Cucurbit Grower Perceptions of Mesotunnel Production Systems

Report of 2021 Grower-Cooperator Interview Findings

[For Project Internal Use Only]

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Introduction

As one part of the USDA-OREI (Organic Agriculture Research and Extension) Initiative project, "Resilient Systems for Sustainable Management of Cucurbit Crops," this report presents findings of a study of perceptions of grower-cooperators who participated in the project's 2021 on-farm trials. It covers key topics of interest including grower experiences with and perceptions of mesotunnels, insect pests and disease, pollination, weed management, and harvest outcomes, and marketability of their yields from their mesotunnel trials. Findings contribute to the project's overall goal of better understanding and validating a set of integrated pest management (IPM) strategies to address the most important problems faced by organic cucurbit growers in the U.S.

Methods

The team conducted this qualitative study utilizing best practices for qualitative research and evaluation[1]. Data collection consisted of nine individual interviews with grower-cooperators conducted by two OREI team members over Zoom video conferencing in Fall 2021. Full methods, including additional methods details, the interview guide used, and an example of the data analysis matrix structure are detailed in Appendices A, B, and C of this report.

2021 On-farm Trial Locations and Weather Conditions

Cooperators, located across upstate New York, central Kentucky, and northeastern Iowa, reported differing weather conditions throughout the 2021 season. New York growers commented on the frequent rains and high humidity in late summer 2021, which was reported as a relief compared to the prior year which experienced severe drought conditions. One New York grower stated*, "It rained every other day for the entire month of July."* Kentucky growers also observed a relatively wet year but experienced less humidity throughout the growing season. Iowa conditions in 2021 remained severely dry for the second year in a row, with rain deficits reported across the state during spring and early summer.

[1]Patton, M. Q. 2014. *Qualitative Research & Evaluation Methods Integrating Theory and Practice* (Fourth Edition), Sage Publications, Thousand Oaks, CA. Retrieved from: https://study.sagepub.com/patton4e

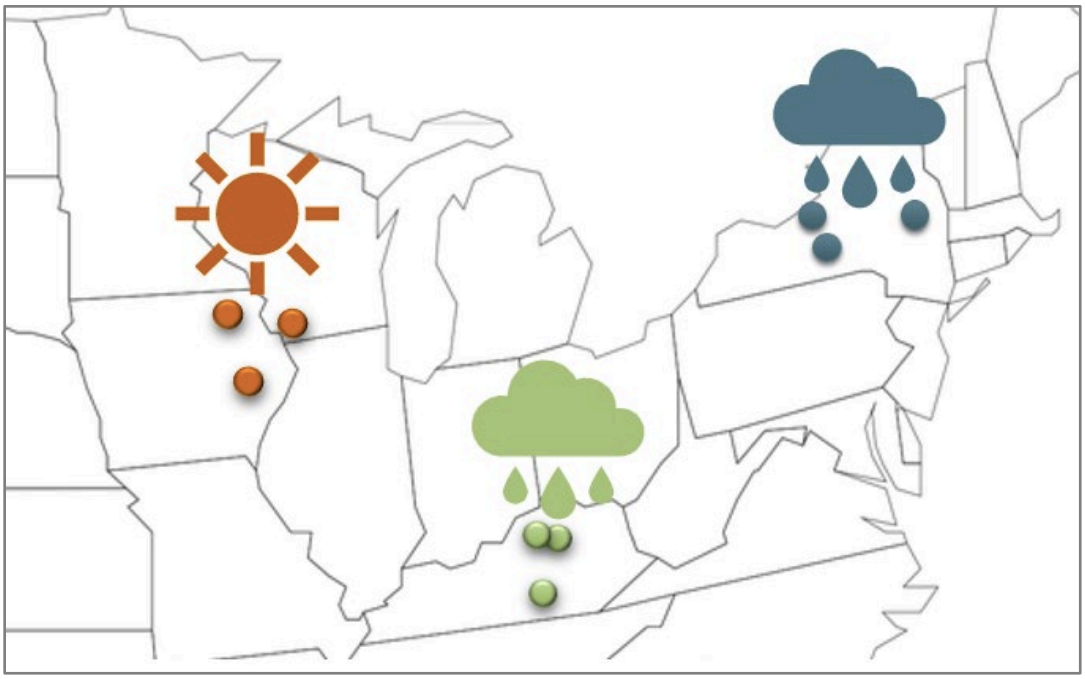

Figure 1. A map of all on-farm trial locations and overall weather trends during the 2021 growing season.

