

USE OF PLASTIC MULCH FILMS IN U.S. STRAWBERRY PRODUCTION



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Results from a Multi-State Survey about U.S. Strawberry Growers' Perceptions and Experiences of Plastic Mulch Films

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INTRODUCTION

Polyethylene (PE) plastic mulch films provide specialty crop growers with many agronomic benefits (e.g., weed management, water conservation, improved crop quality), but the disposal process can be financially and environmentally costly. Biodegradable plastic mulch films, which provide similar agronomic benefits, may be an appealing alternative. Biodegradable plastic mulch films can be tilled into the soil or composted at the end of the growing season, reducing the labor and environmental costs associated with plastic removal and disposal.

To better understand the performance and adoptability of biodegradable plastic mulch films, an interdisciplinary team of researchers at three universities (University of Tennessee, Washington State University, and Montana State University) obtained funding from the United States Department of Agriculture's Specialty Crop Research Initiative (SCRI) program (Grant #2014-51181-22382). The project activities included a survey of U.S. strawberry growers, which was conducted by members of the team's Technology Adoption Working Group.

Strawberry growers, especially those producing berries for the fresh market, often use PE plastic mulch films and, consequently, may be potential early adopters of biodegradable plastic mulch films. Our survey assessed this potential, while also exploring other topics related to the use of plastic mulch films in U.S. strawberry production. The survey included questions about growers' experiences with PE plastic mulch films, opinions about PE plastic mulch films, familiarity and experience with biodegradable plastic mulch films, opinions about biodegradable plastic mulch films, strawberry production and marketing practices, fumigation practices, decision-making and sources of agricultural information, and farm characteristics. The complete survey results are presented in this report.

SURVEY METHODS

Strawberry production involves a variety of markets and production methods, which vary across different regions of the United States. To capture this variety, our study population included growers in six states: California, New York, Oregon, Pennsylvania, Tennessee, and Washington. Most of the grower postal addresses were purchased from Meister Media (n=1,357), a corporation that publishes periodicals on fruit and vegetable production. Because

the Meister Media list included relatively few names in the Pacific Northwest, we decided to supplement the list with addresses from Oregon Tilth (n=40), Oregon Strawberry Commission (n=45), Washington State Department of Agriculture (WSDA) Organic Program (n=78), and Washington Strawberry Commission (n=33). With the help of Washington State University's Social and Economic Sciences Research Center (SESRC), we sent paper questionnaires to 1,553 strawberry growers over a four-month period (January–April 2016). A link to an online version of the survey was provided in all letters and reminder postcards.

Two hundred and twenty-seven (227) strawberry growers completed the survey (see Table 1), for an initial response rate of 18% (after taking into account ineligible individuals and bad addresses). Because of the low response rate, we conducted follow-up phone calls with 300 non-respondents. The phone calls indicated a higher proportion of ineligible names on the mailing list than we had anticipated. We then calculated an adjusted response rate of 21%.

Table 1. Survey Respondents by State

State	Frequency	Percentage
California	32	14%
New York	41	18%
Oregon	30	13%
Pennsylvania	88	39%
Tennessee	8	4%
Washington	28	12%
TOTAL	227	100%

GROWER DEMOGRAPHICS

Eighty-nine percent of the survey respondents were male and 11% were female. Most respondents (92%) were Caucasian; 3% were Asian, 2% were Latino, and 1% were American Indian. Respondents ranged in age from 22 to 91 years with a mean age of 55 years. Respondents had spent 19 years, on average, involved in strawberry production as a farm operator, farm manager, or other primary decision maker. Forty-two percent of respondents had a four-year college degree and 15% had attended graduate school. One-third (31%) of respondents were members of strawberry growers associations.

FARM CHARACTERISTICS AND FARM INCOME

The majority (90%) of survey respondents were farm owners, partners, or lessees, while 8% were hired managers. Respondents operated between <1 acre and 5,000 acres of farm/ranch land in 2015 (mean = 282 acres, median = 74 acres). Twenty-two percent of respondents used some or all of their acreage for certified organic production (ranging from <1 acre to 500 acres).

Respondents grew from <1 acre to 5,000 acres of strawberries (mean = 45 acres, median = 2 acres). Twenty-two percent of respondents reported some certified organic strawberry acres (ranging from <1 acre to 500 acres). Strawberries were the primary agricultural product in terms of value of sales for 21% of respondents. Other primary agricultural products included apples, sweet corn, tomatoes, mixed vegetables, and pumpkins.

Twenty-one percent of respondents had less than \$50,000 in gross farm income in 2015, 33% had between \$50,000 and \$249,999, 26% had between \$250,000 and \$999,999, and 20% had \$1,000,000 or more. Strawberry sales, on average, were 20% of respondents' gross farm income in 2015 (median = 8%).

STANDARD POLYETHYLENE (PE) PLASTIC MULCH FILMS: EXPERIENCES AND OPINIONS

Approximately two-thirds (64%) of respondents had used standard polyethylene (PE) plastic mulch films on some or all of their strawberry fields. Of those respondents, 79% had used PE plastic mulch films during the 2015 growing season. Most respondents who had used PE plastic mulch films in their strawberry fields were satisfied with the results: slightly satisfied (17%), moderately satisfied (37%), and very satisfied (39%). PE plastic mulch disposal methods included landfill or dump site (67%), burning (25%), recycling (18%), and burying (3%).

