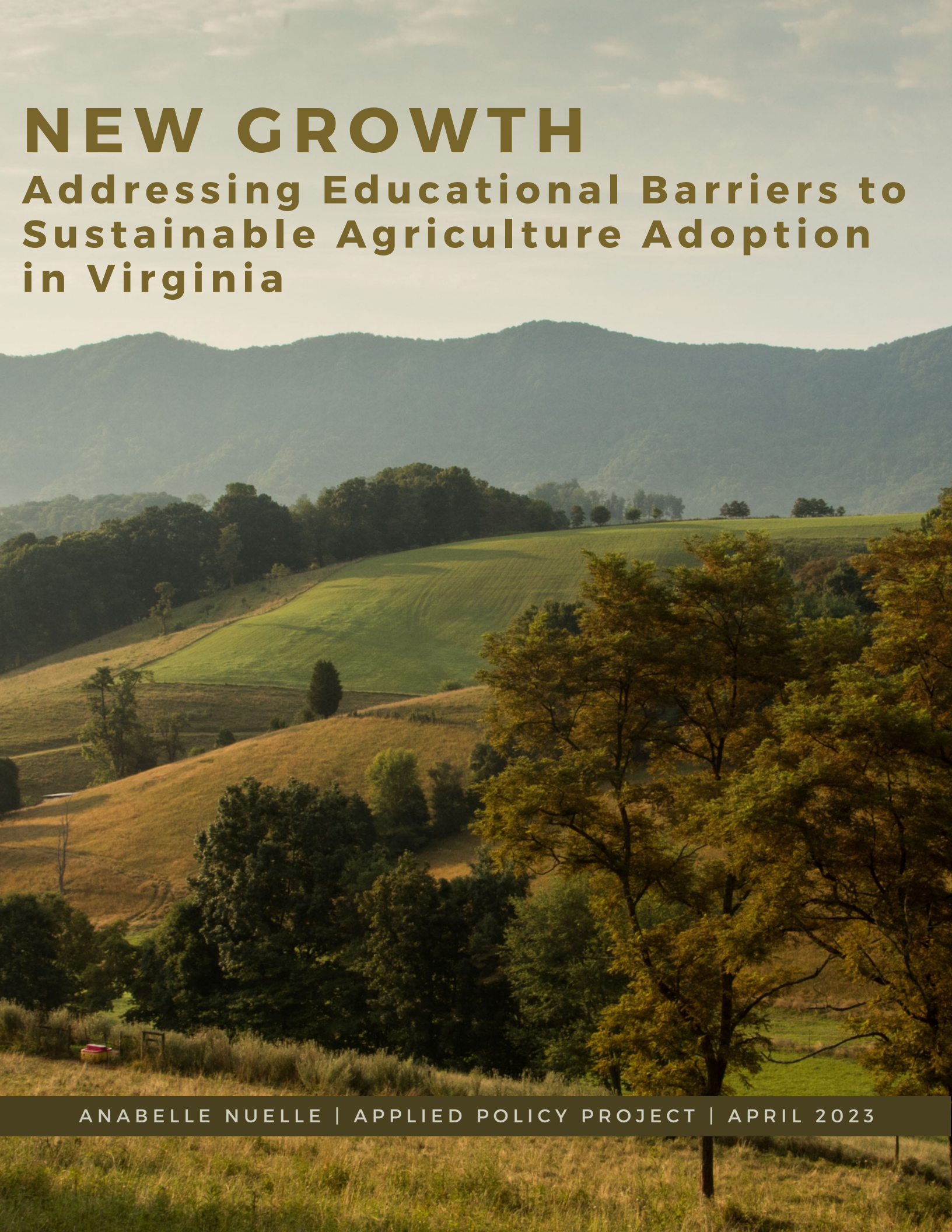
NEW GROWTH

Addressing Educational Barriers to Sustainable Agriculture Adoption in Virginia



ANABELLE NUELLE | APPLIED POLICY PROJECT | APRIL 2023

ACKNOWLEDGEMENTS

I am grateful for the many people who supported and encouraged me throughout this process.

First, thank you to Nadine Clopton and the incredible Rodale Institute. Nadine's ceaseless enthusiasm, stimulating conversation, and steady support propelled this project. My thanks also to Andrew Smith, Sam Malriat, and his team whose conversation and expertise invaluably shaped my work. Your tireless efforts improve the wellbeing of farmers, the environment, and consumers alike. I so appreciate the opportunity to work on a topic I care deeply about, with an organization I greatly admire.

Thank you to Professor Andrew Pennock for your feedback, support, and insight. This project evolved and grew under the guidance of your questions and commitment to my growth as a student, professional, and person.

I am thankful also for my exceptional peers and professors, and the Batten School staff. Megan Finney and Janet Conklin were exceptional partners and advocates throughout this work. I lack adequate words to express how much I have learned from this community, and the growth it has inspired.

Finally, my deepest thanks to my friends and family. Your encouragement, patience, and conversation carried me through this process.

With gratitude,

TABLE OF CONTENTS

OVERVIEW

INTRODUCTION

If how we eat determines how the world is used, how we grow our food decides the condition of our environment and the degree of our own resilience. An absence of sustainable agricultural practices diminishes the wellbeing of people and planet. This analytical report identifies informational and social barriers to sustainable practice adoption in Virginia and proposes viable educational interventions to minimize such barriers. It is comprised of seven sections: overview of the problem, summary of relevant background information, review of existing response evidence, criteria used to analyze proposed interventions, presentation and analysis of proposed interventions, author's recommendation, and implementation guidance. By its conclusion, an overview of lagging sustainable agriculture adoption, its causes, consequences, and the corresponding best means of increasing adoption through education are clear.

This report was completed in support of the Rodale Institute's mission and comes amidst recent headlines scrutinizing the repercussions of pesticide use – namely paraquat and glyphosate - on producer health (Grzincic, 2022; Pierson, 2022). The selected problem is scoped to Virginia to position the author to engage in site visits and first-hand information collection. Given the nation-wide prevalence of the adoption barriers identified in the following pages, this project is likely to maintain relevance beyond Virginia's boarders.

CLIENT OVERVIEW

The Rodale Institute is a 501(c)(3) nonprofit committed to the regenerative organic agriculture movement, and dedicated to creating a more resilient food system that improves human and environmental health in tandem. Headquartered in Kutztown, Pennsylvania with regional centers across the United States, the Rodale Institute is internationally recognized for its rigorous research, education, and farmer training programs. Since its founding in 1947, the Rodale Institute's research has focused on developing organic solutions to disease, pests, and weeds; growing high quality food; and climate change mitigation and adaptation.

The Rodale Institute has recently expanded its focus to include regenerative health, or the interaction of agricultural practices and human health outcomes. This focus presents an opportunity to complement Rodale's natural science expertise with social science approaches. The selected problem – educational barriers to sustainable agriculture adoption – responds to this burgeoning interest by centering social and informational interventions to change producer behavior, and ultimately advance human and environmental health.

DEFINITIONS & ACRONYMS

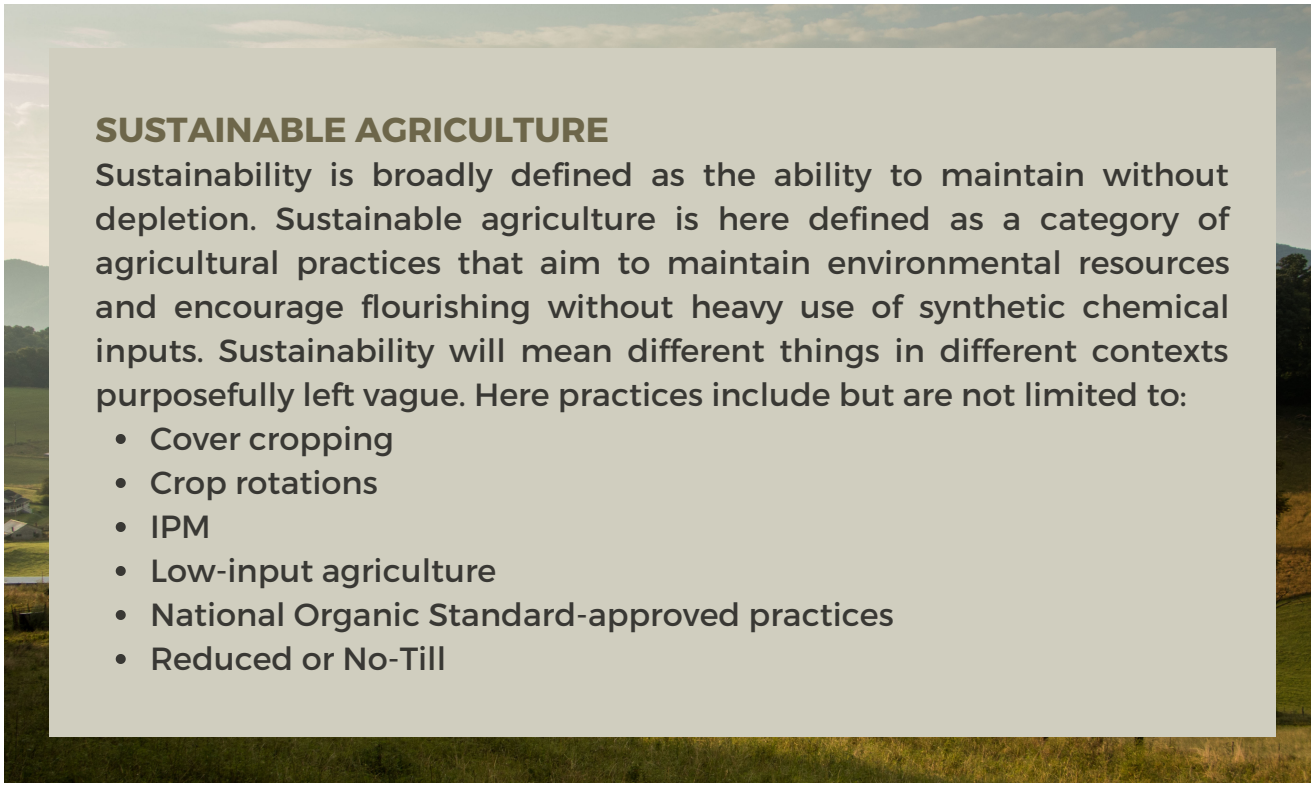
ACRONYMS

Agencies

- AREC - Agriculture Research and Extension Center
- DCR - Virginia Department of Conservation and Recreation
- SWCD - Soil and Water Conservation District, a subset of DCR
- NRCS - USDA Natural Resources Conservation Service
- VCE - Virginia Cooperative Extension
- VDACS - Virginia Department of Agriculture and Consumer Services

Practices

- IPM - Integrated Pest Management
  - A range of practices that seek to manage pests by using information about the relevant pests' life cycles and the surrounding ecosystem. IPM ultimately seeks to use pest management means least hazardous to people and the environment.



SUSTAINABLE AGRICULTURE

Sustainability is broadly defined as the ability to maintain without depletion. Sustainable agriculture is here defined as a category of agricultural practices that aim to maintain environmental resources and encourage flourishing without heavy use of synthetic chemical inputs. Sustainability will mean different things in different contexts purposefully left vague. Here practices include but are not limited to:

- Cover cropping
- Crop rotations
- IPM
- Low-input agriculture
- National Organic Standard-approved practices
- Reduced or No-Till

EXECUTIVE SUMMARY

Agriculture is Virginia's largest private sector industry, but a minority of farms integrate practices that reduce environmental and human harm (VDACS, 2017). In the absence of such sustainable agricultural practices, human and environmental wellbeing degrades. Conventional agricultural practices and inputs have been linked to chronic or deadly human diseases, ecological disruption like reduced biodiversity and diminished soil health, and even missed economic opportunity for agricultural producers.