Characteristics of 2021 Growers' Farms, Markets, and Cucurbits Grown

The nine trial farms in Iowa, Kentucky, and New York varied greatly in size (Table 1). Smaller scale growers tended to be newer to farming, and more of their total production was dependent on the cucurbit crops grown under the mesotunnels. The project had five returning growers, all with at least ten years of experience or more. Two especially seasoned growers participated in the trial, and one of these growers had more than 50 years of experience farming. These larger scale growers were not only experienced, they also grew a greater variety of crops. The 2021 trials tended to contribute less significantly to total overall production for those farms over 12 acres.

Growers commented on market changes in 2021 possibly related to the COVID-19 pandemic. *"Last year we had a restaurant that wanted a lot of butternut squash, but that market does not exist this year,"* recalled one grower. Most farmers grow and sell to multiple markets, but one grower managed a unique school-situated farm that produced solely for its co-located school community. Two-thirds of the growers ran or participated in a CSA (community-supported agriculture) cooperative.

TABLE 1. Farm size, markets, and percentage of total cucurbits grown in the on-farm trial relative to total cucurbits grown in farm.

Overall Farm Size	Markets and Food Use	% Cucurbits in Trial
2 acres	Wholesale	6%
2.5 acres	CSA	8%
3 acres	CSA	30%
4 acres	CSA, Farmers' Market, value-added, restaurants	20%
12 acres	Restaurants, wholesale , local grocers	75%
35 acres	CSA, retail, wholesale	5%
60 acres	Direct clients, CSA, marketing co-op, wholesale, food pantries	1%
180 acres	Personal consumption (school)	5%
550 acres	CSA, wholesale, retail	5%

Plot characteristics varied from farm to farm, with the total plot length ranging from about 150 linear feet to 900 linear feet (Table 2). In 2020, all growers but one planted a single row under the tunnel. In 2021, one grower experimented with a single row under the mesotunnel, two growers covered two rows, and the remaining growers covered three rows with the nylon-mesh netting. The average hoop height was slightly over three feet, but one grower opted out of using hoops entirely, instead, covering the plants directly with the netting and burying the edges to secure the insect barrier and prevent wind and animal damage. Most of the participants grew at least one type of squash, but a few tried other cucurbit varieties such as muskmelon, cucumbers, and watermelon. One returning grower experimented with non-cucurbit plants alongside their cucurbit trial.

TABLE 2. Crops grown under mesotunnels and characteristics of mesotunnel system set up.

Linear Feet	Arrangement	Tunnel Height	Crop(s) Grown in the Mesotunnel	State
150 ft	Single row	3 ft	Acorn squash	NY
230 ft	Triple row	3 ft	Butternut squash	IA
300 ft	Double row	3.5 ft	Muskmelon	KY
300 ft*	Triple row	3.5 ft	Zucchini, slicing and pickling cucumbers, patty pans	NY
440 ft	Double row	3.5 ft	Butternut squash	IA
450 ft	Triple row	3 ft	Butternut squash	IA
450 ft	Triple row	3 ft	Slicing and pickling cucumbers, celery, Swiss chard	NY
900 ft	Triple row	No hoops	Butternut squash	KY
1620 ft*	Triple row	3 ft	Muskmelon, watermelon	KY

*Trials using purchased (Koppert Inc.) bumblebee hives

Growers' Previous Experience with Row Covers

All of the growers in the trial reported having previous experience using a technology similar to a mesotunnel. Four growers returned to the mesotunnel project from the previous year and therefore had more experience working directly with the technology. Zigzagging the conduit hoops down each row (Figures 2 and 3) was a widely adapted practice in the 2021 trials. The modification came from an experienced returning grower and aimed to reinforce the hoops within the plot and allow for mowing between the rows.

Caterpillar tunnels, row covers, low tunnels, or high tunnels were among the other technologies used by cooperators. The grower that opted out of using hoops for the trial did not install supporting structures for any row covers, and stated, *"It would actually complicate it for us if we did [use hoops] I think, just from a time management standpoint."*

Experiences with using other row covers reportedly eased the learning curve for some of the growers new to the project, especially when deciding how to mend damaged netting. When asked how one might extend the life of netting if torn, one grower responded, *"Just take a needle and thread out into the fields… It doesn't need to look perfect; you just need to close the hole."* This same technique was used in prior years to prolong the usefulness of other row cover fabrics.

Figure 2. Fully constructed mesotunnels in New York.

2021 Mesotunnel Production Systems Overview

Mesotunnels are comprised of three major components: nylon-mesh netting, bent conduit hoops, and sandbags or other weights to secure the net. All components were installed on the same day by an OREI project team member, a crew of two to five people at each farm, and in most cases, the grower-cooperator. Returning cooperators commented on the ease of process with one explaining, *"We had enough experience [from] last year… it went pretty smoothly."* Around half of the growers, however, provided mixed reviews regarding installation, typically associated with the intensity of labor and time it took to prepare the plots. One grower recalled, *"I am happy with our production without them [the tunnels]… all the added labor is just a deal breaker*."

