STUDENT RESEARCH REPORT – REEU PROGRAM 2023

Surveying Farmers Perspectives on Integrated Pest Management strategies in Massachusetts

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Abstract

Introduction

Out of a total 7,755 farms in Massachusetts 2,651 are dedicated vegetable, berry, and fruit cultivars generating over $230 million annually in sales (Massachusetts IPM Report, 2019). To maximize their yield of marketable fruits (and, therefore, profit) farmers must rely on effective pest management strategies. In Massachusetts, 94.2% of all farms are under 5 acres, and family or individually owned farms constitute 79.7% . The state is 5th in the country for direct market sales, surpassing $100 million. Additionally, it held the 3rd spot nationally for direct market sales per farm at $55,384 in 2017 (2017 USDA Census of Agriculture; U.S. Census Bureau). Massachusetts farmers combat a large range of pests including weeds, diseases, insects, rodents and nematodes, therefore a variety of pest management practices are adopted by fruit growers. One popular adopted strategy is Integrated Pest Management (IPM).

IPM is a holistic and environmental approach to managing pests in agriculture. It is difficult to define IPM (Sandler, 2010) but most researchers agree that this practice is based on ecological principles and informed by biological knowledge rather than relying on pesticide controls to address economic pest infestations (Sandler, 2010). By employing a combination of strategies, this approach seeks to achieve lasting and sustainable pest control outcomes. Strategies include accurate pest identification, knowledge of biology and life cycle, scouting, monitoring, use of action thresholds, cultural controls, mechanical and physical controls, genetic controls, biological controls, pesticides and record keeping for weather, pest populations, crop conditions and control procedures (UMass). A major component of IPM includes the use of economic or treatment thresholds which ensures application of pesticides and other treatments are strategic and necessary based on specific criteria (Ehler et al. 2006). Surveillance of pests is an essential aspect of IPM when employing economic and treatment thresholds, so the farmer

can apply the practice strategically. Lastly, the core aspect of IPM is the implementation of multiple practices to combat pests effectively (Ehler et al. 2006). IPM is important as it limits the use of traditional pesticides which frequently harms not only pests but natural predators. Regular pesticide use fosters resistance in both the intended and unintended targets over time, while polluting soil and water (Prokopy). To approach this issue, IPM was developed to reduce pesticide usage by employing techniques such as cultivating pest-resistant crops, practicing crop rotation, trap cropping, using bio-insecticides, releasing sterile insects, and employing other methods (Food and Agriculture Organization, 2002; Prokopy & Kogan, 2009). The word 'integrated' means combining natural enemies with pests when making decisions and using methods that work well together without causing problems for beneficials (Ehler et al. 2006).

In the United States, Integrated Pest Management (IPM) received attention during the Nixon and Carter Administrations but it wasn't until 1992 that a nationwide emphasis on IPM implementation emerged. The National IPM Forum consisted of 600 professionals including scientists, growers, educators, regulators, food processors, marketers, agribusinesses who advocated for governmental leadership in IPM. This caused the U.S. Department of Agriculture (USDA), Environmental Protection Agency, and Food and Drug Administration to aim for IPM integration across seventy-five percent of the country's cultivated crop lands by the year 2000 (Puente et al. 2013). In 2001, the U.S. The Government Accountability Office published a report about IPM programs revealing that around 70% of U.S. crop areas were using some form of IPM (Faraar et al. 2016) . The American Cooperative Extension service (CES) played an essential role in advocating and educating farmers, industries, and corporations in the United States in the early stages of IPM advocacy. CES is a government funded program that in the 1970 conducted large scale demonstrations structured as pilot programs. The demonstrations exhibited benefits derived from scouting for infestations as a basis for decisions on pesticide application and the use of economic thresholds. The federal government provided funds to pay for IPM CES specialists, but funding for this program would only continue if there was greater support for IPM from farmers. The success of the scouting program provided an opportunity for a new profession in agriculture; the private consultant. IPM later evolved to include all strategies to combat all pest infestations advocating for an integrated approach of multiple strategies for pest management and research combining all phases of program development, implementation, and evaluation (Marcos et al. 1998).

UMass Amherst is a land grant institution, a part of the public extension system funded by the United States government. The UMass IPM program was first initiated in 1978, and has played a crucial role in research based outreach education focused on integrated pest management for farmers, industries, and communities in Massachusetts and New England. UMass Extension offers region wide educational demonstration, and research for producers of vegetables, fruits, landscape turfs, and greenhouse growers. Additionally, UMass extension faculty are expected to foster and maintain strong relationships, and modes of communications through meetings with advisory committees and direct contact with farmers. Advisory committees are composed of a diverse group of industry, IPM consultants, and advocates.

