrigation	44%
	Watering by hand, watering cans, water hoses	73%
	None of these	0%

B) Soil preparation: compost & manure application practiced by Virginia Master Gardeners

Question	Selection	Responses
Do you top dress the vegetable garden	Prior to planting	51%
	When planting	33%
	Throughout the growing season	44%
	Prior to harvesting	2%
	None of these	9%
	Other	7%
Recommended Types of Top Dressing includes	Fresh manure	9%
	Composted Dry Manure	78%
	Composted Natural (e.g. kitchen scrap) materials	71%
	Recommended IMP Chemicals	18%
	None of these	4%

C) Pest control and fertilizer usage

Question	Selection	Responses
What type of fertilizer do you use	Synthetic (inorganic) fertilizer	44%
	Composted natural materials (kitchen waste)	69%
	Natural fresh materials-manure	20%
	Natural Chemicals (organic)	38%
	None of these	4%
	Other	2%
When do you apply fertilizer to your fruit/vegetable garden	During soil preparation	62%
	When planting	42%
	Throughout the growing season	51%
	Prior to harvesting	2%
	None of these	4%
	Other	2%
What type of Pest control do you use on the fruit/vegetable garden?	Homemade remedies (pepper spray)	31%
	Recommended IMP Chemicals	33%
	Natural (Organic) Chemicals	44%
	Companion Planting	47%
	Manual removal	71%
	None of these	9%
	Other	9%
When do you apply fertilizer to your fruit /vegetable garden	During soil preparation	62%
	During Planting	42%
	Throughout the growing season	51%
	Just prior to harvesting	2%
	None of these	4%
	Other	1%

Figures:

Figure 1. Characteristics of organic and conventionally grown foods as defined by Virginia Master Gardeners