Netting

Mesotunnel netting was used by all growers, but returning growers were able to reuse netting provided in the 2020 trials. Mesotunnel netting was either Agribon, ExcludeNet, or ProtekNet brand, and there were small differences among the three. New growers received unused netting, though all growers recalled reusing different types of row covers from year to year in attempt to maximize crop protection without incurring additional annual costs. However, some growers preferred mesh mesotunnel netting to typical woven row cover netting because they speculated that spunbonded row cover materials contribute to the formation of harsh microclimates, commenting, *"The problem with [spunbonded] row cover is it gets too hot, especially for brassicas that want to bolt…and then our crops are gross and slimy*."

Hoops

Eight of nine growers utilized hoops provided by the project team. Cooperators who bent their own hoops commented, *"They are pretty easy to make… especially using the bender frame. They go up pretty easily, especially in ground that is soft."* When the ground was not soft, some cooperators crimped the ends of the hoops. One grower commented, *"We just seem to have too many rocks [in out soil], so it [the hoops] wasn't successful for our soil."* Some growers adapted a hoop installation practice from a returning grower, who suggested angling the hoops to increase stability (Figure 3). The angled hoops also allowed growers to mow between their

rows. The grower who did not use hoops, but rather draped the netting on the ground and buried the edges in the dirt, was satisfied with their techniques.

Figure 3. Bent conduit hoops installed in a zigzag fashion in New York field trials.

Sandbags

Mesotunnel netting was typically secured by sandbags, rock bags, or other similar weighted objects. One grower who implemented this system for the first time commented, *"When I use [other] row covers, I just bury the edge. By using the sandbags… they really seem to pull it [the mesotunnel] down tight… There was a lot of wind, but there wasn't any abrasion that I could see."* A grower recognized that when the bags break during the season, patches of sandy soil are left behind in the plots. To prevent this, they used bags of lime to secure their tunnel, stating, "*We have to apply it [lime] anyway. If some were to bust open, it is a [positive] addition to the field."*

Plant Growth and Health

All nine growers commented on the differences between the health of the plants in the mesotunnel compared to plant health in the control plots. Several growers stated that there was a "night and day difference" between growth due to the presence of disease in the uncovered control plants, especially at the beginning and the end of the season. At the beginning of the season, cooperators reported significantly faster growth and speculated that the mesotunnel provided a good environment that gave their cucurbits a jumpstart, with less insect and disease pressure around transplant. Some growers thought the difference might be due to microclimates. *"We did notice the plants underneath the tunnel were looking a bit more healthy… maybe it is just a tiny bit warmer underneath there."* (Figure 4).

Figure 4. A healthy muskmelon plant in an Iowa mesotunnel, 2 weeks after transplanting.

However, not all cooperators perceived this as beneficial. "*We had so many bacterial issues because you are creating this disgusting, warm little greenhouse under there. It is fixing one problem and causing another*." Another grower thought the difference in plant health could be attributed to effective insect exclusion, which was thought to lessen disease and feeding damage. Two growers believed that the faster, fuller growth did not translate to yield when compared to other row covers.

Weed Management

Across all the growers and trials, landscape fabric provided better weed management than plastic, hand hoeing, or any other strategy in 2021, regardless of trial type or farm location (Figure 5).

Figure 5. Management strategies of landscape fabric (left) and bare ground (right) in Iowa.

"*When we use it [landscape fabric], it is **really** effective*." Five growers used landscape fabric as weed management, and all of these growers used strong positive language to express their satisfaction throughout the interviews. One New York grower was surprised at how effective the fabric was because the amount of rain was conducive to prolific weed growth. Two growers who had a difficult time managing weeds did not attribute their troubles to the mesotunnel systems, but rather their consistent heavy weed pressure, crop type, or a batch of very weedy hay, which they used as a mulch between the rows. One cooperator who mowed the alleys as a strategy noted that vining cucurbits hindered access to manage weeds after the tendrils were established. **One-third of the growers** concluded that the largest management challenge on their farm for the 2021 growing season was controlling weeds.