Furthermore, Advisory committees actively participate in identifying research and extension requirements, contributing to a crucial 'feedback loop' that assesses feasibility. (UMass). UMass extension attends growers association meetings, and twilight meetings, both organized by growers in order to disburse and provide information on new and existing IPM practices. Funding for UMass IPM is obtained through a grant opportunity provided by the United States Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) UMass Amherst Extension has regional and federal partners that provide additional resources for farmers. Federal partners include the Center for Disease Control (CDC), Environmental Protection Agency (EPA), National Site for the USDA Regional IPM Centers Information System, and the USDA National Institute of Food and Agriculture. Regional partners include Massachusetts Department of Agricultural Resources (MDAR), The Natural Resources Conservation Service (NRCS) and the Northeast IPM Center. Additionally, farmers can participate in Regional Commodity Groups. UMass Extension collaborates with regional commodity groups (New England Vegetable and Berry Growers Association and the Massachusetts Fruit Growers Association), who also provide excellent resources for growers and other professionals (UMass Amherst).

In order for UMass Amherst to have an evolving and influential IPM program, professionals deploy surveys in order to gather farmers' information on Integrated Pest Management. The most recently deployed survey at UMass Amherst was published in 2021 titled *Stakeholder-Identified Priorities for Massachusetts Specialty Crop IPM 2019-2020* conducted by (Sandler et al. 2019). The survey was conducted to identify research priorities, educational priorities, and expertise priorities among growers in the region. Additionally, the survey garnered information on improving IPM practices, demonstrating new practices, and overall growers support on certain IPM issues. Because IPM is an evolving pest management practice, information on growers is necessary in order to assess changes and needs.

We conducted a survey in the summer of 2023 in order to gather perspectives on Integrated Pest Management and to act as a pilot for a broader comprehensive survey concerning IPM in New England. The IPM survey is intended to (1) evaluate farmers' attitudes towards pest management innovation and implementation (2) assess educational and support needs (3) identify challenges and opportunities, and (4) examine the economic implications of IPM adoptions. We hypothesize farmers in Massachusetts and New England have a positive outlook on Integrated Pest Management (IPM) strategies proposed by Universities, recognizing their benefits in terms of sustainable pest control, environmental benefits, and economic viability.

Materials and Methods

The IPM survey was influenced by a previous study conducted by (Piñero et al. 2018) titled "Farming Practices, Knowledge, and Utilization of Integrated Pest Management by Commercial Fruit and Vegetable Producers in Missouri." Both surveys share a common objective of exploring farmers' practices, challenges, and needs concerning Integrated Pest Management (IPM) and contribute to the greater understanding of IPM practices and their impact on fruit producers. A

first draft of the survey was created and developed; the objective was to gather feedback for revisions for a simple survey that would be presented at the Massachusetts Fruit Growers Association meeting on July 12th, 2023. A first draft of the survey was distributed solely for feedback and revision purposes at an extension meeting between University of New Hampshire and UMass Amherst extension programs at Poverty Lane Orchard. In attendance were University of New Hampshire and UMass Amherst IPM specialists, IPM consultants, University of New Hampshire and UMass Amherst extension professionals, apple grower John Green, and farmer Steve Wood.

The paper survey was distributed to farmers at the Massachusetts Fruit Growers Association meeting on July 12th, 2023, held at Honey Pot Hill farm (Stow, MA). Forty-eight responses were received.

Survey Design and Content

The survey consists of a total of 13 questions. This includes one question asking the approximate size of their farm, four questions that involve selecting all that apply, and eight questions presented in a Likert scale format. Google Forms was used to create the survey. All participants received a paper copy of the survey and completed the survey on July 12th where their responses were collected and digitized. Once the survey data entry was completed data analyses and graphs were produced using Microsoft Excel, Microsoft Word (Microsoft Excel for Microsoft 365 Version 2206) and Statistica.

Results

Farm Size Results

A majority, 58% (28 participants) of the respondents, own farms spanning over 51 acres. Following, 31% (15 participants) represented the second largest group, owning farms between 21 to 50 acres. Additionally, 8% (4 participants) of the respondents own farms ranging from 11 to 20 acres. Meanwhile, we received one response from an individual who owned a farm spanning 5 to 10 acres.