While sustainable practice adoption is hindered by several barriers, this report specifically examines informational and social obstacles. It identifies educational interventions as a feasible and effective response to these barriers and tailors them to Virginia's unique context. Best practices are gathered from existing evidence and three policy alternatives, beyond status quo, are proposed:

- Micro-Field Day Programs
- In-person Soil Heath and Water Quality Classes
- Hiring Sustainable Agriculture Extensionists

These alternatives are evaluated based on their cost effectiveness, localized approach, and physical accessibility for producers. Based on these criteria, this report recommends the Commonwealth of Virginia establish Micro-Field Day programs through its network of Soil and Water Conservation Districts (SWCDs). The implementation of this alternative should consider a phased rollout; strategic curriculum and host selection that considers timing and existing relationships; equitable and inclusive participant outreach; utilizing outcome-oriented language; and leveraging the opportunity to collect data about effective producer education.

PROBLEM DEFINITION & BACKGROUND

PROBLEM DEFINITION

Educational barriers to sustainable agriculture adoption are too high for Virginia's farmers. Agriculture is Virginia's largest private industry, with 46,030 farms covering 8,300,000 acres (VDACS, 2017; Virginia Tech, 2023). However, only about 23% of these farms integrate a soil or water conservation practice (Virginia Tech, 2023). In the absence of sustainable, low-input agricultural practices, human and environmental wellbeing degrades (Matson et al., 1997; Pimentel, 2005; Pimentel et al., 1995).

Figure 1. Total Virginia Farms With and Without Soil- or Water-Conservation Methods

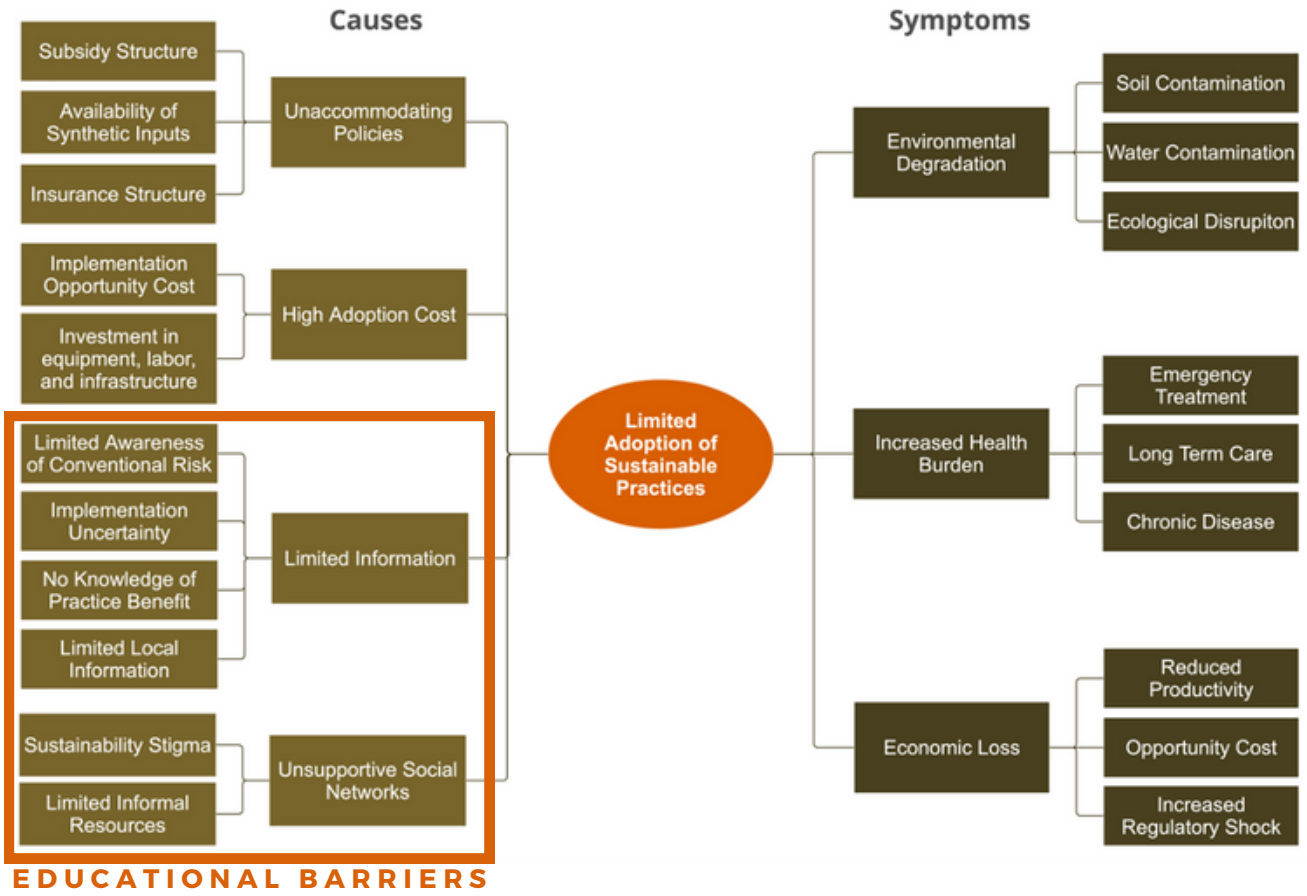
CAUSES & SYMPTOMS

CAUSES

Sustainable agriculture practice adoption is limited by four main categories of barriers: unaccommodating policies, high costs of adoption, limited information, and unsupportive social networks. Figure 2 depicts these barriers and the correlating symptoms.

Current subsidy and crop insurance policies are designed to support conventional agriculture, leaving unconventional sustainable systems more exposed to economic risk (Carlisle, 2016; Tisdell et al., 2001). Coupled with relatively flexible pesticide regulations, synthetic inputs are accessible and better protected (Donley, 2019). The cost of implementation is also steep, investments include equipment, infrastructure, and labor (Carlisle, 2016). These costs are layered onto the potential opportunity costs born while practices are being fully integrated (Carlisle, 2016).

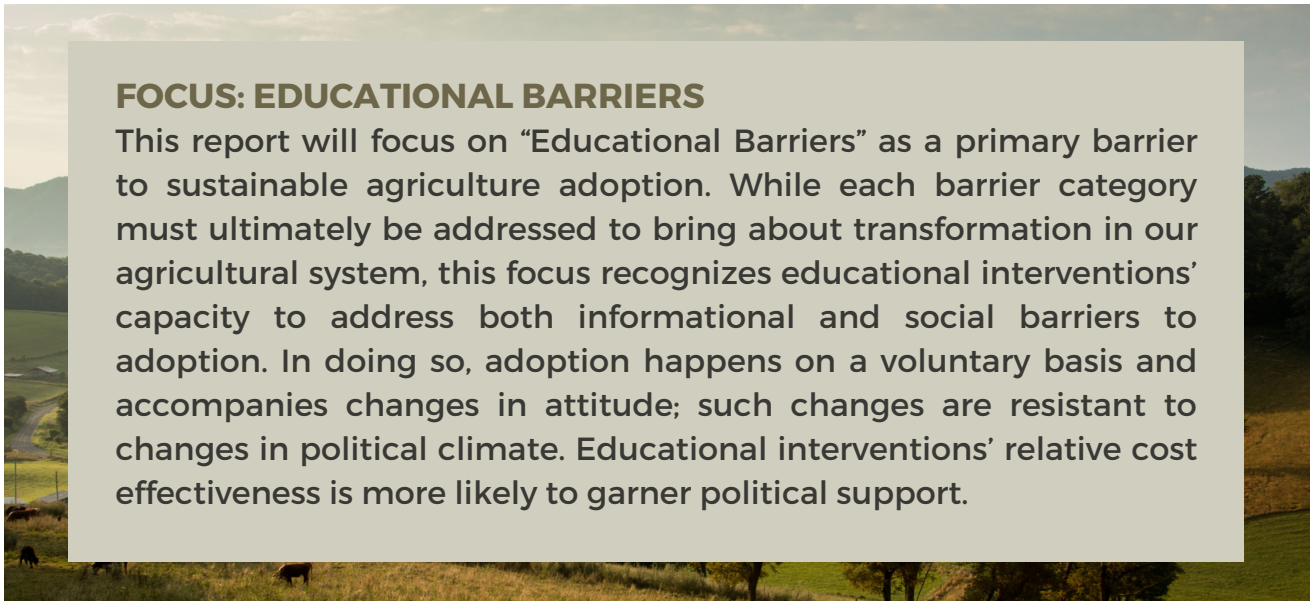
Figure 2. Causes and Symptoms of Limited Sustainable Agriculture Adoption



Limited awareness of the long-term risks of conventional practices or of the benefits of sustainable agriculture hinders practice adoption (Carlisle, 2016). The costs of implementation are too high to shoulder without the promise of gain. Producers also need implementation information tailored to their operation and region. Even a practice a common as cover cropping asks producers to replace their existing definitions of seasonality, process and timing (D. Smith, personal communication, January 17, 2023). If practices are unsuccessfully or incorrected integrated, lead time to realize benefits may be extended and initial investment increased (D. Smith, personal communication, January 17, 2023).

Social networks are an informal source of information, best practices, support, and even equipment (Bliss et al., 2019; Carlisle, 2016; C. B. Henley, personal communication, February 25, 2023). In the absence of these practices, farmers implementing practices for the first time have fewer resources to which to turn. Stigma may also follow sustainable practice adoption as it pursues “legitimacy” in mainstream agricultural channels.

As “alternative” practices, sustainable agriculture and its practitioners are viewed in opposition to conventional practices. Adoption by some may threaten the identity of others (S. Malriat, personal communication, February 6, 2023). Some may subconsciously read criticism into the decision to implement sustainable agricultural practices by neighbors and react. For instance, producers adopting organic practices have faced active retaliation from neighbors like hiding tractor keys (S. Malriat, personal communication, February 6, 2023).



FOCUS: EDUCATIONAL BARRIERS

This report will focus on “Educational Barriers” as a primary barrier to sustainable agriculture adoption. While each barrier category must ultimately be addressed to bring about transformation in our agricultural system, this focus recognizes educational interventions’ capacity to address both informational and social barriers to adoption. In doing so, adoption happens on a voluntary basis and accompanies changes in attitude; such changes are resistant to changes in political climate. Educational interventions’ relative cost effectiveness is more likely to garner political support.

SYMPTOMS

Barriers to sustainable practice adoption maintain agricultural practices that can be harmful to producers and environments. Conventional agriculture has been linked to environmental concerns including soil erosion, reduced soil fertility, reduced biodiversity, and polluted or eutrophic waterways (Matson et al., 1997; Pimentel et al., 1995, 2005). Wildlife habitats and pollinator populations are similarly threatened by synthetic inputs (Belsky & Joshi, 2020; Pimentel et al., 2005; Sponsler et al., 2019). Finally, there is additional risk to nearby communities and land should they be unintentionally exposed tol chemicals through spray drift or water contamination (Ames et al., 1993; Brown et al., 2022; EWG, n.d.).

Some of the most common inputs of conventional agriculture are considered to be toxic or “highly poisonous” to people and have been linked to neurological, respiratory, reproductive, and carcinogenic effects (CDC, 2019; Nicolopoulou-Stamati et al., 2016). Healthcare costs following exposure to such toxic inputs include the economic cost of emergency treatment or the health burdens of long-term symptoms like lung damage and Parkinson’s Disease (CDC, 2019; Engel et al., 2001; Nicolopoulou-Stamati et al., 2016). Healthcare comes with additional costs if individuals are unable to work due to their symptoms (Pimentel, 2005).