Pollination

Growers trialed multiple pollination methods for the 2021 growing season including placing beehives inside the tunnel (Figure 6), removing the cover for native pollinators during the flowering stages, and lifting the ends of the netting during flowering. Most of the growers expressed mixed feelings overall regarding the pollination treatments, despite experiencing yields comparable to previous years. During the first year of the project, a cooperator voiced strong concerns regarding bee health and wellbeing in supplemental hives. This returning grower experimented using parthenocarpic varieties of cucumber to avoid using boxed bees in the 2021 season because they felt the mesotunnel was restrictive and a harsh environment for the bees. Additionally, cooperators who used boxed bees for the first time experienced a learning curve. *"I didn't feel like the instructions on the bumblebee colony were that clear… I didn't see it [information] written anywhere,"* one grower noted.

Figure 6. Purchased bee boxes used for pollination trials.

Cooperators that opened the mesotunnel ends to allow for pollination often reported feeling uncertain about pollination efficacy. *"I might have been skeptical at first… of only opening the ends. How would they find the blooms and pollinate? Why would they take the extra effort to find the opening?"* However, the growers reported seeing no yield difference despite only opening the ends. *"We were impressed with the yield results and frankly didn't understand why insects could not get through the netting, but the bees could…,"* explained one grower.

The overarching theme from all other growers was that crops that are less pollinator dependent would be much easier to manage with the mesotunnel technology, regardless of pollination strategy. Maneuvering the tunnel, opening the ends, inserting boxes, and monitoring the bees was too labor-intense for most growers during the peak of the growing season.

Insect pests and Diseases

Disease

Growers reported that weather conditions played a strong role in pest and disease pressure in the 2021 season. Two-thirds of all growers observed diseases on their cucurbits. Most growers

observed that the mesotunnel technology does not prevent [fungal] diseases, especially downy and powdery mildews. New York and Kentucky cooperators attributed disease to a rainy growing season, reporting mildews in all cucurbit plots, both inside and outside of the tunnel. *"We had downy [mildew] move in… and it was a full month earlier than usual,"* explained one grower. Severity varied, but one Kentucky grower stated, *"[This year] we had the worst disease that we have ever had."* Proximity to point sources also played a role in disease incidence and severity. *"We can't avoid mildews here,"* one New York grower reported. *"Right across the lake from us is Toronto. There are thousands of greenhouses… [the mildew] flows directly across the lake at us."*

Iowa growers also believed the weather played a role in disease incidence, or in 2021, a lack thereof, with one grower explaining, *"It was a pretty disease-free year again, because of the drought."*

Insects

Two-thirds of the cooperators remarked significant insect pressure on their cucurbit trials. Growers who had on-off-on or open ends treatments reported higher pest-insect counts than full-season mesotunnel treatments. Some growers attributed this difference in insect populations to the disruption of the insect barrier during pollination. *"When the ends are open for pollination, that is obviously when the bad bugs got in," explained one.*

Management

Despite heavy insect pressure on some farms, only three growers sprayed insecticides during the 2021 growing season. Timings for each spray varied across farms, and one grower decided to wait to spray until after observing squash bugs, which was a few weeks following pollination. The spray was seemingly ineffective, and they recalled, "*When we closed it back up [post-pollination], there were a lot of squash bugs inside… I probably should have just done a preemptive spray."* Other growers sprayed upon transplant pre-emptively to prevent the possibility of any insect damage. All growers that attempted control were unsure if any of the sprays were impacting the outcome of the trial, cucurbit yield, or any of the insects or diseases observed (e.g., Figure 7). "*What I think it boils down to, on an organic farm, is when you get a disease, there is not much you can do."* One grower reported feeling poorly equipped against the health risks associated with OMRI-approved sprays. *"What worries me… if you aren't wearing a fancy facemask, you can breathe that stuff in, and it can be pretty dangerous. As an organic farmer, I don't have a lot of protective stuff."*

Figure 7. Iowa muskmelon plant infected with the bacterial disease cucurbit yellow vine disease (CYVD), which is transmitted by squash bugs.

Overall, the pest and disease management for these organic growers remained minimal and precautionary. Growers reported being poorly equipped to manage significant pressure once diseases and insects become established in the plots. All cooperators were uncertain of the effects that these OMRI-approved products had on the disease and insect problems in their cucurbit trials.

Netting Performance

Durability

The substantial quality, durability, and thickness of the nylon-mesh netting is what five of the nine cooperators positively commented about the mesotunnel technology. *"It's much better than anything I bought… not going to rip as easily [as spunbonded row cover],"* explained one. Cooperators liked the minimal amount of maintenance required during the growing season, but some still felt the labor at the beginning of the season was not worth the time and effort. While returning growers had only used the mesotunnel system in the previous growing season, many were curious how long mesotunnels would offer protection. *"I would just be anxious to see how many years you could get out of it [the mesotunnel]… I feel like you have to have hands on experience to know," stated one grower echoing sentiments of several others.*

Storage

Depending on experience and infrastructure, cooperators stored mesotunnels and row covers in various ways. One grower recalled, *"During the season, they are often just rolled up in a ball and left in the field… over the winter they go in a barn on shelves."* Growers expressed concerns with the lack of space, modern infrastructure, and tools that would help prevent damage, noting the "archaic systems" already in place on their farms. Four other growers also stored the netting or other row covers in their barns over the winter, but they were trying to find other

methods to overwinter the net due to increasing rodent populations. Cooperators who recognized their rodent populations and had storage area kept the mesotunnel netting in rodent-proof sheds or barrels to minimize damage.