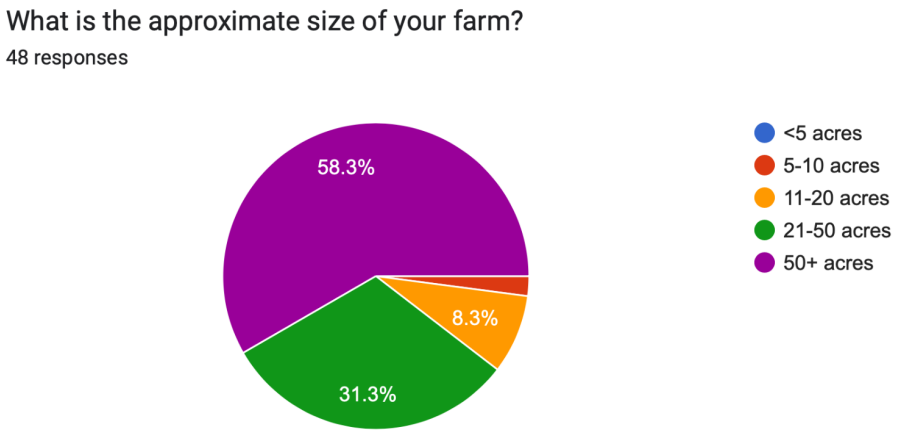
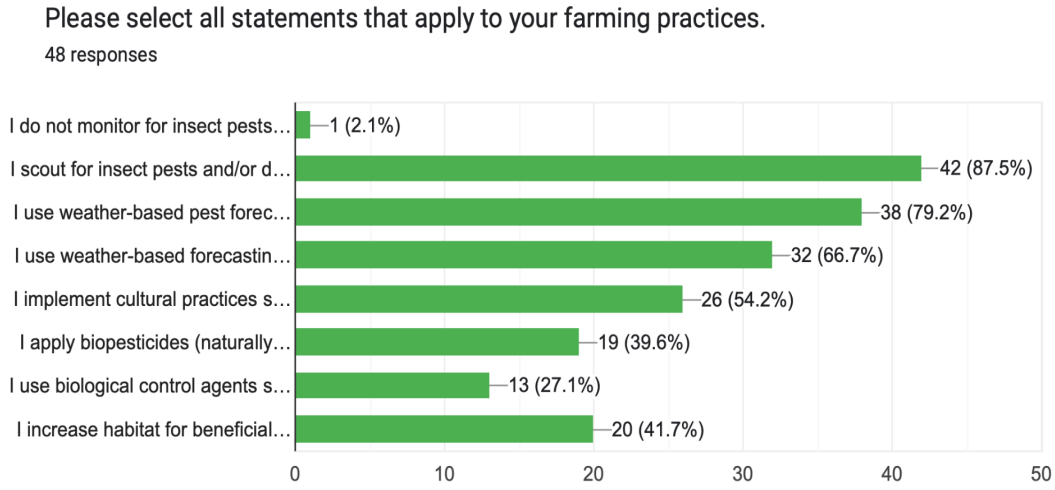


Fig. 1

Levels of IPM Implementation

In our conducted survey we gathered information in order to gauge IPM level among farmers based on a systematic rating approach. We asked farmers to select all the statements aligning with their farming practices to earn a No IPM, Low IPM, Medium IPM or High IPM rating. Farmers can earn a score from 0-12 based on their selection of practices. According to our results 36% (17) of respondents implement Low IPM, who scored three or less based on our rating scale. 19% (8) of the respondents who implement Medium IPM, earned a score between 4-7. Finally, 44% (21) of respondents selected practices to earn an IPM score between 8-12, falling in the high IPM category.



(Figure 2)

High IPM group

Farmers who implement High Integrated Pest Management (IPM) practices have an average farm size of 45 acres. Among the 21 respondents who implement High IPM, 14 of them own farms 51 acres or more, while the remaining seven respondents manage farms ranging from 25 to 50 acres. Those who implement High IPM, are inclined to adopt a new IPM practice earning an average rating of 3.8 out of 5. These farmers expressed a strong level of confidence in the effectiveness of their practices receiving an average of (4.0). Additionally they hold the average of 4.38 regarding the impact of pest management practices on their farm's profitability over the last five years. In terms of financial sustainability, the average level of confidence (3.76) expresses a moderate level of confidence in the long term financial sustainability. Similarly, their average confidence in long-term environmental sustainability stands at 3.71. Farmers who implement high IPM believe they are informed on receiving the latest news and research for IPM earning a 4.14 average rating. On average High IPM farmers engage with research and extension events indicating a participation average of 3.69. Lastly, this group believes there is an impact of extension events on farm pest management practices, receiving an average score of 3.83.

Medium IPM group

The average farm size for farmers who implement medium integrated pest management (IPM) is approximately 30 acres. Those who implement Medium IPM are smaller farms compared to higher IPM and lower IPM levels. Out of nine respondents, two farms exceed 51 acres, while four farms are between 21-50 acres. Additionally two participants own farms approximately 11-20 acres, and one respondent owns a farm 5-10 acres. Regarding this group's openness to adopting new IPM strategies, they have an average rating of 3.77. Their confidence level in the effectiveness of their existing pest management practices is an average score of 3.88. This group holds an average belief of 3.3 regarding the impact of their farms profitability based on their pest management practices. Their confidence in the long-term financial sustainability of their pest management strategies is an average of 3.44. Additionally, this group holds an average confidence level of (3.66) in terms of their beliefs behind environmental sustainability of their management strategies. Staying informed with the latest research on pest management receives an average score of 3.77. In terms of engagement, this group has an average attendance and participation level of 3.3125 in research and Extension events within a given year. This group attributes a higher average impact rating of 4.125 to Extension farm pest management practices.