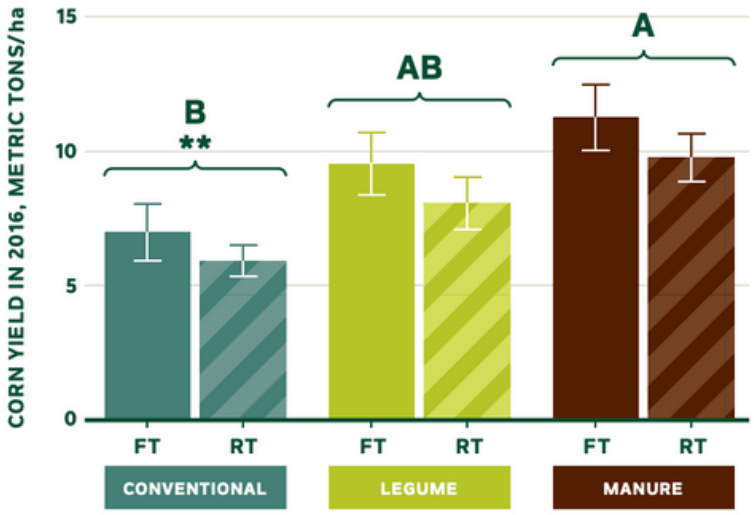
Such health concerns have given way to increased scrutiny and regulatory pressure. Glyphosate, known under the brand Roundup, is one such example (Cox, 2019). Parent company, Bayer, will no longer be selling glyphosate-based herbicides in the US residential market as a response and the EPA is actively reviewing its registration decision (Pierson, 2022; US EPA, 2014).

In contrast, sustainable practices center soil health and water quality which contributes to the longevity and quality of environmental resources These factors ultimately influence farms' economic productivity (Piñeiro et al., 2020). Sustainable practices also encourage reduced dependence on synthetic inputs, effectively minimizing farmer and farmworkers' physical exposure and protecting them from anticipated regulatory shocks. Barriers to sustainable agriculture adoption prevent producers from realizing these benefits.

THE RODALE EXAMPLE

For over 40 years the Rodale Institute has accumulated rigorous scientific data on the distinct impacts of organic and conventional grain cropping systems. The Farming Systems Trial (FST) research project compares a chemical-input system, a legume-based organic system, and a manure-based organic system, each of which is also divided into full-tillage and reduced-tillage practices. As assessment of the cash crop yields found organic grain yields far exceeded conventional in years of severe weather. Figure 3 depicts average corn yields in 2016, an exceptionally dry season. Relative to conventional systems, both legume-organic and manure-organic systems exceeded conventional corn yields, regardless of tillage practices. Results were significant ($P<0.05$) across systems. Average yield differences between reduced- and full-till in conventional practices were significant at a 99% confidence interval (Rodale Institute, 2022).

Figure 3. Average Corn Yield in 2016 between Conventional & Organic Systems



(Rodale Institute, 2022)

GOVERNANCE

Means of educating producers are varied and decentralized, particularly when it comes to sustainable agriculture practices. Table 1 summarizes the primary agencies and programs available at each level of government to support producers in the adopting sustainable practices. Note, the programs administered through USDA NRCS require producers apply and be selected to access program benefits (USDA NRCS, 2023).

Table 1. Core Government Support for Sustainable Agriculture Education

	Resource	Detail
FEDERAL (USDA)	Environmental Quality Incentives Program (EQIP)	Offers technical assistance and financial support to help producers integrate conservation practices that address water and air quality, increase soil health, and reduce soil erosion among others (USDA NRCS, 2023).
	Conservation Stewardship Program (CSP)	Provides technical and financial support to help producers adopt and improve existing conservation practices (USDA NRCS, 2023).
	Sustainable Agriculture Research and Education (SARE)	A National Institute of Food and Agriculture (NIFA) outreach and grant-giving program dedicated to sustainable agriculture research and information dissemination through USDA and state-level extension offices (SARE, 2023).
STATE	Virginia Cooperative Extension (VCE)	VCE disseminates information, conducts research, and provides technical assistance pertaining to production practices, pesticide application, and conservation. It is administered through Virginia's land grant universities (Virginia Polytechnic Institute and Virginia State University), and primarily supported by state and local government funds (Virginia Tech, 2023).
	Agriculture Research and Extension Centers (ARECs)	A part of VCE, there are 11 ARECs throughout Virginia, each operates as a research and outreach facility and has a general research focus area (VCE, 2023).
LOCAL	County VCE Offices	Most hands-on, local expertise is administered through these local offices. Extension experts are given leeway to focus on research topics and agronomic practices of their choosing (K. Rice, personal communication, March 17, 2023). There are 108 county and city offices statewide (VCE, 2023).
	Soil and Water Conservation Districts (SWCDs)	A part of the Virginia Department of Conservation and Recreation (DCR), SWCDs offer individualized, hands-on technical assistance to producers specifically interested in conservation practices.

INTERVENTION STRATEGIES

Sustainable agriculture denotes an agricultural approach whose components will change from region to region, crop to crop, and farm to farm (Schaller, 1993). Consequently, methods to addressing educational barriers to practice adoption must account for its multiplicity and immense learning curve. From a growing body of work examining producer education for adoption of sustainable practices (e.g. soil health, IPM, and organic), I detail five educational best practices that address pertinent barriers and respond to producers' needs.

INCREASE INFORMATION ACCESS TO INCREASE ADOPTION

Relative to conventional growers, sustainable producers lack access to educational resources. Conventional growers gain a notable share of their technical information and support through their input purchases - be it seed, fertilizer, or pesticides (Delbridge et al., 2017). As sustainable practices seek to reduce dependency on agricultural inputs, information recedes with purchases (DeLonge et al., 2016). Information scarcity is noted throughout the literature as one of the greatest barriers to practice adoption. One study found clusters of organic producers were more likely to be located in close physical proximity to organic certifiers providing outreach and supportive services (Marasteanu & Jaenicke, 2015). The study suggests the physical presence and activity of information and supportive services are crucial to practice adoption. While this study focused singularly on organic practice adoption, soil health and IPM literature concurs, underscoring the significance of information access to practice adoption (Bueno et al., 2021; Carlisle, 2016; Carlisle et al., 2019; Parsa et al., 2014; Traoré et al., 1998). In her narrative review of soil health practice adoption literature Carlisle (2016) notes soil health information is of interest to both adopters and non-adopters. Methods for increasing information access and outlets for technical support include but are not limited to classes or workshops, peer-to-peer learning and government-led education courses (Wang et al., 2019).

Trust, however, must serve as cornerstone for any informational exchange. One study examining epistemic obstacles to adoption of sustainable agriculture practices notes that information obtained from trusted sources is seen as truth (Carolan, 2006). While not a causal conclusion, this insight illuminates the importance of practice endorsement from trusted individuals and intuitions.

EMPHASIZE BENEFITS & ADDRESS RISK

Information that emphasizes practice benefits and addresses farmer's sense of risk aids practice adoption. Meta-analyses and quantitative studies have concluded that sustainable agriculture can increase ecosystem services while boosting yields and profitability, even out-performing conventional systems (DeLonge et al., 2016). In a comprehensive review of all quantitative research on agricultural conversation practice adoption in the U.S. between 1982 and 2017, positive association with and expectations of practices are among the variables identified as having a statistically positive correlation with adoption (Prokopy et al., 2019).

Certain benefits will resonate depending on a producer's priorities. A qualitative study of farm management style and agroecological practice adoption among 40 California producers found producers who see themselves as being "stewards" of the land and environment are most likely to adopt more sustainable practices and reduce inputs (Brodt et al., 2004). Other work reviewing producer identity and practice adoption came to similar conclusions (Peter et al., 2009; Prokopy et al., 2019). The environmental benefits and goals of endorsed practices are likely to resonate most with this producer type. Information pertaining to cash crop yield benefits will likely be appealing to producers who prioritize financial concerns and should not be neglected (Carlisle, 2016).

One of the suspected drivers of resistance to practice adoption is risk aversion (Skevas et al., 2013). Literature exploring resistance to low input and organic agricultural practices confirms fear and uncertainty maintains status quo behavior. Weed pests comprise one of the biggest threats to agricultural yields and pesticides are often applied, even over-applied, as a type of 'insurance' against such threats (Lefebvre et al., 2015; Monteiro & Santos, 2022; Oerke, 2006; Skevas et al., 2013). Accordingly, new practices, especially those that seek to reduce pesticide application, can appear to pose an innate risk to farmers (Bueno et al., 2021; Lefebvre et al., 2015). Organic practices in particular almost entirely exclude the synthetic chemicals and antibiotics often used as risk mitigation tools (Hanson et al., 2004). The most robust investigations of mechanisms to overcome such belief barriers spring from the EU's encouragement of IPM and organic practice adoption. Central to the EU's efforts is education that seeks to build technical knowledge of low input practices and their benefits (Dara, 2019; Hillocks, 2012; Lefebvre et al., 2015). This body of work also suggests that farmers may adopt sustainable practices like IPM as a response to limit other forms of risk, namely environmental, property or health (Lichtenberg & Zimmerman, 1999). Producers' sense of risk can thus aid or impede practice adoption and should be considered in tandem with practice benefit education.

BUILD IMPLEMENTATION CONFIDENCE IN THE FIELD

Awareness of practices and their benefits will do little if unaccompanied by knowledge about how to implement a practice. A survey of hundreds of IPM professionals and practitioners from 96 countries across the globe identified 51 obstacles to increased IPM adoption, of which "insufficient training and technical support to farmers" was the most frequently cited (Parsa et al., 2014). U.S.-based research arrives at a similar conclusion, finding producers felt "underprepared to implement and optimize" soil health practices (Carlisle et al., 2019). Effective implementation information must be locally-specific, and provide options not mandates, acknowledging the importance of farmers' ability to choose the practices most suitable to their operation (Bueno et al., 2021; Carlisle, 2016; Davis & Frisvold, 2017). Extant literature emphasizes technical and experiential training programs as mode to increase implementation knowledge and confidence (Millar & Curtis, 1997). Field days are one such example.

Field Days

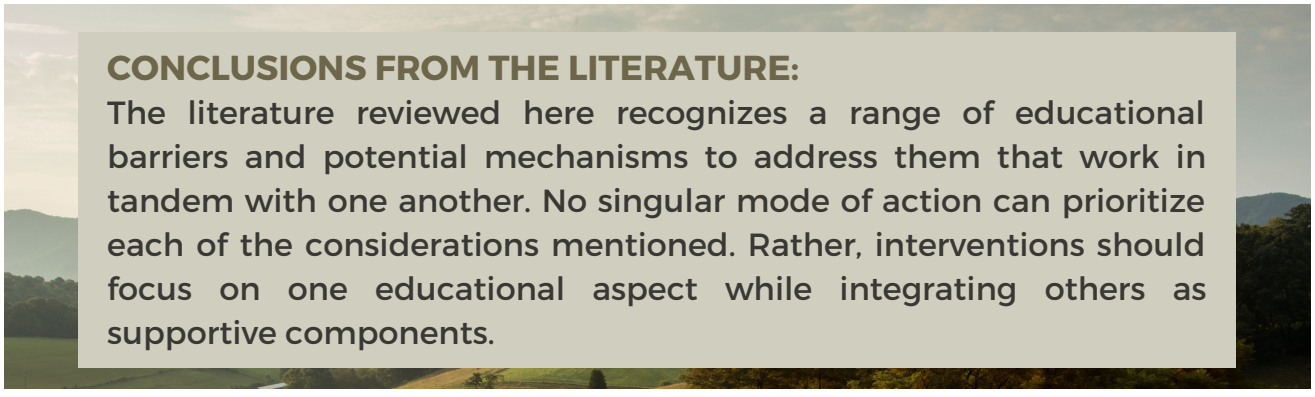
Field days are a popular mode of producer education used globally that offer producers an opportunity to meet in person and learn about a practice or technology through observation and experience (Emerick & Dar, 2021). Much of the literature examining field days' efficacy draws from international examples in low-income countries and finds promising results. A study in India found adoption of improved seeds increased uptake 12% following field day programming (Emerick & Dar, 2021). Another study investigated the cost efficacy of different modes of producer education on IPM adoption in Bangladesh. This study estimated the rate of practice adoption following farmer field days to be 38.8% and noted field days were effective educational models but were somewhat limited in training depth (Harris et al., 2013). Distinctive characteristics of these settings prevents these results from generalizing to the United States. However, field days are a popular producer education model in the US and domestic qualitative studies come to similar conclusions. A review of domestic soil health practice validates the productivity of face-to-face interactions, informational exchanges between farmers, and visual or hands-on learning (Bliss et al., 2019; Carlisle et al., 2016; Carlisle et al., 2019; Mills et al., 2019).