Spunbonded row covers are less expensive than mesotunnel materials and most growers buy them annually instead of trying to fix them. "*Once it [row cover] starts to go, it just hasn't been, in our experience, to see worth it [to repair].*" Eight growers planned to reuse all the mesotunnel materials in the system again, and each had their own ideas of how to mend damaged netting for the next season or in the future. Though most cooperators had no issue with damage, a few used various kinds of tape to keep the smaller holes from unraveling while excluding insects. Two growers used fishing line and thread to sew the holes shut.

2021 Harvest Satisfaction: Yield Perception, Fruit Quality, & Market Price

Growers' harvest outcomes and satisfaction from the 2021 mesotunnel field trials varied substantially across the growers (Table 3).

Iowa: In Iowa, two out of three growers were satisfied with their yields, with one reporting having planted much more in 2021 and therefore not particularly comparable to previous years. All Iowa growers were satisfied or very satisfied with their fruit quality. However, there was only one real market price data point this year among these growers due to certain market circumstances. Feelings about the cost-benefit of mesotunnels[1] for cucurbits were mixed across the Iowa growers with one feeling the system would not be justified; another reporting costs comparable to those that would otherwise be spent on other row cover, and the third reporting very positive feelings because of the high quality and ease of use, despite issues in their market. As in the other states, perceptions of cost-benefit of the mesotunnel system by Iowa growers were mixed due to uncertainties about total cost of the system in relation to potential multi-year use.

Kentucky: In Kentucky, growers experienced lower or comparable yields compared to previous years, and all reported lower fruit quality citing factors including gummy stem blight and fruit taste of the cultivar planted. Those same two growers reported comparable market values (vs. normal), though in one case, the market was flooded due to certain circumstances, affecting price. As in the other states, perceptions of cost-benefit of the mesotunnel system by Kentucky growers were mixed and limited due to uncertainties about total cost of the system in relation to potential multi-year use.

New York: In New York, two out of three growers reported good, higher than normal yields and were generally satisfied with fruit quality, except for cucumbers with one grower. These growers reported comparable market prices, yet none reported cost-benefit of the mesotunnels system for cucurbits in 2021 specifically. As in the other states, perceptions of cost-benefit of the mesotunnel system by New York growers were mixed and, ultimately, limited due to uncertainties about total cost of the system in relation to potential multi-year use.

[1] Cost data were not provided to growers in any states, so cost-benefit findings are limited in this respect.

Table 3. Summary of 2021 Grower Satisfaction Findings.

State	Crop(s)	Satisfaction with Yield (vs. previous yrs)	Fruit Quality Satisfaction	Market Price (vs. normal)
IA	Butternut squash	Not comparable	High	N/A
IA	Butternut squash	Satisfied	High	Comparable
IA	Butternut squash	Satisfied	High	(Fell through)
KY	Muskmelon	Comparable	Lower (taste)	Comparable
KY	Muskmelon & Watermelon	Lower	Low/disappointed	N/A
KY	Butternut squash	Lower (soil)	Low (gummy stem blight)	Good then low
NY	Acorn squash	Higher/Good	Good	Comparable but low
NY	Cucumbers, zucchini, patty pans	Higher/Good	Good/comparable	Satisfied
NY	Cucumbers, celery, Swiss chard	Lower (cucumber) or Comparable	Low	Comparable

Growers' Information Sources and Preferences

In the interviews, the team asked grower-cooperators about their preferred information sources for crop management, how often they generally visit university-specific information sources, and what types and sources of information interest them the most. Preferred information sources cited included:

- University-related resources (general)
- University newsletter
- Personal communications with a specific extension agent
- Magazines (unspecified)
- Websites & Google (unspecified)

- Peers & friends
- Practical Farmers of Iowa (PFI)
- Blogs
- Peer-reviewed research/efficacy trials
- Google lens
- MOSES (Midwest Organic & Sustainable Education Service) audio/video shorts on YouTube

Frequency of visits to university-specific information sources ranged from “frequent” (2 respondents) to “as needed/about once a month” (4 respondents) to “almost never” (3 respondents). However, those citing “almost never” cited university Extension contacts, peers, and PFI as their main information sources. Mentions of interest in certain information included interest in a more localized app for plant diseases/insects, as well as continued interaction and support from university research projects and teams. These findings are expected to inform planning OREI project extension activities in 2022 and beyond.