We asked survey participants open-ended questions about what they liked most and least about using PE plastic mulch films in their strawberry fields. Respondents liked weed control (68%), cleaner berries (28%), moisture retention (15%), earlier production (10%), ease of use (9%), and increased soil temperature (8%). Respondents did not like removal (40%), disposal (26%), purchase/removal/disposal costs (16%), product integrity (tears easily, deterioration in field) (9%), runner-related problems (8%), poor plant health and fruit quality (7%), animal damage (5%), excessive heat (5%), and poor weed control (5%).

Respondents who had *never* used PE plastic mulch films in their strawberry fields provided the following reasons for non-adoption: incompatibility with existing strawberry production practices (26%), high cost (23%), lack of interest (15%), environmental concerns (12%), labor requirements (9%), lack of mulch laying equipment (7%), lack of knowledge (5%), and the inability to reuse PE plastic mulch films for multiple growing seasons (5%).

All survey respondents were asked to indicate the extent to which they disagreed or agreed with six statements about PE plastic mulch films (Table 2). A majority of respondents (59%) agreed that the disposal of used PE plastic mulch films is a big environmental problem, as well as economically burdensome. Two-thirds of respondents believed PE plastic mulch films fragment during removal from fields after harvest (65%). However, only 9% of respondents agreed that PE plastic mulch films harm the soil.

Table 2. Opinions about Standard Polyethylene (PE) Plastic Mulch Films

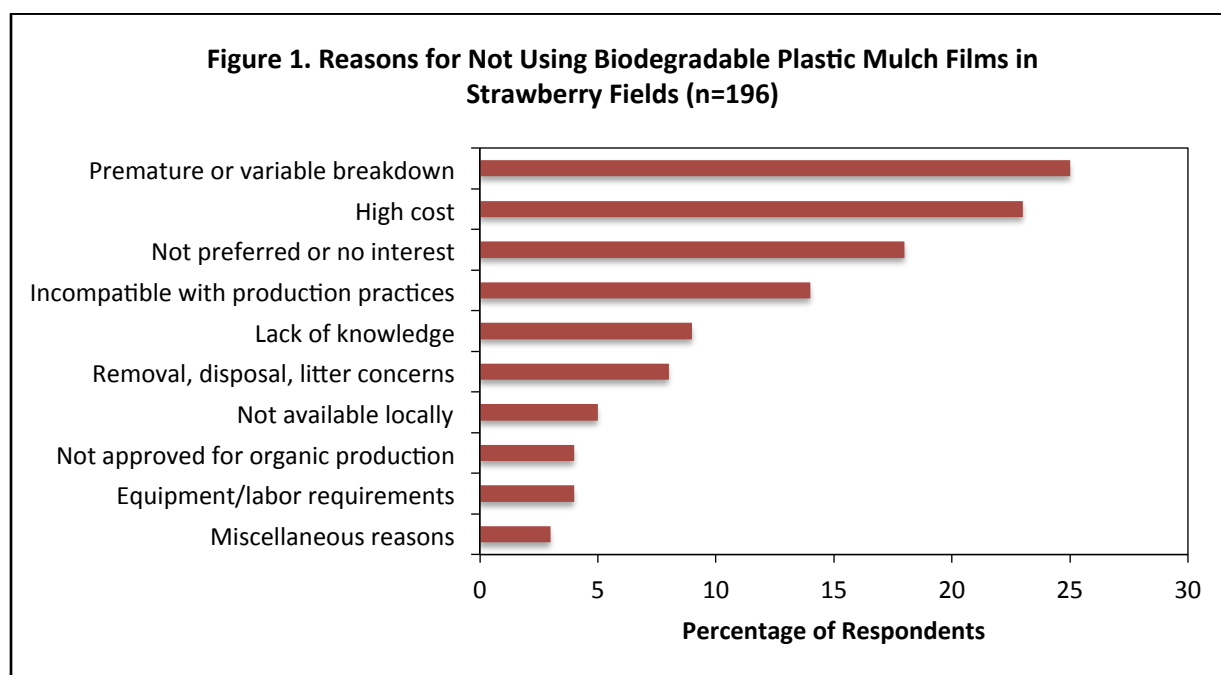
Statements	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
Standard PE plastic mulch films are environmentally friendly.	18%	27%	37%	14%	3%
Standard PE plastic mulch films harm the soil.	24%	37%	30%	6%	3%
Disposal of used standard PE plastic mulch films is a big environmental problem.	6%	12%	24%	41%	18%
Recycling is a viable option for used standard PE plastic mulch films.	14%	24%	31%	25%	6%
Standard PE plastic mulch films often fragment during removal from fields after harvest.	3%	13%	19%	42%	23%
Proper disposal of used standard PE plastic mulch films is economically burdensome.	6%	9%	26%	45%	14%

BIODEGRADABLE PLASTIC MULCH FILMS: FAMILIARITY AND EXPERIENCE

More than half of the survey respondents were familiar with biodegradable plastic mulch films: slightly familiar (31%), moderately familiar (19%), and very familiar (8%). The primary sources of information about biodegradable plastic mulch films were industry sources (e.g., dealers, catalogs, trade shows) (49%), past experience (26%), other farmers (21%), grower meetings and conferences (12%), and Cooperative Extension (10%). Only 8% of respondents had used biodegradable plastic mulch films in some or all of their strawberry fields. The main reasons listed for *not* using biodegradable plastic mulch films were premature or variable breakdown (25%), high cost (23%), not preferred or no interest (18%), and incompatibility with production practices (14%) (Figure 1).