INCREASE SUPPLY OF QUALIFIED EXPERTS

Qualified extensionists and like experts are crucial sources of technical information and training. Integrating sustainable practices is neither an immediate process, nor does it yield immediate results. Rather, sustainable practices are knowledge-intensive; additional support is often needed to refine a plan for implementation and oversee its progress (Carlisle et al. 2019; Mills et al., 2019). Existing literature identifies shortages of well qualified experts and extensionists among the primary barriers to sustainable practice adoption in the United States and other high-income countries (Carlisle, 2016; Hanson et al., 2004; Parsa et al., 2014). Free or subsidized pest management advisors are among the recommended educational modes for IPM adoption in the EU (Lefebvre et al., 2015). This conclusion is endorsed in domestic evidence. A review of 35 years of quantitative conservation practice adoption research found producers who worked with extension or conservation services to develop a conservation plan had a 13.3 percentage point higher adoption rate (24% versus 10.7%), compared to those who did not (Caswell et al., 2001). These results are generalizable to Virginia, stressing the significance of available, accessible expertise.

RECOGNIZE THE SIGNIFICANCE OF SOCIAL NETWORKS

Producer education literature emphasizes the significance of producer networks to support education and encourage practice adoption. A meta-analysis of published and unpublished research assessing Best Management Practice (BMP) adoption in the United States concluded a producers' connection to local farmer networks has one of the largest impacts on practice adoption (Baumgart-Getz et al., 2012). Within networks, producers can find resonance with one another, and endorsements for practice decisions (Peter et al., 2009). One such method comes from the National Wildlife Federation, which encourages the development of "champions," successful individuals eager to share best practices, to expand cover cropping (NWF, 2012). This approach utilizes social currency and peer-to-peer learning. Given the endorsement of social networks and like learning methods throughout the reviewed literature, this approach is likely to work for other practices beyond cover cropping.



CONCLUSIONS FROM THE LITERATURE:

The literature reviewed here recognizes a range of educational barriers and potential mechanisms to address them that work in tandem with one another. No singular mode of action can prioritize each of the considerations mentioned. Rather, interventions should focus on one educational aspect while integrating others as supportive components.

CRITERIA

CRITERIA

The following criteria were chosen based on their pertinence to enhancing sustainable agriculture education, alignment with Rodale's mission, and resonance with the key stakeholder group, Virginia's producers. These criteria will be used to compare, analyze, and evaluate policy alternatives.

COST EFFECTIVENESS

Cost-effectiveness is here defined as the net cost of the proposed educational alternative over the next five years, divided by the estimated number of producers who adopt at least one sustainability practice. Effective policy alternatives remove barriers to attaining the information necessary to adopt a practice, namely an understanding of a practices' benefits, implementation processes, and local specifications. While adoption of a sustainability practice does not represent a complete conversion, extant research suggests adoption of one sustainable practice increases the likelihood of adopting additional practices. The increased prevalence of sustainable agricultural practices is thus evidence of progress towards a healthier people and planet.

Costs encompass both the direct and indirect costs of policy implementation. Direct costs are defined as the accrued operational and administrative costs necessary to implement the proposed policy, like cost to print educational materials and personnel costs. Indirect costs are defined as the opportunity costs from enacting a policy. These costs are discounted over a period of ten years and calculated using a 2% inflation rate and 1.3% discount rate, as recommended by the OMB for cost-effectiveness analysis (Young, 2023). The most cost-effective policies will increase the number of producers integrating sustainable practices, at the lowest cost.

LOCALIZED APPROACH

Localized Approach describes two impact goals, level of localization and information specificity. Higher degrees of both impact categories are viewed more favorably.

Level of Localization captures the level at which program decisions are being made (e.g. federal, state, local) and their decentralization. The higher and more centralized the level of program decision making, the more effort will likely be required to garner decision makers' attention, resources, and political buy in.

Alternatives with more local levels of decision making will inevitably be more decentralized and independent. More local level programs also claim closer proximity to producer stakeholders. Greater degrees of localization are thus viewed more favorably. Policy alternatives are categorized as follows:

Level of Localization	Description
High	Decision makers are decentralized, local, and require little to no state-level approval.
Medium	Decision makers are somewhat decentralized, regional, and requiring some state-level approval.
Low	Decision makers are centralized, state-level and require state-level approval.

Information Specificity recalls the significance of local information to producers. This category notes how specific a program information is to a producers' operation, thus making the information more practical and easier to integrate. Information specified to a single operation tailors recommendations and processes accordingly, leaving little room for error in the adoption process. Greater information specificity is thus viewed most favorably. Policy alternatives will be categorized as having a High, Moderate, or Low degree of information specificity based on the below descriptions:

Information Specificity	Description
High	Information tailored to a specific operation
Moderate	Information tailored to a similar operation in size, region, and output
Low	Information tailored only to regional level

PHYSICAL ACCESSIBILITY

A policy alternative cannot be considered viable if accessing it is a complicated and tedious process for stakeholders. Farming demands work well over the typical 9-hour workday, seven days a week. Further, most farmers in the United States have a primary occupation other than farming (USDA NASS, 2017). Time is a precious resource to producers and alternatives that minimize the time they must invest to access or partake in a policy are considerate of this reality.

Stakeholder accessibility will be evaluated based on the physical dispersion of policy initiatives. Rather than estimate the approximate travel time to resources, alternatives will be evaluated as low, medium, or high effort to access based on the count of access points available throughout Virginia. An 'access point' includes meeting space, implementing agency office, and other locations by which a policy's program or resources can be accessed within a given year. Multiple access points within the same county are not counted twice. Greater physical access and dispersion signals less travel time and effort required to access for farmers. More access points are viewed more favorably.

ALTERNATIVES

ALTERNATIVES

ALTERNATIVE 1: MICRO-FIELD DAYS

To reduce educational barriers to sustainable agriculture adoption for Virginia's producers, the Commonwealth of Virginia could establish a series of Micro-Field Days through the existing network of Soil and Water Conservation Districts (SWCDs). Micro-Field Days would have three objectives: increase implementation knowledge for a regionally appropriate sustainable practice, create space for experiential learning, and increase strength of sustainability-oriented producer networks. This alternative takes the traditional field day model, but focuses on regional participation and small learning groups.

Micro-Field Days would bring together regional groups of approximately ten producers at a host producer's farm to learn about a particular sustainable agriculture practice and its implementation. Host farmers will be in the process of integrating the relevant practice or will have completed practice adoption and will serve as the primary educators day of. Micro-Field Days will take place over a half day and focus on the process of practice implementation, allowing time for participating producers to observe the practice and its implementation firsthand, learn best practices and ask questions of their peers. This type of experiential learning is highly endorsed as a means of increasing implementation confidence (Bliss et al., 2019; Carlisle et al., 2016; Carlisle et al., 2019; Mills et al., 2019).

Local mentorship, example, and expertise are crucial to practice adoption, but are best garnered through casual interactions (S. Malriat, personal communication, February 6, 2023). This alternative seeks to build such networks by considering shared operation characteristics - like size and product – among participating producers. Operation similarity and small group size together, are expected to facilitate social connection with peer producers (C. B. Henley, personal communication, March 5, 2023).

Micro-Field Days could be executed meetings through the Virginia Department of Conservation and Recreation (DCR)'s network of SWCDs. There are forty-seven SWCDs located throughout Virginia, each of which administers programs incentivizing producers to adopt sustainable and conservation practices, serves as practice implementation partners and offers local, agronomic expertise (DCR, 2023). SWCDs' present roles suggests they are well positioned to identify producers interested in sustainable practices and to select Micro-Field Day content based on regional resonance.

Further, as administrator of cost-share, tax credit, and similar incentivizing programs, SWCDs can emphasize program benefits, registration dates, and application pieces to meeting attendees interested in program enrollment to support sustainable practice adoption. Each SWCD could organize four Micro-Field Days annually and Conservation Specialists from within each SWCD can guide the curriculum and day-of content. Host producers could be sourced from DCR's existing farmer network.

The DCR's SWCDs are a strong partner option with shared goals. A similar program could be developed in partnership with other agencies like the Virginia Department of Agriculture and Consumer Services (VDACS), Virginia Cooperative Extension or USDA. This policy alternative could be funded with grants available to agricultural education and conservation programs or the local, state, and federal funding available through the implementing government partner. If implemented through SWCDs, as the taught practices align so closely with DCR and SWCD goals, the program be funded through general SWCDs funding sources, including local government appropriations (New River SWCD, 2023).

ALTERNATIVE 2: SOIL HEALTH & WATER CONSERVATION CLASSES

Virginia could reduce educational barriers to sustainable agriculture adoption through a series of in-person, soil health and water quality classes. This alternative recognizes increased knowledge of practices, their benefits, and their potential role as risk mitigation measures is linked to increased practice adoption (Bueno et al., 2021; Carlisle, 2016; Marasteanu & Jaenicke, 2015; Parsa et al., 2014). These in-person classes would focus on soil health and water quality outcomes of sustainable agriculture, emphasizing the "why" of practices. Additional time would be allotted for farmers to casually interact, and for a producer showcase during which a producers who has already implemented the relevant practice shares the details of his or her experience, the lesson learned, and answers class participants' questions.

This alternative expands upon existing soil health efforts by formally integrating soil health education into in-person extension education and tailoring regional class curriculum to regional interests. Existing soil health initiatives include VCE's Soil Health webinars, and the Virginia Soil Health Coalition, a VCE project. While both initiatives have garnered support and participation, they do not appear to be core components of VCE programming.

The proposed classes could be hosted, and curriculum selected by each of the eleven Agricultural Research and Extension Centers (ARECs) throughout the VCE network. ARECs disseminate research and deliver extension programs, and each AREC also has a specific focus to reflect distinct interests of Virginia's agriculture industry (e.g. fruit trees, row crops, etc.) (Virginia Tech, 2023). Accordingly, AREC staff are recognized experts and trusted sources of regionally relevant information, well suited to guide classes or recruit industry experts to speak to practice benefits. Presently, a number of AREC experts, have research expertise and interest in soil health and IPM (D. Holshouser, personal communication, February 8, 2023; A. Rashed, personal communication, February 7, 2023; K. Rice, personal communication, March 17, 2023; Virginia Tech, 2023).

Each AREC could host five classes annually with topics chosen based on regional relevance. The sustainable practices discussed should be varied, drawing from those approved by the National Organic Practice standard as well as those already accepted in conventional circles, like cover cropping and IPM. This preserves farmers' liberty to choose the practices that best suit their needs, does not exclude conventional farmers, and distances classes from existing stigmas surrounding sustainable agriculture.

While AREC and VCE could serve as primary implementing actors, additional support could be drawn from DCR, USDA, and nongovernmental actors engaged in the sustainable agriculture space. Enacted as a part of VCE and AREC's educational programming, this alternative could be funded through general state funds allotted to Virginia Cooperative Extension and Agriculture Experiment Station, funds disseminated through VDACS, federal funds delivered through USDA-NIFA, or private grants to support sustainable agriculture adoption (The Budget Bill, 2022).