Key Takeaways from 2021 Grower Experiences

Overall key takeaways from the 2021 grower-cooperator on-farm mesotunnel trial experiences include:

- **General satisfaction** with insect control, product quality and yields, with some exceptions
- **Mixed feelings** across growers about labor needed and time inputs to installation with most reporting low labor inputs and relatively easy installation
- **Challenges** with weed control, vining, disease pressure, and feasibility of harvesting under mesotunnels
- **Remaining questions** across all growers regarding cost-benefit of using mesotunnels with cucurbit crops

Due to absent specific cost information most growers felt that mesotunnel netting would likely be cost-prohibitive for most if not all of their cucurbit crops. One grower felt cost could be worth it for cucurbits depending on multi-year durability, and another grower stated they would not be interested in using the system at all again based on their perceived cost. Most growers (8 out of 9) felt the system might prove cost-effective under certain conditions and pending more specific cost information and further study. These conditions, they cited, may include: higher value crops (e.g., brassicas, berries, leafy greens); multi-year durability of netting; crops subject to certain pest types (e.g., flea beetle, leaf miner, sweet midge, aphids, deer); bushing varietals; single harvest crops, and parthenocarpic crops. Several 2021 growers expressed enthusiasm in continuing to experiment with the mesotunnel system under these and other types of conditions in the future.

APPENDICES
Appendix A – Methods

The team conducted this qualitative study utilizing best practices for qualitative research and evaluation[1].

Data collection: In Fall 2021, two members of the OREI Cucurbits project team conducted individual interviews with each of the project's nine grower cooperators to learn more about their perceptions of and experiences during the 2021 growing season. The team conducted the interviews via Zoom video (recorded), with each interview lasting about one hour. Interviews covered descriptive information on each farm's characteristics (e.g., acreage, years in operation, crops grown, staffing/management); characteristics of the cucurbits trial characteristics (e.g., crop type, row length, pollination, plant growth and development, insects and disease, weed management); mesotunnel implementation and management, harvest outcomes and satisfaction, market type, and marketability information. Interviews also included discussion of perceived cost-benefit of mesotunnel applications in cucurbit crops and potentially other crops, and preferences across various information sources for cucurbit and general crop management.

Data analysis: Analysis of interview data included a multi-prong approach to increase accuracy and reliability of findings. Two team members reviewed in full each recorded Zoom interview, along with its auto-generated transcript. In addition, team members prepared a one-page summary for each interview to confirm overall meaning, details, and key takeaways from each interview. A third analytical step involved the development of an Excel-based data extraction and analysis framework built around all topics and subtopics covered in the interview guide. For each interview, one team member populated this database matrix with short, distilled summary information representing the "key takeaway" response from the interview, along with specific supporting details in adjacent columns of the matrix. A second team member then reviewed these inputs and together the team members cross-validated the data inputs against original transcripts and revised as needed to best reflect original response inputs and meaning where needed. Once populated, this database greatly facilitated cross-comparisons both across an individual respondent's response set and also across respondents for any given topic or subtopic. Together, these combined levels of analysis and review bolster confidence in our findings and conclusions and deliver an organized knowledgebase documenting the experience of the 2021 cooperators' season for future use and reference.

Reporting: The information contained in this report is primarily intended for internal consideration by the OREI project team and Advisory Panel for use in planning for the 2022 season and future retrospective analyses. Findings from this study were reported in several formats in Winter 2022, including a presentation of findings to the project team and a summary report to the project team and the project's Advisory Panel.

[1]Patton, M. Q. 2014. *Qualitative Research & Evaluation Methods Integrating Theory and Practice* (Fourth Edition), Sage Publications, Thousand Oaks, CA. Retrieved from: https://study.sagepub.com/patton4e

Appendix B – Interview Guide

USDA-OREI: Resilient Systems for Sustainable Management of Cucurbit Crops (2020-2022)

Interviews with Cooperators in On-Farm Trials: YR2 2021 Growing Season

Informed Consent Information [can be read by, or to, prospective interview participants]: We invite you to take part in this end-of-season cooperators interview, part of the USDA-funded research project *USDA-OREI: Resilient Systems for Sustainable Management of Cucurbit Crops (2020-2022)* led by Dr. Mark Gleason at Iowa State University. This interview should last between 45-60 minutes. Questions focus on your experiences during the 2021 growing season, including your views on disease, pests, effectiveness of mesotunnels, plant growth and health; weather conditions; harvest and crop yields, and post-season observations. This interview will be audio and video recorded to allow us to accurately record your responses. You may pass on questions that you do not want to answer or stop the interview at any time. The audio/video recordings will be saved through the end of the project in our secure online files. Only researchers on our team who are trained and certified to handle identifiable data have access to these files. Your name will never be reported or otherwise associated with your responses in any project reporting.

