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Value-added Vegetable Cultivars: An Assessment of Farmers' Perceptions

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Summary. **Fresh-market vegetable production in the midwestern U.S. has been declining due to diminished returns received by farmers, competition from vegetables produced in other regions, older farmers retiring and not being replaced, and urban sprawl. To reverse this trend, midwestern-U.S. vegetable farmers must find ways to enhance the value of their production. One way might be the production of vegetable cultivars that have enhanced attributes desired by consumers. Our objective was to assess how Illinois farmers' current perceptions may affect acceptance and production of vegetable cultivars with enhanced health benefits. About 20% of Illinois fresh-market vegetable growers were surveyed. We found that the current media attention on genetically modified organisms (GMOs) influenced grower response. Farmers who were concerned about GMOs were 5 times more likely to reject growing new vegetable cultivars with enhanced health benefits even those developed with conventional breeding methods. However, farmers who were not concerned or who were undecided in their opinions concerning GMOs were 11 times more likely to adopt new cultivars. Education and research programs must be developed to supply information about vegetable cultivars with enhanced health benefits and to address farmers' concerns about GMOs.**

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Historical data from the agricultural censuses have shown a decline in midwestern-U.S. fresh-market vegetable production (USDA, 1997). Several factors explain the decline. Midwestern-U.S. vegetable farmers have faced higher costs, especially for labor, and diminished returns for their crops. Competition has been intense from vegetables sold by major supermarket chains, which are largely grown in California, Florida, and Mexico (DeLind, 2000). Increased urbanization has caused a decrease in vegetable acreage and the number of farms in the midwestern U.S. The farm population is aging with the average age (years) of vegetable farmers in their mid-50s (USDA, 1997). Few new people are entering farming to replace retiring farmers. Strategies that enhance the return midwestern-U.S. farmers receive for fresh-market vegetables might foster new farmers and serve to increase vegetable production in the midwestern U.S.

Midwestern-U.S. fresh-market vegetable growers could take advantage of consumer demand for more diverse and locally grown produce. Locally-grown or regionally produced vegetables could be promoted as strengthening the links within the community and supporting local farmers (Hinrichs, 2000; Miller and Kean, 1997; Sommer et al., 1982). Farmers could further enhance the value of their vegetables by growing organic or reduced-pesticide vegetables, providing part of the processing on-farm, using improved and/or innovative marketing methods, or growing and marketing cultivars with special qualities (such as unique flavor characteristics or high levels of health inducing compounds such as antioxidants) (Eilks and Goldsmith, 2001; Jolly and Norris, 1991).

Many fruit and vegetables contain beneficial, biologically active compounds that have activity as antioxidants and can prevent chronic human diseases (Scheerens, 2001). Glucosinolates in brassicas such as broccoli (*Brassica oleracea* var. *italica*) and carotenoids such as lycopene in tomatoes (*Lycopersicon esculentum*) are two of the more promising groups of secondary metabolites in plants that may prevent a variety of chronic human diseases including some cancers (Cohen et al., 2000; Cook et al., 1999; Hasler, 2001; Wise, 2001). Researchers using conventional breeding methods have been developing specific brassica (*Brassica* spp.) cultivars with higher levels of glucosinolates. These cultivars have potential for promotion as health-enhancing. It is the adoption of these cultivars, developed with conventional breeding methods that this survey studies. Genetically modified organisms are different because the vegetable cultivar is created using genetic engineering techniques and not through conventional breeding.

Glucosinolates in plants also defend against plant-feeding organisms including insects and pathogens, and when brassica plant residues decompose the resulting allelochemicals may reduce weed emergence (Borek et al., 1998; Gardiner et al., 1999; Louda and Mole, 1991). Thus, it may be possible to promote and obtain a premium for glucosinolate-rich cultivars as reducing pests and enhancing consumer health. It

is this promotion and ability to charge a premium that creates a value-added cultivar.

It will be a challenge to develop promotion and/or marketing programs to obtain additional value for vegetable cultivars with enhanced health benefits. These cultivars will only provide an additional value to their producers when they are adequately promoted (Kitzmiller, 2001); therefore, educational and promotional campaigns aimed at consumers will be critical. The success of the process to obtain added-value by promoting the enhanced health benefits of some vegetable cultivars will be affected by diverse factors such as consumer and farmer attitudes, product quality and availability, and marketing channels (Bowman et al., 1998; Shepherd, 1997). Before addressing consumer attitudes, farmers must be convinced to grow valued-added cultivars. Our objective was to assess how Illinois farmers' current perceptions may affect acceptance and production of vegetable cultivars with enhanced health benefits.