Low IPM group

Those who Implement low IPM have an average farm size of approximately 41 acres. Out of the 17 respondents who fall into this category 10 have reported owning a farm 50+ acres, and five

reported owning a farm 25-50 acres. The two remaining respondents both reported possessing a farm size of approximately 15 and 7.5 acres. The likelihood of low IPM farmers adopting a new IPM strategy is an average of 3.5. Additionally the level of confidence in the effectiveness of current pest management practices, is an average of 4.375. This group believes their pest management practices contribute to their farm's profitability in the last 5 years with an average of 4.25. Additionally, the low IPM group is fairly confident in their pest management strategies being financially sustainable in the long term with a 3.8125 average. In terms of pest management strategies being environmentally sustainable this group has an average of 3.65 indicating they are the least confident group but variation is minimal. Low IPM farmers are the most confident that they are receiving the latest research earning an average of 4.1875. Low IPM farmers are the least likely to attend extension events with an average of 3.4 events in a given year. The impact of these events on this group's management practices is a 3.6875 average.

What Incentivises farmers to Implement IPM?

We asked farmers ``What contributes to your decision to adopt a new pest management strategy? Please select all that apply''. Farmers were able to select Financial Incentives, Product Marketability, Environmental Concerns, Human Health Concerns, Peer pressure and Community Pressure. We received 20 responses from the high IPM group, 8 responses from the Medium IPM group, and 13 responses for the low IPM group.

High IPM: Out of 20 responses, a majority of 14 farmers (70%) selected the significance of financial incentives. The greatest incentive for farmers in this group is environmental concerns with 15 farmers (75%) selecting this option. Human health concerns ranked as a third greatest incentive, with 13 farmers (65%). Surprisingly, no farmer in this group felt influenced by peer pressure. Community pressure, while not the primary incentive for this group, was selected by 3 farmers (15%). Product marketability was selected by 10 farmers (50%).

Medium IPM: Out of 8 responses, financial incentives were selected by all farmers (8 responses, 100%). Following closely, environmental concerns and human health concerns were selected by 7 farmers (87.5%). Interestingly, none of the farmers selected peer pressure, showing that social influence from peer farmers is not a factor when deciding to implement IPM. Community pressure was selected by 1 farmer (12.5%) and Product marketability was selected by 4 farmers (50%).

Low IPM: Out of 13 responses, the greatest factor for adopting a new IPM practice was financial incentives being selected by 9 farmers (52.94%). Equally as important as financial incentives, product marketability also received the same number of selections (9 responses (52.94%)). Environmental concerns and human health concerns received a considerable number of selections (7 responses (41.18%)). Both “Peer and Community Pressure and Community Pressures' 'were selected by individual farmers. This suggests peer pressure and community

pressures are not a major factor to most when discussing adopting IPM for this group (1 response 5.88%).

What Limits farmers from implementing IPM?

We asked farmers “What are the main factors preventing you from implementing additional pest management at your farm? Please check all that apply.” Farmers were able to select “It is more expensive than my current management practices, The research that was done does not fit my operation, It is too time consuming, It would require me to fundamentally change how I run my farm (e.g. changes in personnel, schedule, budget, etc,), Concerns about scalability of IPM strategy and All of the above. For this question we received 10 answers from the low IPM group, 5 answers from the Medium IPM group, and 16 answers from the high IPM group.

High IPM: Out of 16 responses, the majority of farmers (10, 62.5%) selected cost as a factor for limiting the further implementation of IPM practices. (3, 18.75%) selected research as a factor. Approximately one-third of farmers (6, 37.5%) selected time-consuming as a barrier. Similar to “time consuming", another (6, 37.5%) of farmers selected that the need for fundamental changes to their farm practices is a limiting factor. For this group, no respondents mentioned scalability. One farmer (6.25%) selected "all of the above," indicating all possible selections (expensive, research, time consuming, fundamental changes) all contribute to their decision-making when implementing IPM. A portion of respondents (18.75%) selected "other,"meaning additional factors not provided in this selection limit IPM implementation.

Medium IPM: out of 5 responses, a majority of farmers in the Medium IPM group (60%) selected “it is more expensive than my current pest management practices” highlighting the financial concern many farmers have when considering adopting new IPM practices. Additionally, the biggest limitation identified by this group is time consumption with 80% of farmers selecting this option. One farmer (20%) mentioned that the research doesn't align with their specific farming operation. Furthermore, one farmer (20%) selected that the need for fundamental changes to their farm practices is a limiting factor in implementing further IPM. One farmer (20%) mentioned scalability as a limitation and one farmer selected All of the Above: suggesting that multiple factors provided (expensive, time-consuming, research fit, scalability, fundamental changes) are contributing to their decision in adopting further IPM practices.