The survey included a series of questions *only* for those respondents who had used biodegradable plastic mulch films in their strawberry fields. Most respondents (56%) had used biodegradable plastic mulch films in 2010–2015, while others had used them in 1980–1990 (17%), 1990–1999 (17%), and 2000–2009 (11%). One-third (33%) used the products during the 2015 growing season. Respondents expressed different levels of satisfaction with the results of using biodegradable plastic mulch films in their strawberry fields: not at all satisfied (39%), slightly satisfied (39%), moderately satisfied (17%), and very satisfied (6%).

When asked what they liked most about using biodegradable plastic mulch films in their strawberry fields, survey respondents mentioned the lack of need to remove/dispose of the mulch films (33%), “not much” or “nothing” (33%), healthy/clean plants (20%), weed control (13%), and biodegradability (13%). When asked what they liked least, respondents mentioned that the mulch films break down too quickly (53%), degrade unevenly within fields or season to season (20%), and are expensive (20%).



BIODEGRADABLE PLASTIC MULCH FILMS: OPINIONS AND FUTURE USE

Survey respondents were asked to indicate the extent to which they disagreed or agreed with 19 statements about biodegradable plastic mulch films (Table 3). Approximately one-half (52%) of respondents agreed that biodegradable plastic mulch films are environmentally friendly. A majority believed the products can be tried on a small scale (63%), but are too expensive (68%). Nearly one-half (48%) agreed that biodegradable plastic mulch films can be laid with standard plastic mulch layers. Forty-six percent expressed concern about unpredictable breakdown in the soil. Two-thirds (41%) of respondents agreed that U.S. strawberry growers are interested in using biodegradable plastic mulch films. The high percentage of “neither disagree nor agree” responses in Table 3 suggests that many respondents likely lacked sufficient knowledge of biodegradable plastic mulch films to disagree or agree with the statements provided.

Respondents were asked to imagine designing a biodegradable plastic mulch film to meet their strawberry farming needs; they were then asked to indicate the importance of various mulch traits on a scale from 1=“not at all important” to 4=“very important.” A majority of respondents indicated that the following traits would be very important: compatible with irrigation equipment (78%), can be laid with plastic mulch layer (77%), remains intact until very end of growing season (74%), and can be tilled into the soil at end of growing season (66%). Traits deemed “not at all important” by a majority of respondents included: available in clear (71%), produced without GMO feedstocks (60%), and available in reflective silver (55%). Complete results are presented in Table 4. Respondents were also asked to list additional traits that would be important in a biodegradable plastic mulch film for strawberry production. The most frequent responses were affordability (31%) and holding up for two or more growing seasons (22%).

When asked about hypothetical scenarios that might increase their likelihood of considering using biodegradable plastic mulch films in their strawberry fields, 54% of survey respondents indicated they were “moderately likely” or “very likely” to consider using these products if the price dropped significantly. A similar percentage (51%) of respondents were “moderately likely” or “very likely” to consider using biodegradable plastic mulch films if university research discovered that the products do not harm the soil. Complete results are presented in Table 5.

Most respondents expressed interest in learning more about biodegradable plastic mulch films for U.S. strawberry production: slightly interested (34%), moderately interested (24%), and very interested (21%). Similarly, most respondents indicated the possibility of using biodegradable plastic mulch films in some or all of their strawberry fields in the next five years: slightly likely (39%), moderately likely (20%), and very likely (12%).

When asked about the potential benefits of using biodegradable plastic mulch films in U.S. strawberry production, respondents identified the following: easier (or no) removal and disposal (19%), cost savings (17%), and less trash to landfill (12%). When asked about the potential problems or barriers to using biodegradable plastic mulch films in U.S. strawberry production, respondents reported the following: unpredictable breakdown (36%), high cost (18%), and durability concerns (11%). Complete results are presented in Figures 2 and 3.

Table 3. Opinions about Biodegradable Plastic Mulch Films

Statements	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
Biodegradable plastic mulch films are environmentally friendly.	4%	6%	38%	41%	11%
Biodegradable plastic mulch films are too expensive.	1%	4%	41%	35%	20%
Biodegradable plastic mulch films are an unproven technology.	3%	16%	53%	22%	7%
Biodegradable plastic mulch films can be tried on a small scale.	2%	3%	33%	51%	13%
Biodegradable plastic mulch films can replace standard polyethylene (PE) plastic mulch films.	3%	11%	50%	28%	8%
Biodegradable plastic mulch films harm the soil.	10%	25%	59%	4%	2%
There are NO disposal costs associated with the use of biodegradable plastic mulch films.	5%	23%	44%	22%	8%
Biodegradable plastic mulch films can be laid with standard plastic mulch layers.	0%	3%	49%	38%	10%
Biodegradable plastic mulch films negatively impact fruit quality.	4%	25%	63%	5%	3%
The timing of breakdown of biodegradable plastic mulch films in the soil is unpredictable.	1%	2%	51%	35%	11%
Biodegradable plastic mulch films are easy to use.	2%	13%	66%	16%	4%
Biodegradable plastic mulch films are compatible with my strawberry production practices.	14%	20%	51%	11%	4%
Biodegradable plastic mulch films require too much management.	2%	8%	69%	16%	5%
Biodegradable plastic mulch films are not totally biodegradable.	2%	7%	61%	23%	7%
U.S. strawberry growers should use biodegradable plastic mulch films.	4%	8%	70%	14%	4%
Using biodegradable plastic mulch films would make my farm more sustainable.	7%	10%	56%	22%	6%
Biodegradable plastic mulch films are not available in my area.	9%	33%	46%	8%	4%
Biodegradable plastic mulch films must be composted to totally biodegrade.	4%	12%	68%	10%	6%
U.S. strawberry farmers are interested in using biodegradable plastic mulch films.	0%	3%	56%	33%	8%