ALTERNATIVE 3: EXPAND EXTENSION EXPERTISE

The Commonwealth of Virginia could reduce educational barriers to sustainable practice adoption by hiring additional extension agents specifically trained in sustainable agriculture. Sustainable practice adoption is a knowledge-intensive process and shortages of extensionists qualified to aid the adoption and integration of such practices was one the most frequently requested resources in the literature and in conversation with practitioners (Carlisle, 2016; Hanson et al., 2004; S. Malriat & Consulting Team, personal communication, February 6, 2023; Parsa et al., 2014).

Presently, VCE extension agents are granted a great degree of freedom in the focus of their research and expertise (K. Rice, personal communication, March 17, 2023). This alternative deviates from the present model by hiring extension agents with a specific focus in sustainable agricultural practices, integrating sustainability expertise into the trusted extension service system. The hired extension agents would possess experience and knowledge of sustainable agriculture systems relevant to his or her region. Such practices include but are not limited to organic, IPM, soil health, agroecology, and low input. In this alternative, VCE would hire two extension agents to serve as sustainability experts for each of Virginia's five (i.e. Northwest, Northeast, Central, Southeast, and Southwest). Agents would then be assigned to county offices, as determined by VCE. These agents would provide services typical of other agents, such as offering individualized technical assistance to producers, disseminating information, and supporting extension educational programming (VCE, 2023).

While other government agencies offer technical support to producers, VCE is one of the most trusted educational and informational sources among Virginia's producers (K. Rice, personal communication, March 17, 2023). Trust effects what information is and is not regarded as being true (Carolan, 2006). Accordingly, this alternative is likely strongest if VCE serves as implementing agency. VCE is funded by state general funds, local governments, and a variety of grants (Virginia Tech, 2023; The Budget Bill, 2022). As this alternative proposes a permanent expansion of personnel, it will have to be funded by state and local government sources.

FINDINGS

FINDINGS

Educational barriers prevent Virginia's farmers from adopting sustainable agricultural practices. While conventional farmers are dependent on status quo practices, they are simultaneously most vulnerable to their harmful effects (i.e. declining soil health, chronic human health risks, and weakened environmental resilience). In absence of sustainable practices, the wellbeing of people and planet alike degrade. Current policy trusts producer education to Virginia's cooperative extension services and non-governmental actors, with no coordinated, state-wide sustainability resources. Micro-Field Days, Soil Health and Water Quality Classes, and Expanding Extension Expertise have been evaluated based on each alternative's cost effectiveness, localized approach, and physical accessibility. The proposed alternatives are preferable to current policy.

ALTERNATIVE 1: MICRO-FIELD DAYS

Cost Effectiveness

Micro-field days would increase soil and water health input practice adoption at a cost of $3,215.80 per farmer. By demonstrating successful implementation and measuring of sustainable practices on farms nearby to event attendees, Micro-Field Days increase confidence in practice adoption and increase locally relevant knowledge dissemination. If 188 Micro-Field days are executed throughout Virginia in a single year with 10 attendees each, this alternative will reach 9,400 Virginian producers. With a practice take up rate following a field day of 5%, approximately 94 Virginian farmers are estimated to adopt a sustainable agricultural practice per year (K. Rice, personal communication, March 17, 2023). Calculated over a five-year period, assuming constant attendance rate with no repeat attendees, 470 farmers are estimated to adopt at least one soil or water health practice at an approximate total cost of $1,511,428. Included in this estimate is a personnel cost of $742,093, event materials cost of $551,809, and farmer opportunity cost of $217,526. A 1.3% discount rate, 2% inflation rate, and conservative 1% annual government raise rate were used for estimate calculations. With an estimated total cost of $1,511,428 and 470 farmers adopting sustainable practices, this alternative has an approximate cost of $3,215.80 per farmer adopting at least one sustainable practice.

Localized Approach

Micro-field days have a "High" level of localization and "Moderate" degree of information specificity. As SWCDs coordinate and facilitate events, they are here seen as the implementing actors and decision makers. There are 47 SWCDs throughout Virginia, each representing highly localized interested and

demographics. While budgetary support is allocated through Virginia's DCR, each SWCD is has the authority to develop conservation plans and programs within its district (Code of Virginia, 2022). Political buy in thus needed only at the the level of individual SWCD. There will be additional coordination with ARECs and VCE but their involvement is supportive, working to further legitimize Micro-Field Day programming. SWCDs are thus seen as local and decentralized decision makers, categorized as having a "High" level of localization.

Micro-Field Days are analyzed as having a "Medium" degree of information specificity. Education is driven by interactions between stakeholders of a shared region whose operations share similar size and product characteristics. While this alternative has a high capacity for network development, information is customized to producers with similar operations, not to a producers' unique operation. Information is more specified than at the regional level, but additional expert guidance is still needed for producers to confidently integrate a practice into their operation. The information shared through this alternative is categorized as having a "Moderate" degree of information specificity.

Physical Accessibility

The Micro-field day alternative is designated as being highly accessible, and thus requires little effort from farmers to access. The hyper-local program strategy actively seeks to emphasize knowledge sharing among small groups of farmers within the same 20 mile radius, in a SWDC. Assuming no Micro-Field Days are held at the same host farm more than once within a given year, each counts as a unique access point. If 188 micro-field days occur statewide each year as proposed, this alternative is highly regionally specific and requires minimal travel for participating farmers and producers.

ALTERNATIVE 2 | SOIL HEALTH AND WATER QUALITY CLASSES

Cost Effectiveness

Offering in-person Soil Health and Water Quality Classes throughout Virginia would increase practice adoption at a cost of $5,584 per adopting farmer. Launching a series of regional classes to educate a range of farmers about soil and water health practices, makes space to: discuss and educate on the benefit of adopting such practices, answer technical or implementation-related questions, and teach methods of tracking soil and water health progress. Assuming 55 classes are held across the state annually (each of Virginia's 11 ARECs, coordinates 5 Soil and Water Health classes a year), for 5 years, and are attended by 15 farmers each, this alternative expects to reach 4,125 total farmers. If practice adoption following a class is expected to 5%, 206 farmers will integrate at least one soil and water health practice into their operation over the course of

the intervention (K. Rice, personal communication, March 17, 2023). This alternative has a total cost of $1,151,632, which includes: $366,589 direct event costs such as materials and space rental, $666,405 personnel costs (including guest expert speakers and an assumed annual raise rate of 1%), and $118,639 estimated farmer opportunity cost from traveling to and attending classes. A 1.3% discount rate and 2% interest rate were used for cost calculations.

Localized Approach

Soil Health and Water Quality Classes have a “Medium” level of localization and a low degree of information specificity. This approach upholds extension services’ existing authority and function as a source of information and expertise. Extension agents affiliated with each AREC - alongside AREC staff, experts, and researchers - serve as educators and event coordinators. Additional insight and expertise will be drawn from SWCDs and non-government actors, but these entities play only a supportive role. Accordingly, each ARECs is here seen as the implementing actor. With 11 ARECs located throughout Virginia, each office is considered “regional” and represents regional, not local, interests and demographics. Though a part of VCE, ARECs are somewhat decentralized and can host events independently. This alternative was assessed to have a “Medium” level of localization.

Soil Health and Water Quality Classes have a “Low” level of information specificity. Class materials focus general education of regionally relevant topics, given diversified interests across a region and larger group size. ARECs specialize in a region’s specific producer type (e.g.. miscellaneous crops, tree fruit, etc.) and experts can offer best practices given general knowledge about the area and operations. This information would provide producers a strong understanding of benefits, means of measurements and supportive resources, but information would need to be greatly tailored to define a producer’s plan for practice adoption. Soil Health and Water Quality Classes were categorized as offering a “Low” degree of information specificity.

Physical Accessibility

Soil and Water Health Classes offered throughout Virginia requires a moderate degree of effort from farmers to access the program. Five classes offered per AREC allows for regional customization and access. While digital references from classes will be shared, digital access denies participants the benefit of connecting with other farmers interested in soil and water health and asking technical experts particular or detailed questions. The physical accessibility of this alternative was thus evaluated only in format of in-person attendance. Assuming 55 classes are held annually across Virginia and no two classes take place In the

same 50 mile radius in the same year, each class counts as its own access point. This alternative is regionally specific but requires some effort from farmers to participate.

ALTERNATIVE 3 | EXPANDING EXTENSION AGENT EXPERTISE

Cost Effectiveness

Expanding the number of agricultural extension agents available to offer technical assistance for sustainable practices specific to Virginia is estimated to increase practice adoption at a cost of $10,558.31 per adopting producer. This alternative encourages practice adoption primarily through farmer-agent meetings. If each of the 5 regions identified by the Virginia Cooperative Extension network hired two extension agents skilled in sustainable practices, and each of these extension agents meets with 128 farmers per year to discuss practices and adoption, approximately 6,390 farmers will be reached annually. Assuming about 24% of these farmers follow through with practice adoption and implementation, 304 farmers annually throughout Virginia will implement the desired practices (Caswell et al., 2001). This alternative has a total cost of approximately $16,190,965. The total cost is calculated over five years and includes hiring and personnel costs ($3,146,718), increased operational cooperative extension costs from increased programming and material demands given expanded personnel ($12,986,819), and farmer opportunity costs ($57,427). Per region, the total cost is approximately $635,756 annually, including: $509,517 for operational costs, and $2,253 for farmer opportunity costs. Personnel and hiring costs were calculated as $123,986 in year 1, inclusive of the $4,500 estimated cost to hire new personnel (Navarra, 2022). This one-time cost was removed to calculate personnel costs in years 2-5. Costs were calculated utilizing a 1.3% discount rate, 2% interest rate, and annual salary raise of 1%.

Approach Strategy

This alternative is classified as having a “Low” level of localization and “High” degree of information specificity. Virginia Cooperative Extension offices are presently responsible for producer trainings, creating educational materials, and research. This alternative upholds those entities’ role as experts, coordinators, and implementing agents. VCE is regarded here as the centralized decision-maker. State general funds are the greatest source of VCE’s funding (Virginia Tech, 2023). Oversight and political buy in is thus needed at the state-level, especially to increase personnel. Support is likely also required from the entities to which VCE is beholden - namely Virginia Tech, Virginia State University, and the National Institute for Food and Agriculture (Virginia Cooperative Extension, 2023). As an entity that requires state-level approval, this alternative has a “Low” level of localization.

Expanding Extension Expertise offers producers a “High” degree of information specificity. Producers engage in this alternative as clients of agricultural extension agents, through whose role as experts and educators, information is disseminated and customized. Extension agents and services are a core pillar of and hold a high degree of trust amongst producers. Utilizing individual consultations with extension agents as vehicles for education allows information to be customized exactly to producers’ specific operations and challenges. Through extension agent interactions, producers can build a custom practice implementation plan. This alternative is categorized as having “High” information specificity.

Physical Accessibility

Expanding the number of agricultural extension agents available to research and teach sustainable practices to Virginian producers has low accessibility. Each agent is counted as an ‘access point,’ this alternative creates 10 new ‘access points’. Virginia’s producers are presently oriented with the regional extension agents most aligned with their needs. Increasing the number of extension agents well versed in sustainable practices throughout a region undoubtedly expands expertise. However, travel time for producers to reach extension agents is likely high and physical access limited. Even if agents travel to producers, saving producers time, producers will likely experience significant wait times.

OUTCOMES MATRIX

The below Outcomes Matrix (Table 2) summarizes the goals of assessment criteria, proposed alternatives, and the predicted outcomes for each. It should be stressed the below outcomes are weighted equally to balance outcome and implementation considerations.

Please note, the below matrix includes Effectiveness, or the total number of producers expected to adopt at least one sustainability practice. Cost Effectiveness estimates are made based on Effectiveness calculations. Evaluating each individually would be double counting program effect. Both metrics are included to better describe impact on producer take up. Greater investment in the most cost-effective alternative will result in the greatest number of producers adopting sustainable practices.