Low IPM: out of 10 responses, the most selected limitation was cost, where we received 5 selections (50%) implying half of low IPM farmers believe that the financial investment required for implementing IPM is a barrier. Interestingly, none of the respondents mentioned research as a limitation. Three respondents selected time consuming as a barrier for implementing further IPM practices (30%). A small portion of respondents (20%) selected fundamental changes to their farming operations as a limiting factor in order to adopt further IPM. Farms who implement low

IPM are concerned about the applicability of research with five respondents, 50% selecting scalability.

What practices have farmers adopted in the last five years to combat pests?

We asked farmers "In the last five years, have you adopted a new pest management strategy? If yes, what pest did it combat? Please select all that apply." Farmers had the options to select, "I did not implement a new pest management strategy in the last five years", "Diseases", "insects", and "weeds". For this question we received 14 responses from the low IPM group, 8 responses from the middle IPM group, and 21 for the high IPM group.

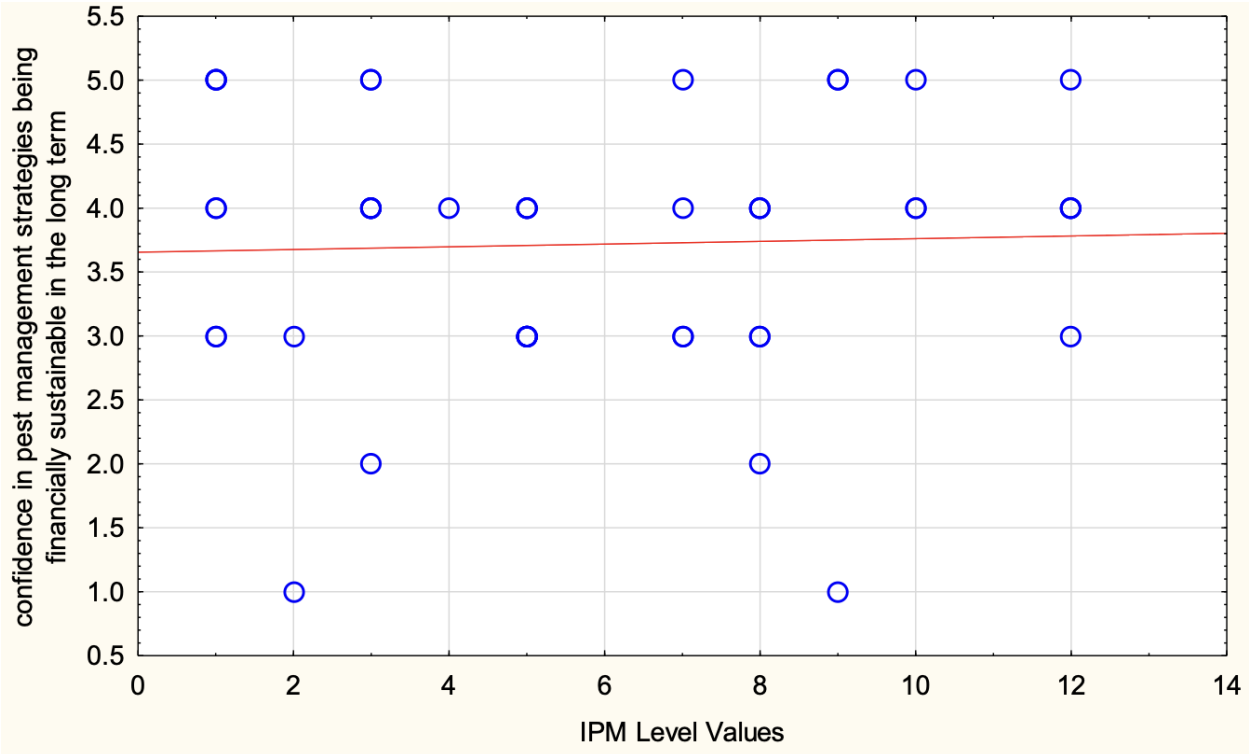
High IPM: For the responses received by the 21 farmers in the high IPM group, it was found that 24% (5 farmers) did not implement any new IPM practices in the last five years. An equal number of farmers (24%, 5 farmers) adopted new practices to combat a single pest, while 29% (6 farmers) adopted strategies combating two pests, and 19% (4 farmers) combatted three pests in the last five years.

Medium IPM: In the Medium IPM group comprised 8 farmers, 25% (2) did not adopt any new IPM practices over the last five years. Meanwhile, a majority of 63% (5) adopted a single practice to combat a one pest. Additionally, 13% (1) one respondent selected two practices, while none selected three practices.