Materials and methods

This descriptive survey research tool was adapted from methodologies developed in a previous study used to assess the Illinois vegetable industry (Drury, 1994). A written survey containing 21 questions was developed, reviewed by the Univ. of Illinois Survey Research Laboratory and modified accordingly. Most of the survey questions were written in either a binomial or multiple selection format. An introductory paragraph was included in the survey to help the farmers define the term valued-added and to avoid any potential confusion about plant breeding methods used to develop the cultivars. The introductory paragraph explained that the new vegetable cultivars referred to in this survey were not produced through genetic engineering techniques. The value-added vegetable cultivars were defined as vegetable cultivars with high levels of naturally occurring beneficial compounds that might reduce pesticide use and provide a price premium while providing health benefits for consumers.

The survey was conducted between January and April 2001 at three annual meetings for Illinois fruit and vegetable growers: the Illinois Specialty Growers Conference (Champaign), the Horseradish Growers School (Collinsville), and the Southern Illinois Vegetable Growers meeting (Mount Vernon). Meeting attendees who were willing to participate in this study completed the survey on-site or returned it by mail. In addition, copies of the same survey were mailed in April 2001 to select vegetable growers who did not attend these meetings in order to ensure that the results were representative of Illinois vegetable farmers and to increase the proportion of the industry included in the survey. Farmers included in the mail survey were selected from a mailing list developed by staff of the Univ. of Illinois Department of Natural Resources and Environmental Sciences from attendee lists at recent Extension meetings. It is estimated that there are between 400 to 500 commercial vegetable growers in Illinois (USDA, 1997).

Demographic questions included farm location, how the produce was sold, crop mix, and years growing vegetables. The core questions asked the farmers about their knowledge of value-added vegetable cultivars, as well as the production and marketing issues they would consider in deciding whether to grow any new value-added vegetable crops.

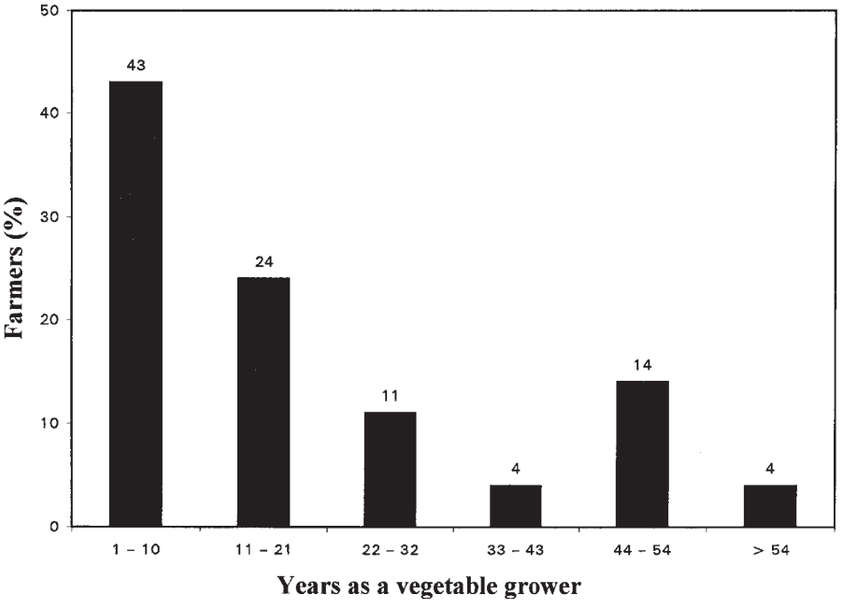
Only completed surveys were included in the final data processing and analysis; incomplete surveys were eliminated. A survey was considered incomplete if more than 5 questions were not answered. Surveys were also discarded if completed by a non-Illinois farmer. The survey predominately included farmers growing vegetables for fresh market, and it was biased toward growers attending Univ. of Illinois Extension-sponsored meetings.