Your verbal consent to continue with the interview is sufficient indication of your consent to participate. If you have any questions, please feel free to contact project team members Jose Gonzalez jgonzal@iastate.edu, Heather Dantzker heather@dantzker.com, or Dr. Mark Gleason mgleason@iastate.edu. If you have questions or concerns about your rights as a research participant, you may also contact the Iowa State IRB at (515) 294-4215, IRB@iastate.edu.

ID NUMBER of the field trial experiment_____ **Cucurbit crop(s) grown in 2021**_____

Date of interview_____ **Name of Interviewer(s)**_____

Introduction: We'll start our conversation today by asking you to give us a brief overview of your farm, generally, but focusing on what cucurbit crops you grew in 2021, including those grown with mesotunnels. Then we'll talk about your mesotunnels in more detail. After that, we'll talk about how you feel mesotunnels impacted your 2021 crops, and we'll wrap up with some questions about key take-aways and how you like to receive information.

SECTION 1 – Overview of Your Farm and Cucurbit Crops

Q1. Farm Overview

- Please tell us a bit about your farm, such as:
  - How long you have worked on it?
  - Overall size?
  - Who works on it?
  - What is grown on it?
  - What kind of cucurbit crops are grown?

Q2. Cucurbit Crops and Mesotunnels

- What cucurbit crops did you grow under mesotunnel row covers this year?
  - How many linear feet (or acres) did you plant of cucurbit crop/s
  - About what percent of your total cucurbit crops were grown using mesotunnels?

SECTION 2 - Mesotunnels

Now let's talk in more detail about the mesotunnels used on your cucurbit crops. Let's talk about storage and maintenance first (if applicable), then we'll talk about construction, installation, and other factors like pollination. Please recall the 2021 growing season when answering these questions.

Q3. Mesotunnel storage and maintenance

- In 2021, to what extent did you use or reuse mesotunnels materials (netting, hoops, etc.) from a prior season? How did you store your nets?
- What, if any, maintenance was done prior to this year's use?
  - How well did the nets hold up the second year?
- Generally:
  - What worked well (with storage and maintenance)?
  - What were the challenges?
  - Are there any lessons learned or take-aways you can share? (What would you do differently next time?)

Q4. Mesotunnel construction and configuration

- Please tell us a bit about how your mesotunnels were configured and constructed.
  - Was the nylon-mesh netting supported by hoops? If so, how tall were the hoops?
  - When did you construct your mesotunnels/s?
- Generally:
  - What worked well?
  - What were the challenges?
  - Are there any lessons learned or take-aways you can share? (What would you do differently next time?)

Q5. Mesotunnel Installation

- How did the mesotunnel installation process go with your cucurbit crops?
  - How many people did you need to build it?
  - How long did it take?
- Was the mesotunnel plot set up as single rows, or in a multiple-row arrangement covered by single pieces of the netting?
- When were the mesotunnels installed (for example, in relation to transplanting)?
- Generally:
  - What worked well?
  - What were the challenges?
  - Are there any lessons learned or take-aways you can share? (What would you do differently next time?)

Q6. Pollination

Let's talk now about how pollination worked with your mesotunnels...

- How was pollination of the mesotunnel-covered plot ensured? (e.g., was netting removed? If so, for how long?)
- Generally:
  - What worked well?
  - What were the challenges?
  - Are there any lessons learned or take-aways you can share? (What would you do differently next time?)

Q7. Mesotunnel performance and maintenance
Thinking now about mesotunnel maintenance and how they held up…

- To what extent did you observe any damage to the mesotunnels during the growing season? (e.g., from animals, weather, or other causes?) What did damage look like? What repairs or modifications were made?
- How did managing the tunnels at harvest work out? Was the netting removed immediately before harvest began, or at some other time?
- Do you plan to use the mesotunnels materials in a future year? If so, how do you plan to store the materials? What types of repairs do you plan to make, if any?
- Generally:
    - What worked well?
    - What were the challenges?
    - Are there any lessons learned or take-aways you can share? (What would you do differently next time?)

Q8. Costs and Labor
Now let's talk about your thoughts on the costs of using mesotunnels.

- What do you estimate was the cost of installing the mesotunnels(s) in 2021?
    - Time?
    - Materials?
    - Labor?
- What are the relative costs and benefits of using mesotunnels that you have experienced?
- Are there any lessons learned or take-aways regarding cost you can share? (What would you do differently next time?)