Low IPM: Among the low IPM group of 14 farmers, 57% (8) did not adopt new IPM practices within the last five years. Of the remaining farmers, 14% (2) adopted a new practice to combat one pest, while 29% (4) adopted strategies to combat three pests. No respondents from this group selected adopted practices targeting 2 pests.

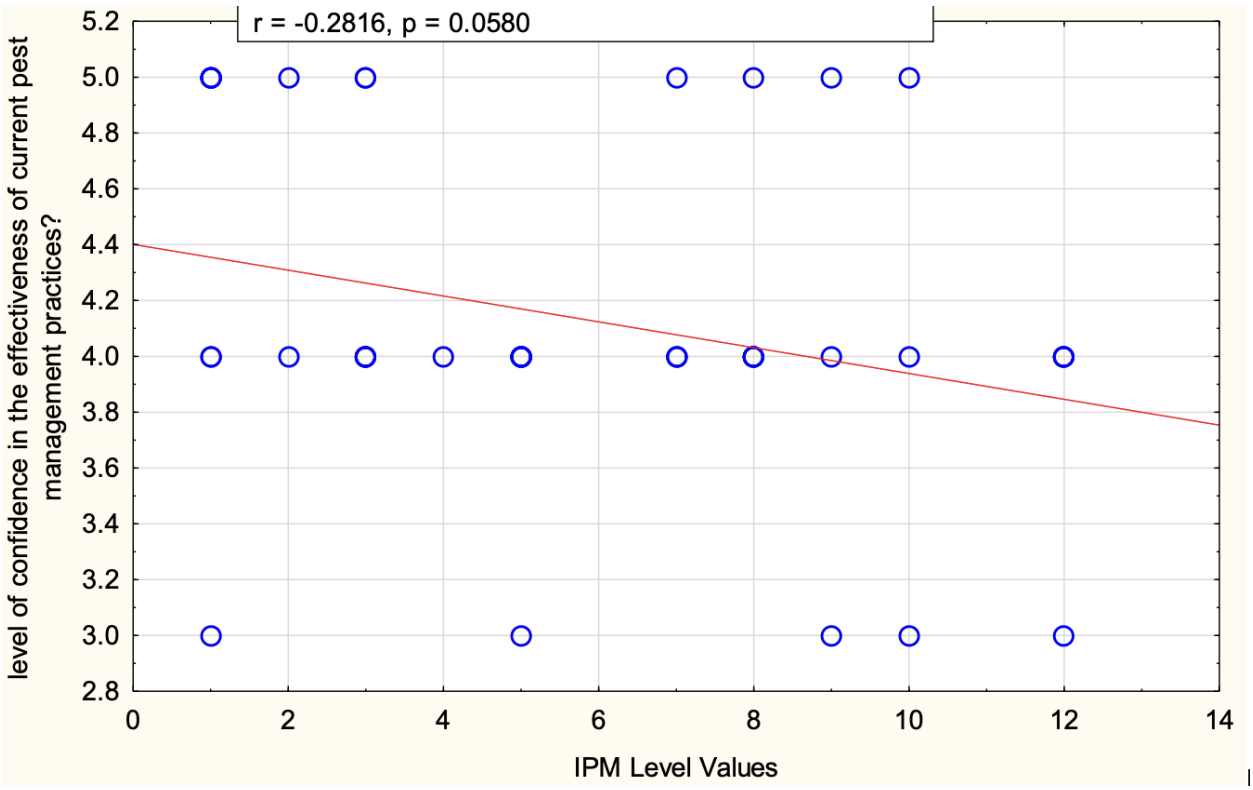
Further Analysis

We compared the answers of farmers to various questions based on their 'IPM level'. For the following results, we analyzed self-reported scores *across* IPM values, instead of across categories of IPM implementation (i.e. Low vs Mid vs High). We observed no statistically relevant trend ($p = 0.8037$) in the relationship between the level of confidence in the financial sustainability of pest management strategies in the long term across IPM values, meaning that farmers employing low levels of IPM (as indicated by the value on the X-axis), rate their confidence in pest management strategies similarly to those implementing high levels of IPM.



