Cucurbits under Cover: Assessing the Economic Efficiency of Mesotunnels for Organic Cucurbit Growers

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Problem / Rationale

Cucurbits are among the most important food crops worldwide. Of the cucurbit family, pumpkin and squash make up 18% of the top 10 vegetables marketed in the United States (USDA 2020) and are major sources of income for specialty crop growers. Meanwhile, consumer demand for fresh and locally produced organic vegetables and fruits is rising rapidly in the United States. However, growers in the southern, Midwest, and northeast United States struggle to capture this opportunity due to crop damage caused by pests and disease complexes that collectively cost growers more than $100 million per year. Unlike conventional synthetic chemical pesticides, organic pesticides are few in number and often fail to stop cucurbit pests and diseases. In addition, pesticides can injure pollinators that are essential to cucurbit-crop production. Thus, organic cucurbit growers lose income from pest and disease damage and also from missing key marketing opportunities. Furthermore, producer-to-consumer distribution channels are threatened by inconsistent yield and quality.

Focal Technology: Mesotunnels for Cucurbit Growers

A novel option for cucurbit growers is to use a season-long barrier system called "mesotunnels." Mesotunnels deploy a tough, breathable, lightweight, nylon-mesh fabric that covers 3.5-foot-tall support hoops. The fabric keeps out cucumber beetles, squash bugs, and squash vine borers, as well as the diseases they spread. In small-plot trials from 2016 to 2018, Iowa State University researchers used mesotunnels to produce consistently large gains in marketable yields for organic muskmelon and acorn squash with sharp reductions in pesticide spraying (Nelson and Gleason, 2016, 2017, 2018). An ongoing project is scaling up mesotunnels to commercial scale in Kentucky, New York, and Iowa.

Figure 1. A mesotunnel system in cucurbit production. The nylon-mesh fabric covering the plants is secured to the ground with sandbags.

However, the high cost of nylon-mesh netting raises growers' concerns about mesotunnel system profitability and cost-efficiency compared to current organic production methods. I interviewed organic cucurbit growers that are on the advisory panel of a USDA-NIFA funded project to learn their viewpoints on the practical use of mesotunnels for cucurbit production. This extension project is designed to inform the USDA-NIFA project about grower receptivity to the mesotunnel system.

The **goal** of the program is to help organic cucurbit growers increase their knowledge of the profitability and cost-efficiency of mesotunnels and to decide if they should adopt mesotunnels to increase profits and create new marketing opportunities. Table 1 and figure 2 illustrate the broad and specific logic model of how this program can achieve this goal. The red font in Figure 2 indicates the activities in which I am involved.

Table 1. Extension Program Overview

Extension Program Overview	
Need Assessment	• Organic cucurbit growers struggle with pests and diseases and miss opportunities to expand into a larger organic market share. • Organic pesticides do not work well against key pests.
Significance	Inform organic growers about economic efficiency of mesotunnels and expand growers' crop production system options.
Target Audience	• Organic cucurbit growers in Iowa, Kentucky, New York and 14 surrounding states.
Delivery modes	• Semi-annual grower interviews (completed for 2020). • Blog posts, project website, podcast series, YouTube videos, Twitter, Facebook. • Workshops and extension presentations.
Outcomes	• Short term: Increase knowledge of profitability and cost-efficiency of mesotunnel systems. • Medium term: Document growers' changes in managing pests and disease in organic cucurbit crops. • Long term: Expand organic marketing opportunities for locally grown cucurbit crops.
Evaluation	• Number of visits to website, podcasts, blog posts, and videos. • Number of workshops conducted and number of attendees. • Number of key growers' quotes and testimonials.

Accompanying our scaled-up mesotunnel experiments are cost and yield data. I organized these data, differentiated cost items for each experiment, calculated total costs, and applied partial budget analysis (Alimi, 2000) to reveal when and where mesotunnels were profitable and cost-efficient. In addition, I conducted eight grower interviews to determine their level of satisfaction with mesotunnels and learn about problems they encountered when applying the system on their farms (Morton, Cheng, and Diggins, 2021). With my supervisor as co-author, I wrote a technical report summarizing the year 1 grower survey (Cheng and Zhang, 2021) . To spread the messages from our project, we developed a central website, a blog series, a podcast series, and a YouTube video series. [1] My supervisor and I wrote a blog post describing how we approach analyzing the economic efficiency of mesotunnels. (Cheng and Zhang, 2020)

[1] Project website https://www.cucurbit.plantpath.iastate.edu/

In the short term (1–3 years), the program is helping increase cucurbit growers' knowledge of the profitability and cost-efficiency of mesotunnel systems. In the long term, the project will impact cucurbit growers' decision-making processes on adoption of production systems and the potential to expand organic fresh-vegetable marketing opportunities.