Table 4. Importance of Biodegradable Plastic Mulch Film Traits for Strawberry Farming Needs

Traits	Not at all Important	Slightly Important	Moderately Important	Very Important
Compatible with irrigation equipment	6%	3%	13%	78%
Can be laid with plastic mulch layer	11%	6%	6%	77%
Remains intact until very end of growing season	5%	5%	16%	74%
Can be tilled into the soil at end of growing season	11%	9%	14%	66%
Completely biodegrades in soil within one year	15%	17%	21%	46%
Compostable on-farm at end of growing season	15%	13%	27%	45%
Durable enough to allow double cropping	19%	14%	23%	44%
Completely biodegrades in soil within two years	15%	16%	26%	43%
Available in black	14%	17%	28%	41%
Reaches 90% biodegradation in soil within two years	18%	17%	25%	40%
Reaches 90% biodegradation in soil within one year	20%	21%	24%	34%
Produced with 100% bio-based materials	21%	24%	25%	30%
Produced without GMO feedstocks	60%	16%	7%	17%
Compostable at municipal facility at end of growing season	40%	22%	23%	16%
Available in white or white-on-black	33%	27%	26%	15%
Produced with 50% bio-based materials	33%	38%	23%	6%
Available in reflective silver	55%	25%	14%	6%
Available in clear	71%	13%	10%	6%

Table 5. Likelihood of Considering Use of Biodegradable Plastic Mulch Films in Strawberry Fields: Seven Hypothetical Scenarios

Hypothetical Scenarios	Not at all Likely	Slightly Likely	Moderately Likely	Very Likely
The price of biodegradable plastic mulch films drops significantly.	20%	25%	26%	28%
University research indicates biodegradable plastic mulch films do not harm the soil.	23%	26%	34%	17%
Biodegradable plastic mulch films are readily available at local agricultural input supply stores.	28%	23%	32%	17%
Use of biodegradable plastic mulch films improves Good Agricultural Practices (GAP) or sustainability audit score.	20%	33%	32%	16%
Consumers are willing to pay a premium for products grown with biodegradable plastic mulch films.	38%	19%	27%	16%
Specific biodegradable plastic mulch films are approved for use in U.S. certified organic production	36%	27%	24%	13%
Biodegradable plastic mulch film use is required by a processor, wholesale buyer, or retailer.	45%	21%	24%	10%

Figure 2. Perceived Benefits to Using Biodegradable Plastic Mulch Films in U.S. Strawberry Production (n=181)