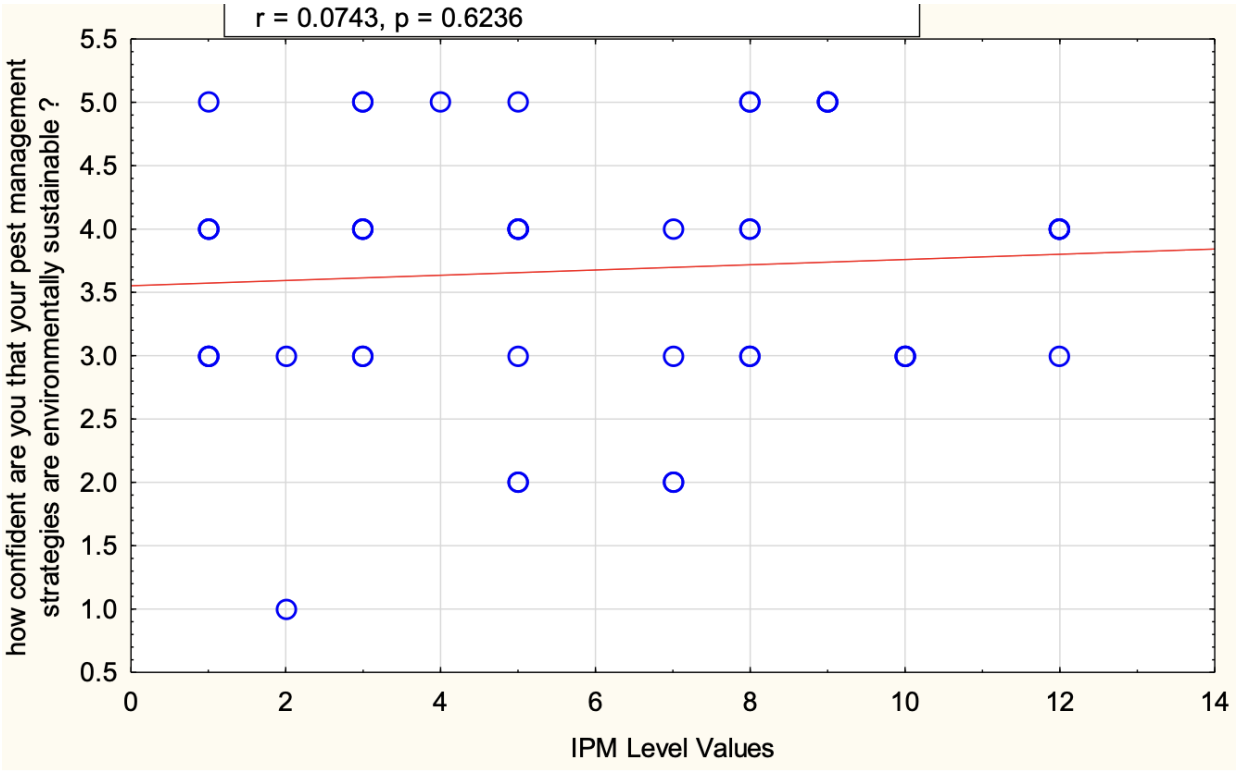
(Figure 3)

The chart below analyzes the level of confidence of the effectiveness of current pest management practices in relation to IPM level values. We observed a statistically relevant trend ($p= 0.0580$) in the relationship between level of confidence of current pest management practices across IPM level values. The data below shows farmers who implement low IPM are more confident in the effectiveness of their pest management practices compared to those who implement high IPM on their farms.



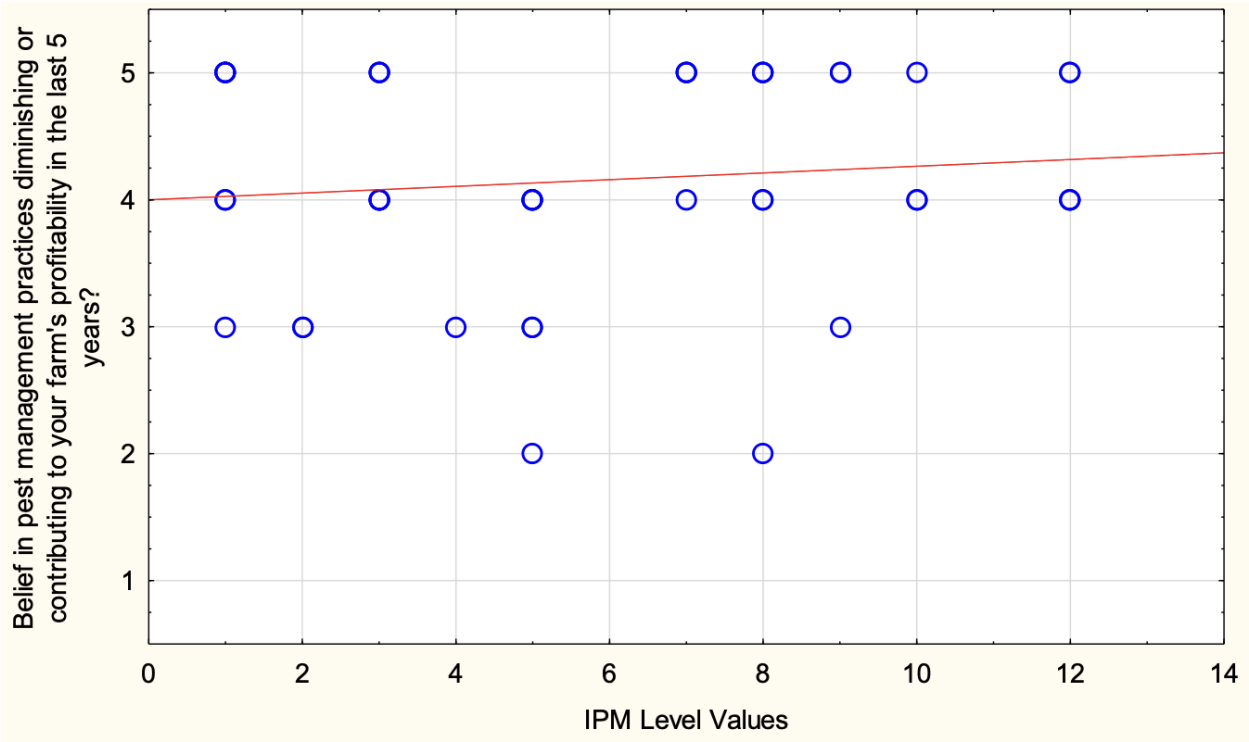
(Figure 4)