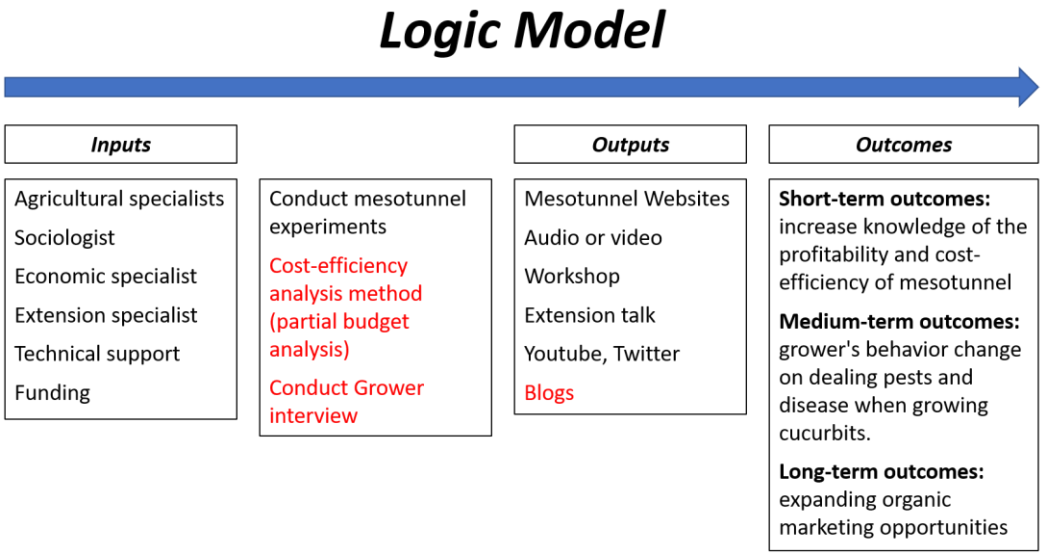

Figure 2: Logic model for assessing profitability and cost-efficiency of mesotunnel systems.

Activities and Program Delivery

In addition to the delivery activities described above, I also plan to disseminate the project's economic analysis results through extension outlets from Iowa State University Ag Decision Maker and horticulture extension newsletters from Iowa State University, the University of Kentucky, and Cornell University.

Preliminary Findings

Cucurbit Growers' Perceptions of Mesotunnel Production Systems

The 2020 grower interviews found that growers believe mesotunnels are very efficient crop production systems, but they were uncertain about what happened inside the mesotunnels. Due to the high cost of nylon-mesh netting, some growers were concerned that the costs could exceed returns they would get for acorn squash. Several growers recommended that a higher value crop like brassicas, peppers, eggplant, or brussels sprouts could be more profitable. Most growers did not think mesotunnels could be paid off in a short period, but did think there was potential in the long term.

Economic Profitability Analysis (Cost-efficiency)

The 2020 economic efficiency analysis found that small-scale mesotunnel production systems (12 ft. by 40 ft.) in which the netting is removed during pollination and replaced after pollination are more cost efficient than systems in which the netting is left in place all season and beehives inside the mesotunnels act as pollinators. However, enlarging the production scale to one acre or above has the potential to achieve higher cost-efficiency.

The OREI Cucurbit Crops Project Year 1 Whole Team and Advisory Panel/Cooperative Grower Surveys

This report found that growers were receptive to possible advantages of mesotunnels but also hoped for more options for crop disease management. When making decisions to use a pest and disease management system, growers considered higher yields, product quality, and soil health, as well as reducing pesticide runoff or leaching, as the most important factors in favor of switching to mesotunnels.

Evaluation Plan

To determine whether our grower-communication initiatives were the best methods to deliver our findings, we conducted a pre-investigation online survey to gather information about growers' preferred ways to learn new agricultural knowledge. Grower interviews were also conducted to collect information about the frequency of visiting university-related websites, blog posts, podcasts, videos, or webinars to get information that could be useful for crop management, as well as preferred sources of information.

We identified several potential key indicators to determine whether our project was successful in delivering knowledge to organic cucurbit growers: (*a*) the number of visits to websites or blogs; (*b*) the number of audio or video reproductions; (*c*) the number of workshops conducted and attendance thereof; (*d*) the number of Twitter interactions and YouTube views; and, (*e*) the number of key growers' quotes and testimonials. The Twitter account has 87 followers and up to 300 interactions per month on average, and the YouTube videos have more than 50 views. [2]

Our evaluation program consists of three parts. First, we will hold short pre- and post-workshop surveys to gauge how much knowledge organic cucurbit growers gain from the workshops. Second, will use follow-up surveys, approximately 6 months after the workshop, to see how much the workshops affected growers' crop-production-system adoption behaviors. Third, we will record the number of farms adopting mesotunnel technology for organic cucurbit production and estimate average cost savings associated with mesotunnel use.

Stakeholders and Target Audience

The targeted audience is organic cucurbit growers in Iowa, Kentucky, New York, and 14 surrounding states. The stakeholders include an advisory panel, on-farm demonstration trial partners, and all organic vegetable growers within reach of our outreach programs. Additional partners include Extension specialists and research/teaching faculty members from Cornell University and the University of Kentucky, as well as statewide vegetable-grower associations.

Team and My role

My main role is analyzing the economic cost-efficiency of mesotunnel systems using data provided by the team's agricultural specialists. In addition, I help conduct grower interviews, organize the responses, and summarize the take-home messages, and I write blog posts and annual reports. My advisor, Wendong Zhang—an Assistant Professor at Iowa State University—helps construct the interview script and survey questions and provides guidance on using partial budget analysis methods to evaluate the economic efficiency of mesotunnels.

[2] Twitter link https://twitter.com/TCucurbit;
YouTube link https://www.youtube.com/channel/UCjyDwtnC4FDGKz1PU2QKrVw?view_as=subscriber

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