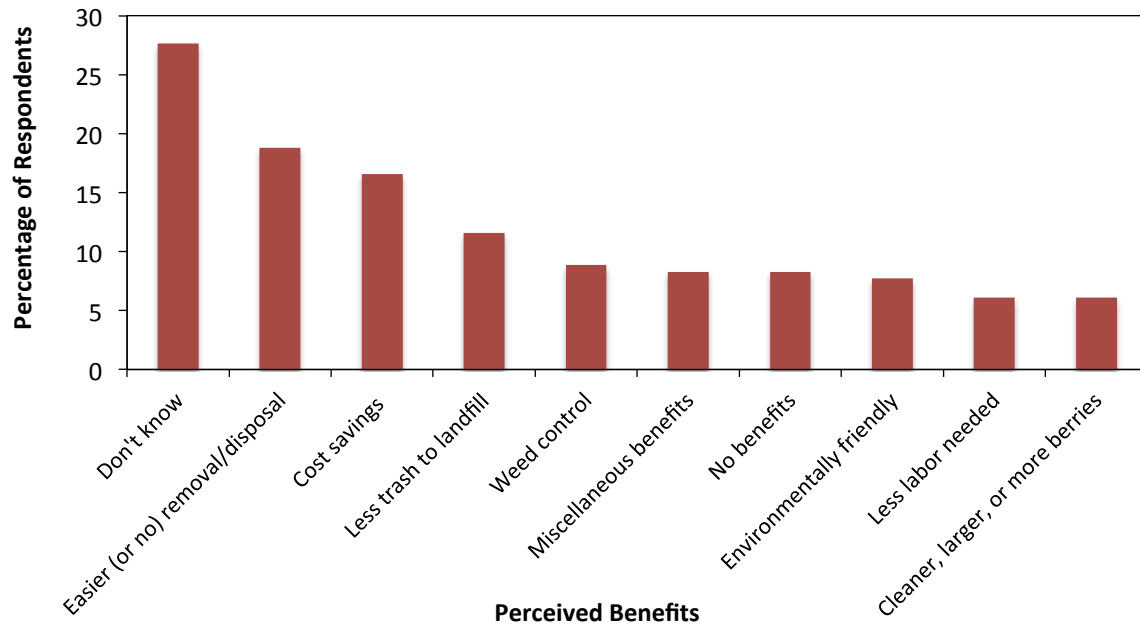
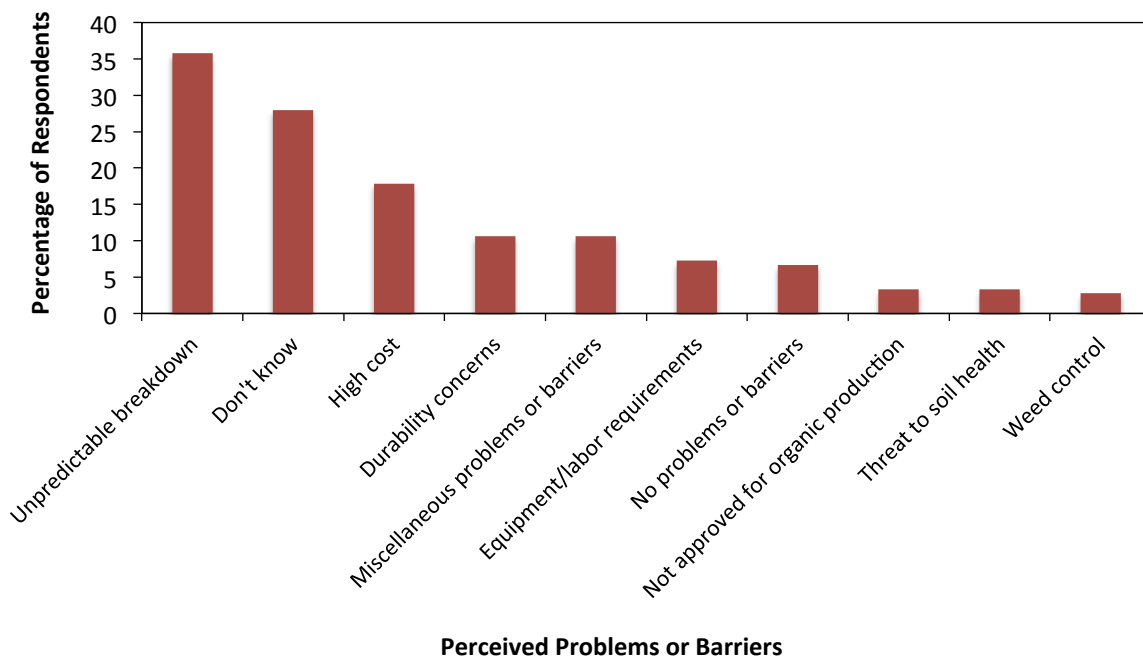


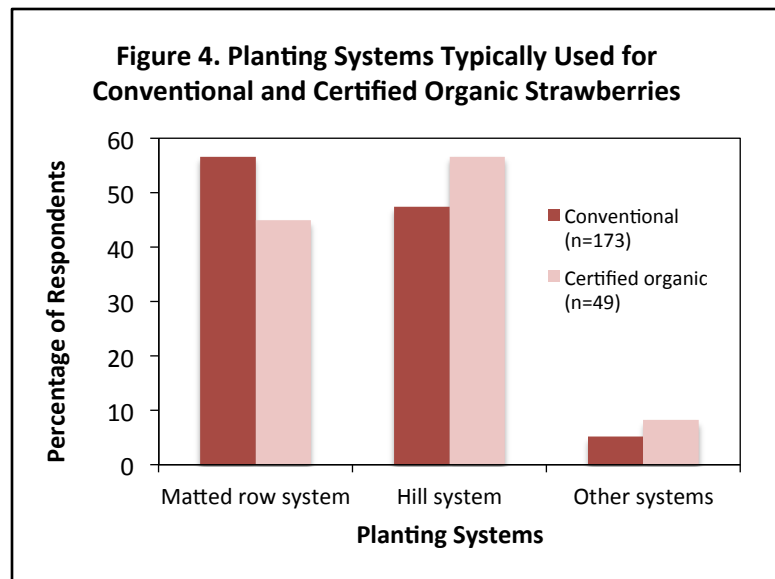
Figure 3. Perceived Problems or Barriers to Using Biodegradable Plastic Mulch Films in U.S. Strawberry Production (n=179)