Table 2. Outcomes Matrix

Goal	Impact Category	Micro-Field Days	Soil Health & Water Quality Classes	Expanding Extension Expertise
ECONOMIC EFFICIENCY	$/Adopting Producer	$3,216	$5,584	$10,558
	No. of Adopting Producers	470	206	1533
LOCALIZED APPROACH	Level of Localization	High	Medium	Low
	Information Specificity	Moderate - specified to similar operation	Low - specified to regional knowledge	High - specified to unique operation
PHYSICAL ACCESSIBILITY	No. of Annual Physical Access Points	188	55	10

RECOMMENDATION

Based on the selected criteria, I recommend that the state of Virginia implement a Micro-Field Days program, led by Soil and Water Conservation Districts. Micro-Field Days is the highest ranked alternative in terms of economic efficiency, effectiveness, and accessibility. It achieves the second greatest reach at the lowest costs with the most physical accessibility for Virginia's agricultural population.

This alternative takes a bottom-up approach to change with decentralized implementation decisions, allowing for greater implementation independence. While potentially sacrificing state-wide coordination and uniform information sharing, this alternative centers stakeholder involvement and producer network-building. However, in taking a bottom-up approach, SWCDs and Micro Field Days operate outside of the established and trusted extension and land grant university network. Information is customized to operations with a shared region but may not be specified to size and exact production type (e.g. "apples" vs. "tree fruit"). While Expanding Extension Agent Expertise provides producers with more highly tailored information with the largest reach, it does so at the highest cost per producer who adopts improved practices. This cost suggests the alternative is unlikely to garner political support without a drastic shift in agricultural priorities and expenditures. Soil and Water Health Classes most closely represent current extension classes. While this alternative leverages VCE's existing authority as a trusted information source, it likely will reach the smallest number of producers and information is not expected to be highly individualized and thus less applicable.

IMPLEMENTATION CONSIDERATIONS

IMPLEMENTATION CONSIDERATIONS

Soil and Water Conservation Districts are overseen by Virginia's Department of Conservation and Recreation however, each is independently authorized to develop plans, programs, and projects pertaining to its in-district goals (Code of Virginia, 2022). Accordingly, the establishment, development, and implementation of Micro-Field Days ultimately falls under the authority of each SWCD. Effective implementation requires multiple steps in coordination with other conservation, education, and regulatory actors. These steps are outlined below.

I. PHASED ROLL OUT

While SWCDs can established and implement programming independently, budget and expenditures are reviewed semi-annually and actions approved by each SWCD's elected board (Stovall, 2022; VA Soil & Water Conservation Districts, 2011). It is unlikely all 47 SWCD's will allocate the financial and personnel resources needed to launch MFDs without proof of concept. Micro-Field Days should be launched as a pilot program with 2-6 districts that have expressed interest in the program and have the most funding flexibility. The Thomas Jefferson SWCD, for instance, is actively exploring the concept (L. Hyatt, personal communication, February 23, 2023). Resource use, cost, impact, and best practices from the pilot project should be communicated to James Martin, Division Director for Soil and Water Conservation Districts (DCR, 2021). Assuming successful implementation, the Director's office will oversee best practice dissemination and recommend additional districts to adopt Micro-Field Days in following years, aiming to expand the program by 10 SWCDs annually, with at least one SWCD participating per district area. Micro-Field Day's close affiliation with impact metrics tracked annually by SWCD's (e.g. BMP participation, cost share program enrollment, etc.) should be emphasized in district recruitment (TJSWCD, 2022).

Affiliated nongovernmental actors dedicated to supporting SWCDs, like the Virginia Association of Soil and Water Conservation Districts, could be advantageous dissemination and recruitment partners (VA Soil & Water Conservation Districts, 2011). As SWCD leadership shares the goals of SWCDs, no political push back is anticipated within SWCD leadership.

II. CURRICULUM AND HOST SELECTION

Extant research emphasizes poor curriculum design can greatly reduce the field day quality and efficacy (Braun & Duveskog, 2009). Annual curriculum will be determined by SWCD District Manager based on regional interests and educational need to preserve flexibility and local resonance. Micro-Field Day timing will be determined based on each event's topic and best time for demonstration, but weighed against producers' busy season and related program enrollment or application deadlines (K. Rice, personal communication, March 17, 2023; Weigel et al., 2021). Once decided upon, SWCDs Conservation Specialists and Education Coordinator will select three potential hosts per field day from the district's existing network of producer partners based on degree of practice adoption, disposition, and willingness. If possible, individuals with existing relationships should reach out to potential hosts. Otherwise, the district's Education Coordinator will reach out to potential hosts to determine interest and availability and confirm his or her commitment as host. Paying hosts for their time, as included in estimated program costs, is likely to increase host recruitment response and willingness (Weigel et al., 2021).

III. PARTICIPANT RECRUITMENT & OUTREACH

Micro-Field Days offer experiential, localized education, and mentorship. Participants should be selected from SWCD's existing pool of producers – both those in the process of adopting practices endorsed by SWCDs and those who have expressed interest but have not yet implemented improved practices. This pool of producers is predicted to be receptive of the educational opportunity. Each district's Outreach Supervisor is best positioned to recommend participants (Weigel et al., 2021). Invitations are best sent during producers' slow times of the year and with reminders closer to event date. Micro-Field Days should have a target attendance of 10 producers, more producers should be invited based on past each SWCD's past attendance to invitee ratios. Characteristics that should be considered include production type, operation size, phase of practice implementation, competition within marketplaces, and existing relationships. Ensuring adequate attendance is likely the greatest organizational challenge. Charging small entrance fees ($5-15) or offering additional support (e.g. cost-share application assistance, certification, etc.) is recommended to encourage attendance (SARE, 2016).

Composition of attendees should be considered carefully to maximize educational value and equitable access to resources and networks. While participants are best selected from SWCD's existing contacts, outreach should be diversified to ensure BIPOC, female, new, young, and veteran producers are

included. Appendix C outlines groups, networks, and resources that will aid SWCD outreach efforts. Methods of outreach should also be diversified (e.g. digital, print, in-person) to ensure no demographic group is unintentionally excluded on the basis of resource access. Participant invite lists should be checked to ensure no one producer type or demographic is over- or under-represented (Anandajayasekeram et al., 2007).

IV. OUTCOME-ORIENTED LANGUAGE

Field Day materials and outreach should utilize outcome-oriented language to describe practices. While this report utilizes categorical practice terminology such as “sustainability,” this and other such categorical terms (e.g. “climate-smart agriculture,” “regenerative agriculture,” “conservation agriculture”) may isolate certain producers. Utilizing outcome-oriented terminology emphasizes environmental benefits and may better connect with producers who identify as stewards of the land. Research suggests stewardship motivations are positively associated with conservation practice adoption Outcome-oriented language also orient Micro-Field Days around practice benefits and how to measure them, directly addressing core educational barriers.

V. INFORMATION COLLECTION & RESEARCH

While Micro-Field Day present an opportunity for data collection and evidence building (Weigel et al., 2021). Greater insight into domestic agricultural education methods and producer preference is limited; research is often conducted outside of the United States and may not be transferable, or local analysis are conducted informally. Virginian extension offices and land grant universities are actively engaging in interdisciplinary research about best educational practices, producer information dissemination preferences and practice adoption (K. Rice, personal communication, March 17, 2023). Virginia Tech’s Center for Advanced Innovation in Agriculture is one such example. Accordingly, anonymous feedback channels should be developed following Micro-Field Days and standardized across the state. This feedback should emphasize producer experience, allowing space for recommendations, knowledge acquisition, future host or participant suggestions, and future curricula (van den Berg et al., 2021).

Utilizing Micro-Field Days to collect producer education data may garner additional support from other educators, like extension services. Extension agent support further legitimizes Micro-Field Days and the practices they teach. While the relationship between SWCDs and extension agents is positive, not all extension agents share SWCDs’ priorities. Extension partners will need to be selected based on shared agronomic interests like cover cropping, low input production, and IPM.

CONCLUSION

Presently, only about 23% of Virginia's farms integrate a soil or water conservation practice (Virginia Tech, 2023). In the absence of sustainability practices, producer health and environmental wellbeing degrade (Matson et al., 1997; Pimentel, 2005; Pimentel et al., 1995). Extant research suggests lacking knowledge of practice benefits, implementation uncertainty, limited local information and unsupportive social networks are among the biggest barriers to practice adoption. These educational barriers prevent Virginia's farmers from adopting sustainable agricultural practices.

Micro-Field Days offer farmers relevant, resonant, experiential learning opportunities to overcome these barriers. While impact is magnified with greater SWCD adoption, Micro-Field Day coordination is complex, and implementation must be detail oriented. Establishing a pilot program among interested SWCDs allows best practices to be identified and program efficacy data to build before statewide adoption. Curriculum, timing, and Micro-Field Day host selection are best determined by individual SWCDs and existing producer rapport. Participant recruitment must be balanced across demographics and attendance incentives should be considered. Finally, Micro-Field Days can serve as information sources to guide future educational interventions.

APPENDIX

APPENDIX A - LIMITATIONS OF THE LITERATURE

The above literature is limited in its broad focus on sustainable agriculture, inclusive of literature reviewing IPM, organic, soil health and agroecological practice adoption. The work reviewed focused primarily on the United States but the heterogenous nature of agriculture ad practice implementation, exact effect in the unique social, cultural, environmental, and agricultural context of Virginia. Additional information is drawn from research conducted aboard, often in low-income country contexts. This information can provide only directional insight into program effects.

Much of the data reviewed comes from published academic journals, books, and reports generated by national and international nongovernmental organizations. Additional information is drawn from government sources. The quality of the conclusions is limited to the quality of reporting and recordkeeping.

APPENDIX B - COST EFFECTIVENESS

ALTERNATIVE 1 - COST EFFECTIVENESS

Event Costs were calculated based on expert interviews and quoted and estimated market costs for necessary materials. Compensation for hosts farmers was acquired through an interview with a producer local to Albemarle County, who has hosted field days previously (C. B. Henley, personal communication, February 25, 2023). The quoted number, $150, is the upper estimate of quoted compensation. Event day material costs include the most recent edition of SARE Better Soils for Better crops (assuming 12 books ordered per class, inclusive of the permanent bulk order discount advertised), refreshments, 10 pages of hand outs (calculated as $0.10/page), and marketing materials (Errera, 2019; C. B. Henley, personal communication, February 25, 2023; SARE, 2023). Assuming $150 compensation for host farmers, $138 for SARE book, $12 for additional materials, $25 for refreshments, and $250 for marketing materials, the per event cost is estimated to be $575.

Personnel Costs include the hourly wage for a conservation specialist, calculated based on the median quoted salary for a Clinch Valley SWCD Conservation Specialist, based on an active job SWCD job posting (VASWCD, 2023). The quoted salary was divided by the nationwide average of 2080 annual working hours to arrive at a $22 hourly wage. Hourly wage was multiplied by 35, the upper end of hours estimated to coordinate and host a Micro-Field Day, based on steps laid out in SARE's Field Day toolkit (SARE, 2016). Personnel costs were calculated to be $765.63 per event.

Farmer Opportunity costs were the final cost category calculated. The 2017 USDA National Statistics Service (NASS) Virginia Net Cash Farm Income of the Operations and Producers Table (USDA, 2017). Virginia producers had annual net cash farm income of $19,306, per operation (USDA, 2017). This number was divided by 4380 (365 days, 12 hours a day), to arrive at an hourly wage of $4.41. Assuming Micro-Field Days require 5 hours of farmer time, inclusive of travel time, opportunity cost was estimated to be $22.04, per producer, per event. Assuming ten producers attend each event, total farmer opportunity cost per event is $220.39.

In this alternative, each SWCD hosts 4 Micro-Field Days annually, based on estimated capacity of SWCDs. With 47 SWCDs located throughout Virginia, 188 events will be held annually with approximately 1880 attending producers.