The chart below compares confidence of management practices being environmentally sustainable to IPM level values. We observed no statistical relevant trend (p= .6236) in how confident farmers are that their strategies are environmentally sustainable. The data below shows that farmers who implement low IPM are equally as confident in their practices being environmentally sustainable compared to those who implement Medium and high IPM.



(Figure 5)

The chart below analyzes belief in pest management practices diminishing or contributing to farms profitability where 1 is no confidence and 5 is maximum confidence compared to IPM level values. We observed no statistical relevant trend (p= 0.4663) on farmers' beliefs in pest management practices diminishing or contributing to farms profitability in the last 5 years across IPM level values, meaning that farmers implementing low IPM rate their belief in profitability similarly to those who implement Medium and high IPM.



(Figure 6) **r= 0.1114 p= 0.4666**

Discussion

Massachusetts farmers combat a large range of pests including weeds, diseases, insects, rodents and nematodes, therefore a variety of pest management practices are adopted by fruit growers. One popular adopted strategy is Integrated Pest Management (IPM). UMass Amherst extension attends growers association meetings, and twilight meetings, both organized by growers in order to disburse and provide information on new and existing IPM practices. In order for UMass Amherst to have an evolving and influential IPM program, professionals employ surveys in order to gather farmers' information on Integrated Pest Management. UMass Amherst extension is motivated to maintain an influential IPM program that caters to the needs of farmers. The conducted 2023 MFGA annonus survey includes one question asking the approximate size of their farm, four questions that involve selecting all that apply, and eight questions presented in a Likert scale format. We wanted to make the survey anonymous to receive a higher response rate and to receive truthful responses. Although studies have concluded results showed no association between privacy and response rate or survey completeness (Murdoch), due to UMass's close relationship with farmers, we felt our specific situation called for anonymity. During the MFGA meeting, we handed out paper surveys to ensure a high response rate, as distributing them online wasn't feasible and respondents didn't have an alternative way to access an online survey.

The paper survey was a success, but the instructions provided at the meeting were not sufficiently clear. As a result, respondents omitted certain questions since they were unaware that the 3-page survey was printed on both sides. This led to a lower response rate among individual questions and an uneven distribution of responses impacting the reliability of our data. Receiving a high response rate for each individual question is necessary for conducting statistical analysis and comparisons. Our analysis margin of error, which diminishes as the number of responses increases, highlights the importance of obtaining a greater number of responses to increase statistical accuracy. The survey consists of a total of 13 questions. This includes one question asking the approximate size of their farm, four questions involving selecting all that apply, and eight questions presented in a Likert scale format. Literature suggests likert scale format of questions when analyzing data into subgroups (Mircioiu). For this survey our subgroups are Low IPM, Medium IPM and High IPM. In order to gauge IPM level among farmers based on a systematic rating approach, we asked farmers to select all the statements aligning with their farming practices to earn a No IPM, Low IPM, Medium IPM or High IPM rating. Farmers can earn a score from 0-12 based on their selection of practices. Researchers are known to develop a list of IPM practices and sum up adopted practices to calculate an overall adoption score (Punte et al. 2011)but there are variations amongst researchers on how they arrive at their IPM score. This causes a lack of consensus among the research community on a standardized approach on how to develop IPM scores. Our selections were assigned weights directly based on the significance of certain practices, which has occurred in other surveys. Due to lack of consensus, we created our own ranking system to determine and group IPM levels amongst farmers. I hypothesized farmers in Massachusetts and New England have a positive outlook on Integrated Pest Management (IPM) strategies proposed by Universities, recognizing their benefits in terms of sustainable pest control, environmental benefits, and economic viability. Our results conclude this hypothesis to be true. Although IPM levels vary among farmers, all surveyed farmers implement IPM. All three levels of IPM grouped farmers expressed an inclination towards adopting new IPM practices earning an average of above a 3.0 on the likert scale. (Not Finished)

Conclusion

Acknowledgements

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