The survey data were analyzed using the SPSS 10.0 (SPSS, Inc., Chicago) statistical software. The question asking the farmers about their willingness to grow new vegetable cultivars was chosen as the predictor variable because it is the best indicator of farmers' receptiveness to the new non-GMO vegetable cultivars. The predictor variable had to be re-coded in order to use the statistical software's logistic regression option. The "no" and "don't know" responses were coded 2 and the "yes" responses were coded 3. A logistic regression model was developed to predict the trend of the predictor variable. The binomial format of the questions dictated the use of this modeling option (Berenson and Levine, 1996). The general model was

$$\log [p/(1 - p)] = C + \beta_1 X_1 + \beta_2 X_2 \qquad [1]$$

where, $[p/(1 - p)]$ = probability of farmers adopting a new vegetable cultivar (predictor variable); C = intercept; β = coefficient of variation in X; X_1 = probability that lack of farmer concerns or undecidedness about GMOs affect the predictor variable; and X_2 = probability that farmer concerns about GMOs affect the predictor variable. Additional descriptors (percentages and frequencies) were calculated for

Fig. 1. The number of years that the farmers had been growing vegetables. There were a total of 80 usable responses.



all the answers to give a general view of the survey responses.

Results and discussion

In total, 93 surveys were completed, yielding 80 surveys (completed and from Illinois farmers) that were included in the data analysis. Seventy-six surveys were completed at grower meetings and 17 received by mail (27% response rate for mail survey). This represents about 20% of the 400 to 500 Illinois vegetable farmers. Farmers from fifty different counties throughout the state responded to the survey. The farmers grew a wide range of vegetable crops including sweet corn (*Zea mays*) (69% of respondents), peppers (*Capsicum* spp.) (81%), tomatoes (81%) and cabbage (*Brassica oleracea* var. *capitata*) (51%).

Many farmers (41%) in this survey had been producing vegetables for less than 10 years, and only 3% had been producing vegetables for more than 55 years (Fig. 1). The average number of years that the respondents to this survey had been growing vegetables was 28 years and the medium 15 years. In a previous survey, Illinois farmers had a mean of 17.6 years marketing vegetables, and the more recent commercial growers were not as big a proportion of the respondents (Drury, 1994). The difference between the surveys may be a result of this survey being administered at extension meetings, which may have attracted younger vegetable growers.

Fifty-one percent of the respondents marketed their produce at farmers' markets and 62% marketed vegetables at roadside stands (Table 1). Thus, most of the respondents' produce was destined for fresh market consumption. The importance of farmers' markets probably reflects the increasing desire of consumers to purchase locally grown, fresh, favorable produce at low prices (Hinrichs, 2000; Sommer et al., 1982; USDA, 1999). U-pick operations (18%) and direct marketing to supermarkets or restaurants (19%) were less common. Direct marketing to supermarkets could be difficult for small-scale farmers in the midwestern U.S.; a previous study showed that contractual provisions (e.g., insurance) and inability to produce adequate supplies to meet the demand could limit local food buying by supermarkets (Enshayan, 2001).

A number of the responses to questions indicated a need for educational programs on health-enhanced cultivars and the process of added-value. For example, the respondents' knowledge about value-added vegetable cultivars was limited. Only 31% of the farmers purposely grew value-added vegetable cultivars, yet 54% of the respondents were aware of the health benefits of vegetables. When yields were similar, farmers were only willing to grow new cultivars if they had excellent qualities and a reliable market (Table 2). About two-thirds of the farmers also desired a premium price. Seventy-six percent of farmers were interested in growing vegetable cultivars that reduce pesticide use. Thus, it may be possible to promote consumer acceptance of vegetable cultivars that contain health benefitting compounds, by tying promotion of these new cultivars to reduced pesticide use. Organic and reduced-pesticide vegetables are two of the most rapidly increasing areas of consumer demand, yet only 2% to 5% of Illinois growers are producing vegetables organically (DeLind, 2000; Jolly and Norris, 1991).

A logistical model was developed using response to "willingness to grow new vegetable cultivars" as the predictor variable. The willingness to grow new vegetables cultivars was not affected by number of years growing vegetables, marketing methods, location of farm, crops grown, knowledge about valued-added vegetables, field practices, and cultivar hardiness. Thus, for example, persons growing vegetables for less than 10 years were as likely to adopt new cultivars as persons growing vegetables for more than 40 years.