Statewide, annual event costs ($108,100.00), personnel costs ($143,937.50), and farmer opportunity costs ($41,433.00) were summed ($293,470.50) and calculated over an analysis period of 5 years using a 1.3% discount rate, 2% inflation rate, and conservative 1% annual government raise rate. Total costs ($1,511,427.55) were divided by the number of producers adopting sustainable practices (470), based on 5% take up rate (K. Rice, personal communication, March 17, 2023). This alternative was found to have an approximate cost of $3,215.80 per farmer adopting at least one sustainable practice.

Assumptions and Cost Tables

ASSUMPTIONS - MICRO-FIELD DAYS

Analysis Period (years)	5
Annual Salary Rate	1%
Discount Rate	1.3%
Inflation Rate	2%
Estimated Total Participants	9,400
Estimated Total Farmer Adoption (5% Take Up)	470

ANNUAL COSTS - MICRO-FIELD DAYS

Year	2024	2025	2026	2027	2028
Event Cost	$108,846.99	$109,599.14	$110,356.49	$111,119.07	$111,886.92
Personnel Cost	$146,381.45	$146,381.45	$148,411.48	$149,427.03	$150,469.67
Producer Opportunity Cost	$41,432.97	$41,719.28	$43,180.77	$44,386.75	$45,941.69
Annual Total	$293,470.47	$296,947.72	$299,289.96	$304,942.85	$308,298.28

TOTAL COSTS - MICRO-FIELD DAYS

Event Cost	$551,808.61
Personnel Cost	$742,092.61
Producer Opportunity Cost	$217,526.33
Total (5 Years)	$1,511,427.55

ALTERNATIVE 2 - COST EFFECTIVENESS

Event Costs were calculated based on quoted and estimated market costs for necessary materials. Event day material costs include the most recent edition of SARE Better Soils for Better crops (assuming 19 books ordered per class, inclusive of the permanent bulk order discount advertised), 10 pages of hand outs (calculated as $0.10/page), and marketing materials (Errera, 2019; SARE, 2023). Classroom space was quoted at $250 for the day, per Nelson County meeting space advertisements (Nelson County, 2023). Food and beverage was included, calculated as $30 a meal, per person (19 attendees: 15 participants, 2 AREC or VCE staff, 1 farmer invited for showcase) (Roaming Hunger, 2023). These costs were tallied and calculated to be $1,308, per event.

Personnel Costs include the total employee time needed for event coordination and the event itself. Hourly wage for AREC and VCE employees was based on reported average extension agent salaries in Virginia, divided by the nationwide average of 2080 annual working hours to arrive at a $25 hourly wage (Salary.com, 2023). Hourly wage was multiplied by 84, the upper end of hours estimated to coordinate and host a Soil Health and Water Quality class, based on steps laid out in SARE's Field Day toolkit (SARE, 2016). Total employee costs, per event were calculated to be $2,124.55. Also included in personnel costs are guest speakers, based on Agricultural Consultant average salary, divided by 2080 annual worked hours, and multiplied by 6, hours necessary for events including 1 hour of travel time each way. Total costs for guest speakers were $233.34, per event (Comparably, 2023). Total Producer opportunity costs per event were calculated to be $2,357.89.

Farmer Opportunity costs were the final cost category calculated. The 2017 USDA National Statistics Service (NASS) Virginia Net Cash Farm Income of the Operations and Producers Table (USDA, 2017). Virginia producers had annual net cash farm income of $19,306, per operation (USDA, 2017). This number was divided by 4380 (365 days, 12 hours a day), to arrive at an hourly wage of $4.41. Assuming Soil Health and Water Quality classes require 6 hours of farmer time, inclusive of travel time, opportunity cost was estimated to be $26.45, per producer, per event. Assuming fifteen producers attend each event, plus one producer to share his or her success story, total farmer opportunity cost per event is $423.15.

In this alternative, each AREC hosts 5 Soil Health and Water Quality annually, based on estimated capacity of ARECs. With 11 ARECs located throughout Virginia, 75 events will be held annually with approximately 825 attending producers. Statewide, annual event costs ($71,912.50), personnel costs

($129,684.13), and farmer opportunity costs ($23,272.99) were summed ($293,470.50) and calculated over an analysis period of 5 years using a 1.3% discount rate, 2% inflation rate, and conservative 1% annual government raise rate. Total costs ($1,151,632.43) were divided by the number of producers (206) adopting sustainable practices, based on 5% take up rate (K. Rice, personal communication, March 17, 2023). This alternative was found to have an approximate cost of $5,583.67 per farmer adopting at least one sustainable practice.

Assumptions and Cost Tables

ASSUMPTIONS - SOIL HEALTH & WATER QUALITY CLASSES

Analysis Period (years)	5
Annual Salary Rate	1%
Discount Rate	1.3%
Inflation Rate	2%
Estimated Total Participants	4,125
Estimated Total Farmer Adoption (5% Take Up)	206

ANNUAL COSTS - SOIL HEALTH & WATER QUALITY CLASSES

Year	2024	2025	2026	2027	2028
Event Cost	$71,912.50	$72,909.79	$73,413.61	$73,920.91	$74,431.71
Personnel Cost	$129,684.13	$132,797.43	$133,715.08	$134,569.45	$135,569.45
Producer Opportunity Cost	$23,272.99	$23,595.74	$23,758.79	$23,922.97	$24,088.28
Annual Total	$224,869.62	$229,302.95	$230,887.48	$232,482.95	$234,089.44

TOTAL COSTS - SOIL HEALTH & WATER QUALITY CLASSES

Event Cost	$366,588.52
Personnel Cost	$666,405.16
Producer Opportunity Cost	$118,638.76
Total (5 Years)	$1,151,632.43

ALTERNATIVE 3 - COST EFFECTIVENESS

Costs to expand extension agent workforce were estimated per new extension agent hired and include estimated hiring costs ($4,700) and annual average salary of Virginia Agricultural Extension Agents, $57,293 (Glassdoor, Inc., 2022; Navarra, 2022).

Increased extension agents were assumed to lead to a proportional increase in extension operation costs. Operational costs were calculated per VCE-defined region. Assuming there are at least 2 extensions agents per 107 county offices, hiring an additional 2 agents per VCE region (10 statewide) represents a 4.7% personnel increase. Based on FY20-21 Cooperative Extension/Agricultural Experiment Station reported budgets, a proportional 4.7% budget increase is an additional $2,547,582.90 in annual operational costs, or $509,516.58 per region (Virginia Tech, 2021).

Farmer Opportunity costs were also calculated. The 2017 USDA National Statistics Service (NASS) Virginia Net Cash Farm Income of the Operations and Producers Table (USDA, 2017). Virginia producers had annual net cash farm income of $19,306, per operation (USDA, 2017). This number was divided by 4380 (365 days, 12 hours a day), to arrive at an hourly wage of $4.41. Assuming each extension agent conducts 128 in-person consultations, with a meeting time of 2 hours each, producer opportunity cost was estimated to be $8.82, per producer, per consultation. Multiplied by 128 in-person producer opportunity costs, per agent, was calculated to be $1,126.54.

In this alternative, 10 extension agents are hired statewide to provide additional technical sustainability support to Virginia's agricultural producers. The 10 new extension agents are expected to see a combined 1278 producers annually. Hiring costs were only included in year calculations for year 1. Statewide, annual hiring costs ($619,930), increased operational costs ($2,547,582.90), and farmer opportunity costs ($11,265.36) were summed ($3,178,778.26) and calculated over an analysis period of 5 years using a 1.3% discount rate, 2% inflation rate, and conservative 1% annual government raise rate. Total costs ($16,190,964.60) were divided by the number of producers (1533) adopting sustainable practices, based on 24% take up rate (Caswell et al., 2001). This alternative was found to have an approximate cost of $10,558.31 per farmer adopting at least one sustainable practice.

Assumptions and Cost Tables

ASSUMPTIONS - EXPAND EXTENSION EXPERTISE

Analysis Period (years)	5
Annual Salary Rate	1%
Discount Rate	1.3%
Inflation Rate	2%
Estimated Total Participants	6390
Estimated Total Farmer Adoption (24% Take Up)	1,533

ANNUAL COSTS - EXPAND EXTENSION EXPERTISE

Year	2024	2025	2026	2027	2028
Event Cost	$619,930.00	$625,186.85	$629,507.00	$633,857.00	$638,237.05
Personnel Cost	$2,547,582.90	$2,582,913.00	$2,600,761.36	$2,618,733.06	$2,636,828.94
Producer Opportunity Cost	$11,265.36	$11,421.59	$11,500.51	$11,579.98	$11,660.00
Annual Total	$3,178,778.26	$3,219,521.44	$3,241,768.87	$3,264,170.04	$3,286,726.00

TOTAL COSTS - EXPAND EXTENSION EXPERTISE

Operational Cost	$12,986,819.25
Personnel Cost	$3,146,717.90
Producer Opportunity Cost	$57,427.45
Total (5 Years)	$16,190,964.60

APPENDIX C - SUGGESTED VIRGINIA CONTACT LIST

American Farmland Trust, Mid-Atlantic Office

- Nonprofit national organization that seeks. to protect farmland, support farmer landownership, and endorse environmentally-conscious practices.

Black Church Food Security Network

- A network of Black churches working with Black farmers to create a sustainable food system across the U.S.

Carter Farms

- Operated by Michael Carter Jr., Carter Farms is an ethnic vegetable afrotourism teaching farm. Michael Carter Jr. is. an 11th generation American/farmer, speaker, and teacher.

Common Grain Alliance

- Connects farmers, millers, and bakers to build a more equitable and regenerative grain economy in the Mid-Atlantic region.

Foodshed Capital

- Offers low-cost capital to regenerative farmers and food enterprises. Prioritizes low-income, BIPOC, female, immigrant, LGBTQ, and indigenous borrowers, as well as those using regenerative practices.

Local Food Hub

- Seeks to advance equitable food access and fairness in farming. Offers financial support, food safety training, and market access support.

Mountains to Bay Grazing Alliance

- Interdisciplinary alliance encouraging the adoption of rotational grazing and conservation practices.

National Women in Agriculture Association, Virginia Chapter

- Largest agricultural organization for women in the world, focuses on supporting minority women farmers.

Piedmont Environmental Council

- Seeks. to protect Virginia Piedmont's rural economy, and natural resources. Endorses soil health practices and supports VA's working farms.

VA Association for Biological Farming

- A community. of farmers, gardeners, educators, and more supporting local and sustainable food systems.

VA Soil Health Coalition

- A network of producers and organizations endorsing soil health practice adoption through education, media, and training. A USDA NRCS project.

Virginia Black Farmers Directory

- A comprehensive resource to connect black famers with one another, consumers and other market opportunities.