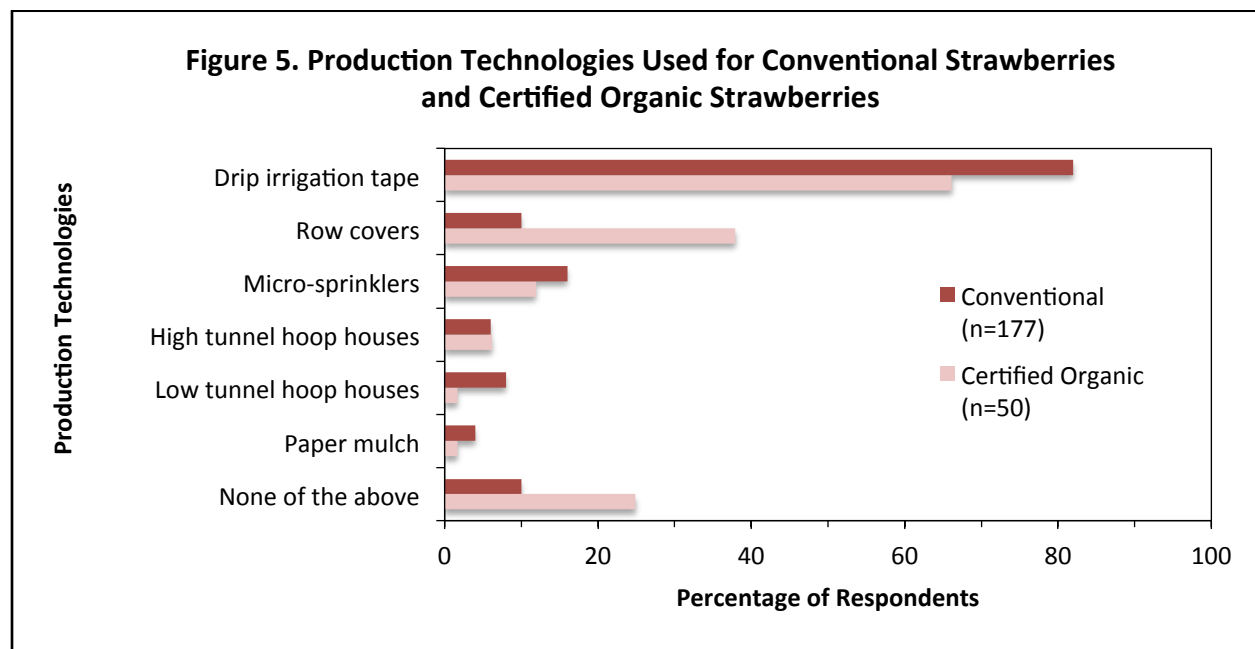
STRAWBERRY PRODUCTION AND MARKETING PRACTICES

There are two main planting systems for growing strawberries. In a *matted row system*, runners spread freely and root within the row to make a row matted with strawberry plants. June-bearing strawberry plants are often planted using the matted row system. In a *hill system*, runners are removed to encourage the production of large plants and berries. The hill system relies on raised beds with or without plastic mulch films. Everbearing and day-neutral strawberry plants are often planted using the hill

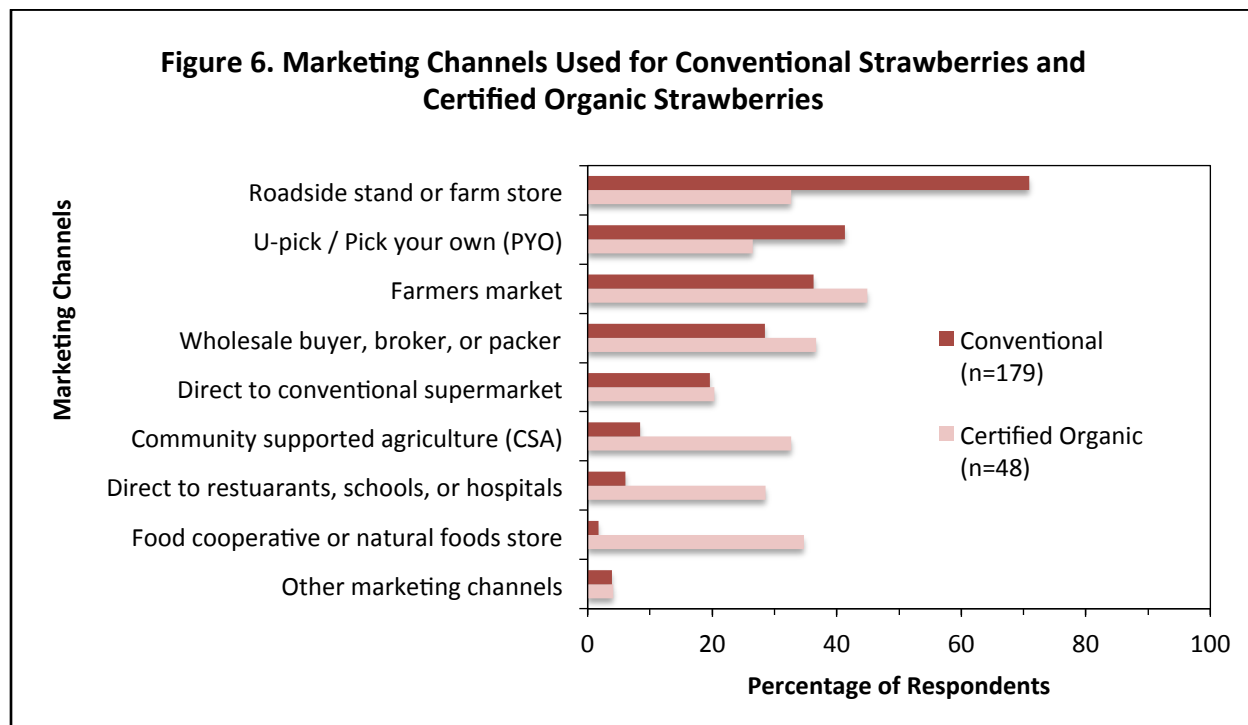
system. Figure 4 indicates that the matted row and hill systems were both popular among the survey respondents. Nearly half (47%) of growers of conventional strawberries used the hill system and 57% used the matted row system. Over half (55%) of growers of certified organic strawberries used the hill system and 45% used the matted system. Other planting systems reported by respondents included hydroponic systems and ribbon rows.