SECTION 3 - 2021 Growing Season: Your Observations and Perceptions of Impacts
Now let's talk about the 2021 growing season to learn more about your thoughts on impacts of the mesotunnels on your crops…

Q9. Plant growth and development

- Considering plant growth and development, how did your cucurbit crops with mesotunnels fare throughout the 2021 season?
- In what ways do you think the mesotunnels/s affected plant growth and development?

Q10. Insect pressure and impacts

- What kind of insect damage and disease pressure did you observe this season?
- To what extent do you think the mesotunnels/s impacted insects and disease? How?

Q11. Weed management

- What kind of weed management did you use with your mesotunnel? How well did it work?

Q12. Biological controls

- What biological controls and other OMRI-approved products did you use? How well did they work this season?

Q13. Timing of harvest

- To what extent do you think the mesotunnel affected your crop harvest date? (e.g., earlier than usual? Delayed?) Why?

Q14. Crop yield cost-benefit

- **Year to year comparison:** If you raised this crop before, how did this year's yields compare to past years?
- **Satisfaction:** How satisfied were you this year with your yields from cucurbit crops grown with mesotunnels?
  - Product quality?
  - Market prices?
- **Cost benefit:** Based on the cost (time, labor, materials, etc.) of the mesotunnels/s, do you think there was a payoff this season in having your crop protected under nets?

SECTION 4 – Key take-aways: Successes, Challenges, and Lessons Learned

Q15. Growing seasons 2021: Greatest success in general and then in the mesotunnel

- What do you consider your greatest management **success** from this year?
  - Lessons learned?
  - Key take-aways?

Q16. Growing season 2021: Greatest challenge in general and then in the mesotunnel

- **What** has been the most difficult management **challenge** this year?
  - Lessons learned?
  - Key take-aways?

Q17. Other inputs

- Is there any else you would like the project scientists to know about your 2021 field trial?

Q18. Other mesotunnels applications

- For what other crops do you think mesotunnel/protection row covers and nets could be a useful management tool?

SECTION 5 - Information and Resources

Q19. Information sources and preferences

- How often do you visit university-related websites, blog posts, podcasts, videos, or webinars to get information that could be useful for crop management?
  - What is your preferred source (or sources) of information?

Q20. Need support or have questions?

- Are there resources or additional support you'd like from the project science team?
- Do you have any questions at this time we can refer to the team?

Thank you for your time!

If you think of additional information that you'd like to share with us, please drop us an email at:

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Appendix C – Data Analysis Matrix Example

				SECTION 3 - 2021 Growing Seasons: Observations & Perceptions					
Q9 Plant growth and development	Plant growth and development	**Q10 Insect pressure and impacts**	Insect pressure and impacts	**Q11 Weed mgmt**	Weed mgmt	**Q12 Biological controls**	Biological controls	**Q13 Timing of harvest**	Timing of harvest
ow did your curbits with nesotunnels re in 2021?	Perceptions of mesotunnel effect on plant growth & development	Kinds of insect pressure and disease observed in 2021	Perceptions of mesotunnel impact on insects/disease (how and to what extent)?	What kind used with mesotunnel ?	How well did it work?	What biocontrol/ OMRI-approved products were used?	How well did they work in 2021?	Perception of mesotunnel effect on harvest date	Why? (explain)
me acking and t due to ning of rvest, good ality herwise, rong healthy ants, did not e back ickly	"Night and day" difference between covered crops and control crops, did not harvest any of the control melons due to poor quality	Minimal insect, some wilt, few squash bugs, a few cucumber beetles, some fungal disease	Some insect damage in the tunnel after opened ends, but protection during the season was good	Landscape fabric	Sufficient, but noted they have heavy weed pressure every year	None	None	Delayed harvest, but also noted she forgot about harvesting the melons	Could not monitor the plants through the netting
bust, althier, tter quality mpared to ose not in e tunnel til llination	More robust, healthier, no disease or insect damage	Squash bugs, cucumber beetles, fusarium wilt, other wilts	Great until pollination	Landscape fabric, hand pulling x2	Great, really good results	Pyganic, Espinosa product	Not well at all	Delayed the harvest	Plants outside the mesotunnel deteriorate quicker, stayed healthier longer in the tunnel
ere was a t of loss but suggested was due to	Positive impact	Mininmal due to the netting, but this year	No diseases mentioned, minimal insects	Planted into plastic, mowing the alleys	Weeds were a huge managment	Azera	Unsure, applies it as a knockdown	Moves up harvest date due to GH effect	Late, difficult to see through the row