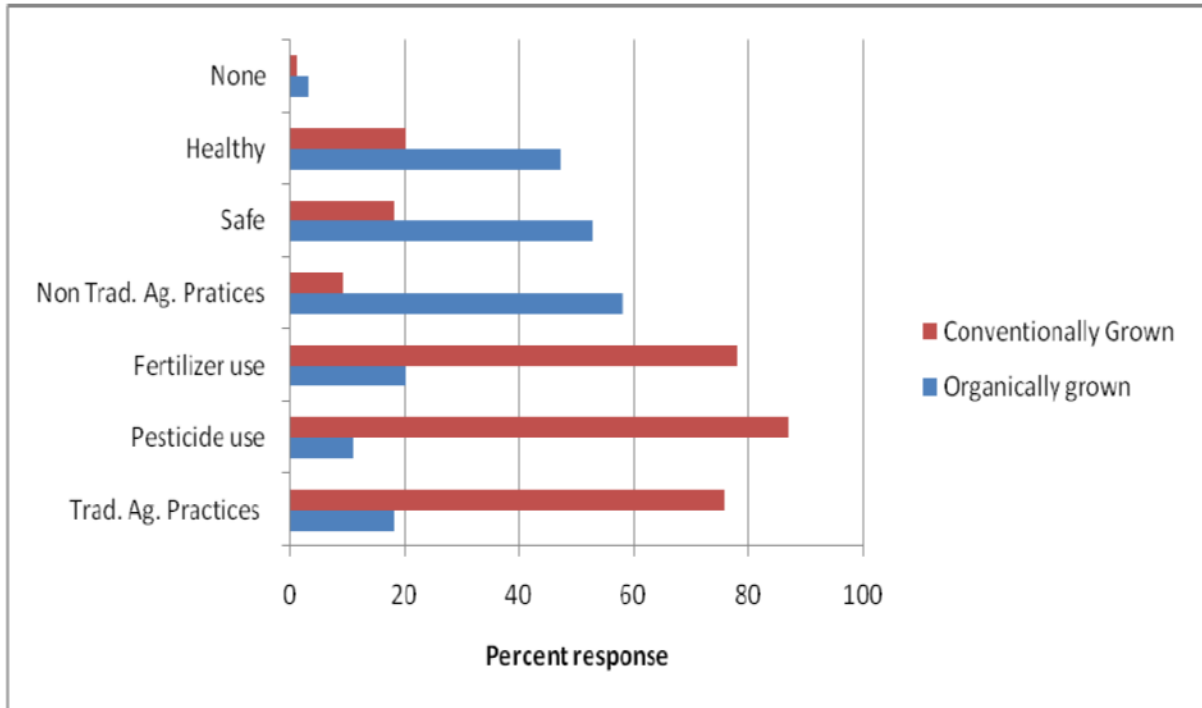


Figure 2. Percent of Virginia MG's that use animal exclusion practices

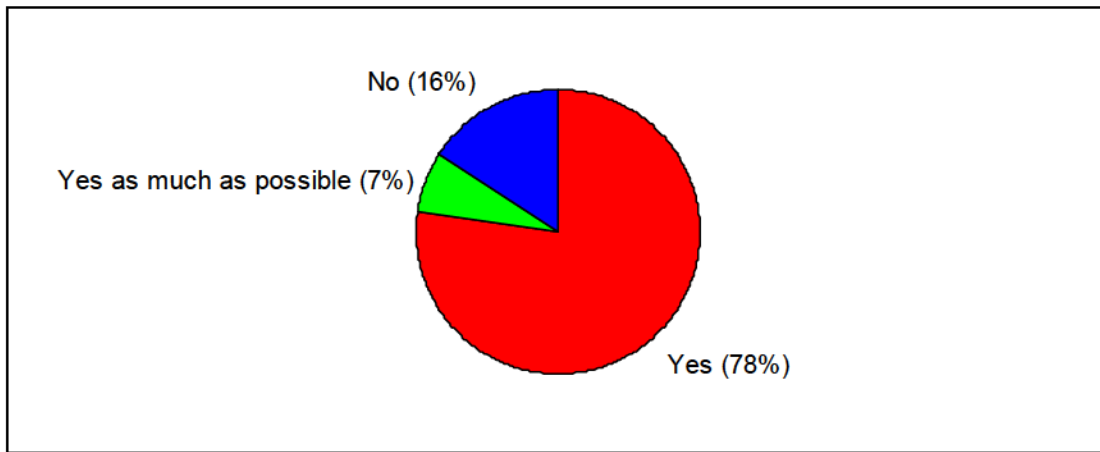
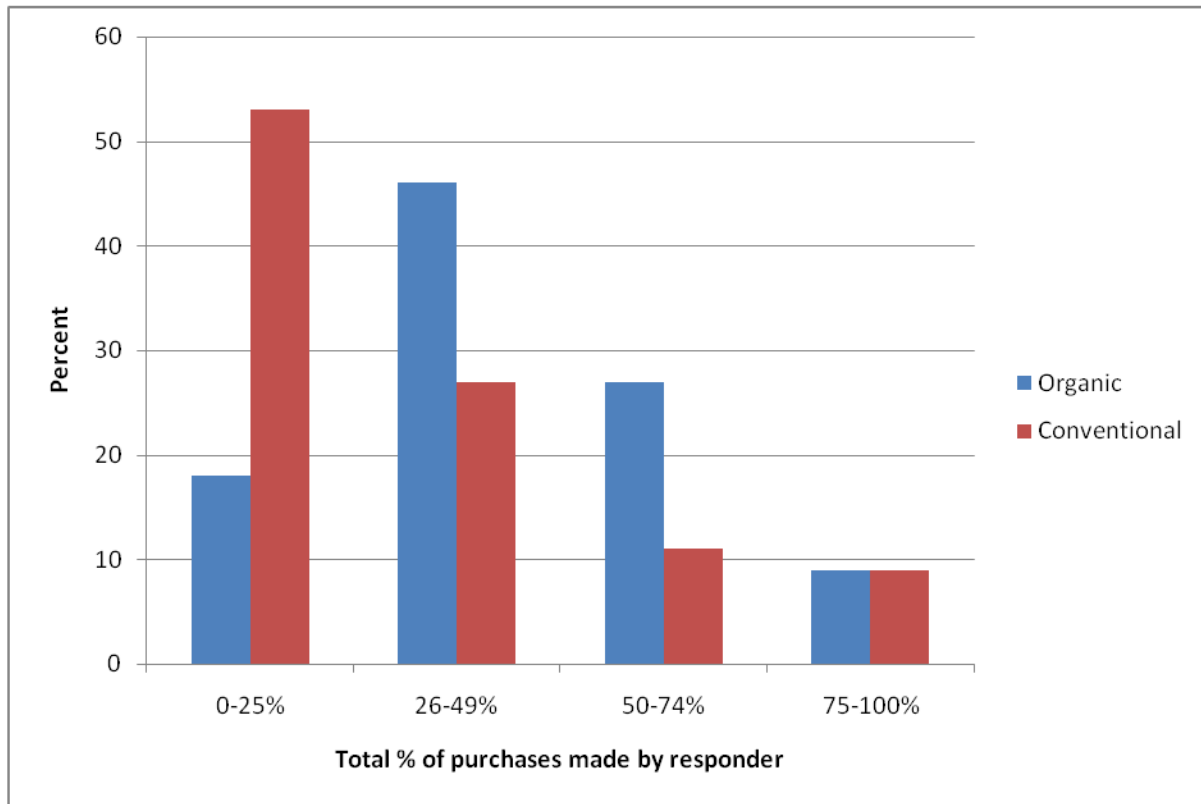


Figure 3. Percent of household purchasing made by Virginia Master Gardeners which consist of organic or conventional fresh fruits and vegetables.



Appendix #1:

There were some questions that were asked which we felt didn't really fit into the report as it is written:

Results:

When asked what makes vegetables and fruit healthy; 82% of MG's answered vitamins, 11% chose appearance and color, while 31% responded other (Table 1). When questioned as to what makes fruits and vegetables safe: 73% of MG's responded post harvesting handling, 67% pre-harvesting handling, and 62% listed VA Cooperative Extension Gardening practices, 20% answered FDA/USDA (Table 2).

Eighty-seven percent of Master Gardeners reported that they followed USDA/FDA recommendations by washing the exterior of all fruits and vegetables before consuming (Figure 1). Sixty seven percent reported washing all bagged fruits and vegetables, which in some cases is an additional step in assuring food safety and in most cases is not recommended by the manufacturers (Figure 1). Many consumers do not realize the potential for bacterial contamination from the non-edible portion of produce such as melon rinds. MG's were questioned as to the frequency of washing the exterior of melons prior to consuming. Only 51% reported washing the exterior of all melons (Figure 1) which is slightly lower than the responses of a national survey which reported, 57% of respondents who washing the outside of cantaloupes before cutting and eating (Amy Lando, Linda Virrill 2006).

Table 1. Master Gardener's perception of what makes fruits and vegetables healthy?

Vitamin Content	82%
Pesticides	0%
Appearance/color	11%
Flavor	9%
None of these	11%
Other	31%

Table 2. Master Gardener's perception of what makes fruits and vegetables safe?

VCE gardening practices	62%
Pre-harvesting practices	67%
Post harvesting practices	73%
Appearance /flavor	2%
FDA/USDA	20%
Vitamin Content	7%
Pesticides	2%
None of these	4%
Other	13%

Figure 1. Virginia Master Gardeners Food Safety Practices- Frequency of Washing: 1) the exteriors of fruits and vegetables, 2) exterior of melons, 3) bagged produce.