Respondents were also asked about the types of production technologies used in their strawberry fields (Figure 5). The most common technology used for the production of both conventional and certified organic strawberries was drip irrigation tape.



We asked survey respondents to provide the percentages of their conventional and certified organic strawberries grown for the fresh and processing markets. On average, 92% of conventional strawberries were grown for the fresh market and 8% were grown for the processing market. Percentages were identical for certified organic strawberries. We also asked about specific marketing channels for conventional and certified organic strawberries. Roadside stand or farm store was the most popular marketing channel for conventional strawberries. Farmers market was the most popular marketing channel for certified organic strawberries. Complete results are presented in Figure 6.



FUMIGATION PRACTICES

Fumigation is a production practice that removes pests and diseases via the application of chemicals to the soil. New regulations in some states require the use of specific plastic tarps (which are not biodegradable) in conjunction with fumigation efforts. Fumigation practice, therefore, may act as a barrier to the adoption of biodegradable plastic mulch films. Only 16% of survey respondents typically fumigate their strawberry fields. Those respondents rely on custom applicators (50%), themselves (38%), or other primary decision makers or employees (6%) to apply the chemicals. Forty-nine percent use raised bed fumigation, while 43% use broadcast (or flat) fumigation. One-quarter (24%) of respondents use high density polyethylene (HDPE) film (24%), 24% use totally impermeable film (TIF), 18% use virtually impermeable film (VIF), 21% do not use fumigation films, and 15% did not know the film type used in their fields. For those respondents who use fumigation films, the most common disposal method is landfill or dump site (62%), followed by recycling facility (27%), burning (8%), and burying (4%).

DECISION-MAKING AND SOURCES OF AGRICULTURAL INFORMATION

Sustainable agriculture encompasses economic profit, cropland productivity, quality of life, and environmental stewardship. A majority of survey respondents indicated that three out of the four sustainability components were very important to them when making decisions about production inputs and practices for their strawberry fields (Table 6).

Table 6. Importance of Sustainable Agriculture Components When Making Decisions About Production Inputs/Practices for Strawberry Fields

Sustainable Agriculture Components	Not at all Important	Slightly Important	Moderately Important	Very Important
Economic profit	1%	1%	21%	76%
Cropland productivity	2%	3%	30%	66%
Quality of life (farmers, families, communities)	1%	7%	36%	56%
Environmental stewardship	1%	11%	47%	41%

Agricultural information can be communicated in many different ways—from farm walks to workshops to social media. Survey respondents were asked to indicate the degree to which they preferred ten different options for receiving information about strawberry production inputs and practices. The most preferred communication channels were field days or farms walks, printed materials, and on-farm demonstrations (Table 7).

Table 7. Preference for Receiving Information About Strawberry Production Inputs/Practices

Communication Channels	Not at all Preferred	Slightly Preferred	Moderately Preferred	Very Preferred
Field days or farm walks	11%	22%	36%	31%
Printed materials	3%	20%	48%	29%
On-farm demonstrations (hands-on)	10%	23%	39%	28%
In-person conferences or large meetings	11%	32%	34%	24%
One-on-one consultations	13%	29%	36%	23%
In-person workshops or courses	14%	28%	35%	23%
Online materials	18%	22%	38%	22%
E-mail or listserv	39%	30%	23%	9%
Online meetings, workshops, or webinars	42%	35%	16%	8%
Social media (e.g., Facebook, Twitter)	66%	25%	7%	2%

Strawberry growers obtain information about production inputs and practices from many different sources. Survey respondents were asked about the level of importance of eighteen information sources. Personal experimentation and creativity, other farmers, university Extension educators, family members, and university scientists were the most important information sources (Table 8).

Table 8. Importance of Sources of Information About Strawberry Production Inputs/Practices

Sources of Information	Not at all Important	Slightly Important	Moderately Important	Very Important
My own experimentation, creativity, and innovation	1%	7%	37%	54%
Other farmers	5%	16%	39%	40%
University Extension educators	7%	15%	38%	40%
Family members	21%	20%	24%	34%
University scientists	11%	20%	39%	30%
Farm employees or field workers	17%	20%	38%	25%
Agricultural input suppliers	11%	29%	42%	18%
Certified crop advisors	32%	23%	27%	18%
State Department of Agriculture	14%	34%	38%	14%
Private consultants	35%	24%	28%	13%
Commodity or growers association	26%	28%	34%	12%
Organic certifiers	69%	12%	10%	10%
Distributors or retailers	50%	22%	19%	9%
Processors or packers	56%	26%	9%	9%
Sustainable Agriculture Research and Education Program (SARE)	39%	34%	20%	8%
Marketing organization or cooperative	39%	38%	16%	7%
Natural Resources Conservation Service (NRCS)	32%	40%	23%	5%
National Sustainable Agriculture Information Service (ATTRA)	47%	33%	16%	4%