The only variable that had any predictive power was the concern about GMOs . This is another indication of the need for grower education because we clearly indicated that the vegetable cultivars referred to in the survey were not produced using genetic engineering techniques. Forty-eight percent of the farmers indicated they were concerned about GMOs. Another 29% were not concerned about GMOs, 17% were undecided, and 6% did not answer the question about GMOs. The odds ratios of the logistic model were for growers without concerns about GMOs and those willing to adopt new cultivars:

$$\log [p/(1-p)]_{(no)} = 0.693 + 2.40\ X_1 \quad [2]$$

$X_1 = 1$ if willing to adopt new cultivars or 0 if not willing, odds ratio = $e \bullet \beta(X_{no} - X_{yes}) = 11$.

For growers with concerns about GMOs and not willing to adopt new cultivars:

$$\log [p/(1-p)]_{(no)} = 0.693 + 1.61\ X_2 \quad [3]$$

$X_2 = 1$ if not willing to adopt new cultivars or 0 if willing, odds ratio = $e \bullet \beta(X_{no} - X_{yes}) = 5$.

These odds ratios indicate that farmers who said that they were not concerned or who were undecided in their opinions concerning GMOs were 11 times more likely to adopt new cultivars. Farmers who were concerned about GMOs were 5 times more likely to reject growing new cultivars, even if they are non-GMO cultivars.

Table 1. Marketing methods used by Illinois vegetable growers.[z]

Marketing method	Proportion (%)[y]
Roadside stands	62[x]
Farmers' markets	51
Directly to supermarkets and restaurants	19
U-pick	18
Through brokers	9
Under contract to a processor	6
Community-supported agriculture	5

[z]Marketing methods used by less than 5% of the respondents: wholesale, pre-paid orders, personal orders, roadside stands owned by others, and food cooperatives.
[y]There were 80 usable responses.
[x]Growers may use more than one marketing method.

Table 2. Reasons that vegetable farmers will grow a new, health-enhanced vegetable cultivar, assuming that the new cultivar has similar yields as the current cultivars.

Reason	Proportion (%)[z]
Has excellent qualities	76
Reduces pesticide use	76
There is a good reliable market	74
Provides premium price	68
Does not complicate usual field practices	51

[z]There were 80 usable responses. Growers may have more than one reason.

From their comments, farmers who indicated they had concerns about GMOs did not mention either marketing or lack of consumer acceptance. Farmers who were concerned about this technology had questions mainly about GMOs effects on consumer health (30% of the respondents) and on the environment (55% of the respondents)—issues for which there is a diversity of opinion in the scientific and popular press (Ervin et al., 2000; Fernandez-Cornejo and McBride, 2002). At the time this study was conducted there were many stories in the media about the acceptance of GMOs in the market and their effects on the environment, in particular as a result of the StarLink corn incident (Barbazo, 2000; Linn et al., 2001). These factors may have influenced the farmers' opinions. Future research is planned to determine if grower concern about GMOs persists and do define the factors influencing that concern. Education and research programs must be developed to supply information about these cultivars and to address farmers' concerns about GMOs.

To take full advantage of the potential of these new cultivars, marketing and production programs for value-added crops must also be developed because farmers participating in our survey had only limited knowledge about value-added vegetable cultivars. Only 31% purposely grew value-added vegetable cultivars, yet 54% were aware of the health benefits of vegetables. Nearly one quarter of the farmers indicated a need for additional information about marketing value-added vegetable crops. These results suggest that vegetable farmers need more up-to-date information about new vegetable cultivars with health benefits and about creating value in the marketing of fresh vegetables (Kitzmiller, 2001).

The dominant markets among respondents - direct sales of vegetables to consumers (e.g., farm stands, farmers' markets, and roadside stands) - will be where acceptance of value-added cultivars will be determined. Few of the participating growers sell to health food stores, so if cultivars with health benefits are to have an impact they must be promoted to consumers purchasing vegetables directly from growers. Promotion and marketing strategies for cultivars with potential health benefits for consumers will require additional organizational and institutional support by extension and other federal and state agencies to educate farmers and consumers.

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