CONCLUSION

The survey results provide insight into U.S. strawberry growers' experiences with both standard PE plastic mulch films and biodegradable plastic mulch films. While nearly two-thirds (64%) of survey respondents had used PE plastic mulch films, only 8% had used biodegradable plastic mulch films in their strawberry fields. Respondents were generally satisfied with the results of using PE plastic mulch films; however, they did not like having to remove and dispose of the films. Respondents were far less satisfied with the results of using biodegradable plastic mulch films in their strawberry fields. Past users liked not having to remove and dispose of the biodegradable plastic mulch films, but they expressed concerns about early breakdown, uneven breakdown (within fields and season to season), and high purchase cost.

Most survey respondents expressed an interest in learning more about biodegradable plastic mulch films for U.S. strawberry production. Approximately one-third of respondents indicated they were moderately or very likely to consider using biodegradable plastic mulch films in their strawberry fields. When asked about the potential benefits to using biodegradable plastic mulch films in U.S. strawberry production, survey respondents mentioned removal/disposal

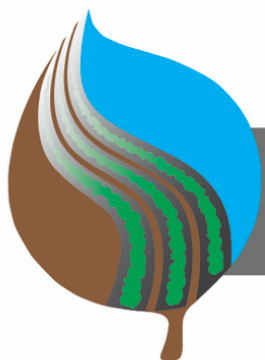
benefits, cost savings, and reduced waste. However, they saw unpredictable (especially early) breakdown, high purchase cost, and limited durability as problems or barriers to adoption. Based on the results of our hypothetical scenarios question, the likelihood of strawberry growers' adoption of biodegradable plastic mulch films would increase if the price dropped significantly and university research indicated no negative impacts on soil health.

At the end of the survey we asked participants if they had any additional comments about the use of plastic mulch films in U.S. strawberry production. To conclude this survey summary report and give voice to our survey participants, we present selected responses in Box 1. Comments focus on dissatisfaction with the past use of biodegradable plastic mulch films, the desire for durable plastic mulch films designed for multi-season crops (such as strawberries), and the need for further research and product development.

For more information about the survey results or the activities of the Technology Adoption Working Group, please contact: Dr. Jessica Goldberger, Rural Sociologist, Department of Crop and Soil Sciences, Washington State University, Pullman, WA 99164, 509-335-8540 (office) or jgoldberger@wsu.edu.

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Performance and Adoptability
Biodegradable Mulch

biodegradablemulch.org

Box 1. Selected Comments by Survey Participants

"Even though we currently use biodegradable film on all our strawberries, I feel more research is important to wider adoption in the industry and feel it will benefit our operation with improved films and tools better adapted to strawberry production as most of the bio-film industry it currently catering to short-season vegetable production."

— 31-year old with 4 acres of conventional strawberries in Pennsylvania

"I think about bio-films a lot for the ease of removal. We like to keep berries for 2–3 years. If a field will survive 3 years, how do we decide which mulch will last that long? Would be good for annual vegetable production: melons, tomatoes, peppers, and eggplants."

— 56-year old with 2 acres of conventional strawberries in Oregon

"In our strawberry production, the plastic needs to last a year or more. We have not tried the heavier mil. biodegradable [plastic mulch] available in more recent years. We have been able to keep our fields cleaner by removing PE plastic mulch. Biodegradable [plastic mulch] didn't biodegrade as we had hoped and we couldn't remove it."

— 61-year old with 6 acres of conventional strawberries in Pennsylvania

"I hope something useful comes from this with regard to getting more and better mulch materials available to organic growers."

— 63-year old with 4 acres of certified organic strawberries in California

"Shifting from no mulch to plastic mulch means also shifting from sprinkler irrigation to drip [irrigation], which is an additional cost and management concern."

— 77-year old with 1 acre of conventional strawberries in New York

"All of the plastic type mulches seem to be more about accommodating the problem instead of fixing it. They return nothing to the soil and quite possibly represent an increasing risk when continuously used. In order to quit making a mess you actually have to stop."

— 63-year old with $\frac{3}{4}$ acre of certified organic strawberries in Oregon

"We use the toughest regular embossed black poly (1.25 to 1.50 mil.) so it will pick up easier after use. We have a good many sharp stones and every hole will leave weed grow. Every time I used biodegradable it was either not tough or broke down early or not early enough. So I quit using them. Maybe the new ones are better!"

— 68-year old with 2 acres of conventional strawberries in Pennsylvania

"The cleanup process of mulch films is the setback. We should also consider weed materials that can be reused in multiple strawberry plantings."

— 41-year old with 1 acre of conventional strawberries in Washington State

"Make sure new plastic mulch is truly compostable before hyping it to farmers! If it is biodegradable in the sense of other plastics labeled biodegradable, it will leave side effects in the soil. We will switch to using these plastics when they can be completely composted with no residue."

— 53-year old with 3 acres of certified organic strawberries in Oregon

"I hope to see some useful info come out of here. I would like to know where I can recycle PE films from fields and from greenhouses. I would like to be informed of conclusions drawn from this survey and your research."

— 25-year old with $\frac{1}{2}$ acre of conventional strawberries in New York