WORKS CITED

WORKS CITED

Ames, R. G., Howd, R. A., & Doherty, L. (1993). Community exposure to a paraquat drift. *Archives of Environmental Health*, *48*(1), 47–52. https://doi.org/10.1080/00039896.1993.9938392

Anandajayasekeram, P., Davis, K., & Workneh, S. (2007). Farmer Field Schools: An Alternative to Existing Extension Systems? Experience from Eastern and Southern Africa. *Journal of International Agricultural and Extension Education*, *14*(1). https://doi.org/10.5191/jiaee.2007.14107

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17–25. https://doi.org/10.1016/j.jenvman.2011.10.006

Belsky, J., & Joshi, N. K. (2020). Effects of Fungicide and Herbicide Chemical Exposure on Apis and Non-Apis Bees in Agricultural Landscape. *Frontiers in Environmental Science*, *8*. https://www.frontiersin.org/articles/10.3389/fenvs.2020.00081

Bliss, K., Padel, S., Cullen, B., Ducottet, C., Mullender, S., Rasmussen, I. A., & Moeskops, B. (2019). Exchanging knowledge to improve organic arable farming: An evaluation of knowledge exchange tools with farmer groups across Europe. *Organic Agriculture*, *9*(4), 383–398. https://doi.org/10.1007/s13165-018-0238-6

Braun, A., & Duveskog, D. (2009). *The Farmer Field School Approach – History, Global Assessment and Success Stories*. https://www.semanticscholar.org/paper/The-Farmer-Field-School-Approach-%E2%80%93-History-%2C-Global-Braun-Duveskog/a62f8b606c60f40356284bf33086ab3611a79efd

Brodt, S., Klonsky, K., Tourte, L., Duncan, R., Hendricks, L., Ohmart, C., & Verdegaal, P. (2004). Influence of farm management style on adoption of biologically integrated farming practices in California. *Renewable Agriculture and Food Systems*, *19*(4), 237–247. https://doi.org/10.1079/RAFS200488

Brown, N., Colson, G., & Roessing, M. (2022). Tort tradeoffs in cases of pesticide drift: A legal and economic analysis. *PLOS ONE*, *17*(10), e0276418. https://doi.org/10.1371/journal.pone.0276418

Bueno, A. F., Panizzi, A. R., Hunt, T. E., Dourado, P. M., Pitta, R. M., & Gonçalves, J. (2021). Challenges for Adoption of Integrated Pest Management (IPM): The Soybean Example. *Neotropical Entomology*, *50*(1), 5–20. https://doi.org/10.1007/s13744-020-00792-9

Carlisle, L. (2016). Factors influencing farmer adoption of soil health practices in the United States: A narrative review. *Agroecology and Sustainable Food Systems*, *40*(6), 583–613. https://doi.org/10.1080/21683565.2016.1156596

Carlisle, L., Montenegro de Wit, M., DeLonge, M. S., Iles, A., Calo, A., Getz, C., Ory, J., Munden-Dixon, K., Galt, R., Melone, B., Knox, R., & Press, D. (2019). Transitioning to Sustainable Agriculture Requires Growing and Sustaining an Ecologically Skilled Workforce. *Frontiers in Sustainable Food Systems*, *3*. https://www.frontiersin.org/articles/10.3389/fsufs.2019.00096

Carolan, M. S. (2006). Social change and the adoption and adaptation of knowledge claims: Whose truth do you trust in regard to sustainable agriculture? *Agriculture and Human Values*, *23*(3), 325–339. https://doi.org/10.1007/s10460-006-9006-4

Caswell, M., Fuglie, K. O., Ingram, C., Jans, S., & Kascak, C. (Eds.). (2001). *Adoption of Agricultural Production Practices: Lessons Learned from the U.S. Department of Agriculture Area Studies Project*. https://doi.org/10.22004/ag.econ.33985

CDC. (2019, May 16). *Facts about Paraquat*. https://emergency.cdc.gov/agent/paraquat/basics/facts.asp

Code of Virginia, Title 10.1, Chapter 5, Article 3. Soil and Water Conservation Districts, (2022). https://law.lis.virginia.gov/vacode/title10.1/chapter5/section10.1-546/

Comparably. (2023). *Agriculture Consultant Salary*. Comparably. https://www.comparably.com/salaries/salaries-for-developer

Cox, D. (2019, March 9). The Roundup row: Is the world's most popular weedkiller carcinogenic? *The Observer*. https://www.theguardian.com/environment/2019/mar/09/spray-pray-is-roundup-carcinogenic-monsanto-farmers-suing

Dara, S. K. (2019). The New Integrated Pest Management Paradigm for the Modern Age. *Journal of Integrated Pest Management*, *10*(1), 12. https://doi.org/10.1093/jipm/pmz010

Davis, A. S., & Frisvold, G. B. (2017). Are herbicides a once in a century method of weed control? *Pest Management Science*, *73*(11), 2209–2220. https://doi.org/10.1002/ps.4643

Delbridge, T. A., King, R. P., Short, G., & James, K. (2017). Risk and Red Tape: Barriers to Organic Transition for U.S. Farmers. *Choices*, *32*(4), 1–10.

DeLonge, M. S., Miles, A., & Carlisle, L. (2016). Investing in the transition to sustainable agriculture. *Environmental Science & Policy*, *55*, 266–273. https://doi.org/10.1016/j.envsci.2015.09.013

Donley, N. (2019). The USA lags behind other agricultural nations in banning harmful pesticides. *Environmental Health*, *18*(1), 44. https://doi.org/10.1186/s12940-019-0488-0

Emerick, K., & Dar, M. (2020). Farmer Field Days and Demonstrator Selection for Increasing Technology Adoption. *The Review of Economics and Statistics*, 1–41. https://doi.org/10.1162/rest_a_00917

Engel, L. S., Checkoway, H., Keifer, M. C., Seixas, N. S., Longstreth, W. T., Scott, K. C., Hudnell, K., Anger, W. K., & Camicioli, R. (2001). Parkinsonism and occupational exposure to pesticides. *Occupational and Environmental Medicine*, *58*(9), 582–589. https://doi.org/10.1136/oem.58.9.582

Errera, R. (2019, August 20). Printing Costs: How To Accurately Calculate Your Printing Cost Per Page—Toner Buzz. *Toner Buzz*. https://www.tonerbuzz.com/blog/printing-costs-how-to-accurately-calculate-your-printing-cost-per-page/

EWG. (n.d.). *EWG's Tap Water Database: Contaminants in Your Water*. Environmental Working Group. Retrieved October 12, 2022, from https://www.ewg.org/tapwater/contaminant.php?contamcode=2028?contamcode=2028

Glassdoor, Inc. (2022, November 11). *Virginia Cooperative Extension, Extension Agent Salaries*. Glassdoor. https://www.glassdoor.com/Salary/Virginia-Cooperative-Extension-Extension-Agent-Salaries-E1149620_D_KO31,46.htm, https://www.glassdoor.com/Salary/Virginia-Cooperative-Extension-Extension-Agent-Salaries-E1149620_D_KO31,46.htm

Grzincic, B. (2022, February 15). MDL judge advances most paraquat claims against Syngenta, Chevron. *Reuters*. https://www.reuters.com/legal/litigation/mdl-judge-advances-most-paraquat-claims-against-syngenta-chevron-2022-02-15/

Hanson, J., Dismukes, R., Chambers, W., Greene, C., & Kremen, A. (2004). Risk and risk management in organic agriculture: Views of organic farmers. *Renewable Agriculture and Food Systems*, *19*(4), 218–227. https://doi.org/10.1079/RAFS200482

Harris, L. M., Norton, G. W., Rezaul Karim, A. N. M., Alwang, J. R., & Taylor, D. B. (2013). *Bridging the Information Gap with Cost-Effective Dissemination Strategies: The Case of Integrated Pest Management in Bangladesh*. https://doi.org/10.1017/s1074070800005174

Henley, C. B. (2023, March 5). *Brook Henley, Farmer Interview* [Personal communication].

Hillocks, R. J. (2012). Farming with fewer pesticides: EU pesticide review and resulting challenges for UK agriculture. *Crop Protection*, *31*(1), 85–93. https://doi.org/10.1016/j.cropro.2011.08.008

Holshouser, D. (2023, February 8). *David Holshouser- Tidewater Virginia Agricultural Research and Extension Centers, Virginia Tech Professor* [Phone].

Hyatt, L. (2023, February 23). *Informational call, TJ SWCD* [Phone call and email exchange].

Lefebvre, M., Langrell, S. R. H., & Gomez-y-Paloma, S. (2015). Incentives and policies for integrated pest management in Europe: A review. *Agronomy for Sustainable Development*, *35*(1), 27–45. https://doi.org/10.1007/s13593-014-0237-2

Lichtenberg, E., & Zimmerman, R. (1999). Adverse Health Experiences, Environmental Attitudes, and Pesticide Usage Behavior of Farm Operators. *Risk Analysis*, *19*(2), 283–294. https://doi.org/10.1111/j.1539-6924.1999.tb00405.x

Malriat, S. (2023, February 6). *Sam Malriat, Director of Organic Consulting, Rodale Institute* [Phone].

Malriat, S., & Consulting Team. (2023, February 6). *Organic Consulting Team, Rodale Institute* [Zoom].

Marasteanu, I., & Jaenicke, E. (2015). *The role of US organic certifiers in organic hotspot formation* (2015 AAEA & WAEA Joint Annual Meeting, July 26-28, San Francisco, California No. 205528). Agricultural and Applied Economics Association. https://econpapers.repec.org/paper/agsaaea15/205528.htm

Matson, P. A., Parton, W. J., Power, A. G., & Swift, M. J. (1997). Agricultural intensification and ecosystem properties. *Science (New York, N.Y.)*, *277*(5325), 504–509. https://doi.org/10.1126/science.277.5325.504

Millar, J., & Curtis, A. (1997). Moving farmer knowledge beyond the farm gate: An Australian study of farmer knowledge in group learning. *European Journal of Agricultural Education and Extension*, *4*(2), 133–142. https://doi.org/10.1080/13892249785300241

Mills, J., Reed, M., Skaalsveen, K., & Ingram, J. (2019). The use of Twitter for knowledge exchange on sustainable soil management. *Soil Use and Management*, *35*(1), 195–203. https://doi.org/10.1111/sum.12485

Monteiro, A., & Santos, S. (2022). Sustainable Approach to Weed Management: The Role of Precision Weed Management. *Agronomy*, *12*(1), Article 1. https://doi.org/10.3390/agronomy12010118

Navarra, K. (2022, April 11). *The Real Costs of Recruitment*. SHRM. https://www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/the-real-costs-of-recruitment.aspx

Nelson County. (2023). *Meeting Space, Nelson County* [Government]. https://www.nelsoncounty-va.gov/residents/meeting-space/

New River SWCD. (2023). *About New River Soil and Water Conservation District*. New River SWCD. https://www.newriverswcd.org/about-us

Nicolopoulou-Stamati, P., Maipas, S., Kotampasi, C., Stamatis, P., & Hens, L. (2016). Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture. *Frontiers in Public Health*, *4*, 148. https://doi.org/10.3389/fpubh.2016.00148

NWF. (2012). *National Wildlife Federation Report: Roadmap to Increased Cover Crop Adoption*. https://www.nwf.org/Home/Educational-Resources/Reports/2012/11-01-2012-Roadmap-Cover-Crop-Adoption

Oerke, E.-C. (2006). Crop losses to pests. *The Journal of Agricultural Science*, *144*(1), 31–43. https://doi.org/10.1017/S0021859605005708

Parsa, S., Morse, S., Bonifacio, A., Chancellor, T. C. B., Condori, B., Crespo-Pérez, V., Hobbs, S. L. A., Kroschel, J., Ba, M. N., Rebaudo, F., Sherwood, S. G., Vanek, S. J., Faye, E., Herrera, M. A., & Dangles, O. (2014). Obstacles to integrated pest management adoption in developing countries. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(10), 3889–3894. https://doi.org/10.1073/pnas.1312693111

Peter, G., Bell, M., Jarnagin, S., & Bauer, D. (2009). Coming Back Across the Fence: Masculinity and the Transition to Sustainable Agriculture*. *Rural Sociology*, *65*, 215–233. https://doi.org/10.1111/j.1549-0831.2000.tb00026.x

Pierson, B. (2022, September 2). Bayer on winning streak in Roundup litigation after huge initial losses. *Reuters*. https://www.reuters.com/legal/litigation/bayer-winning-streak-roundup-litigation-after-huge-initial-losses-2022-09-02/

Pimentel, D. (2005). Environmental and Economic Costs of the Application of Pesticides Primarily in the United States. *Environment, Development and Sustainability*, *7*(2), 229–252. https://doi.org/10.1007/s10668-005-7314-2

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri, R., & Blair, R. (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science (New York, N.Y.)*, *267*(5201), 1117–1123. https://doi.org/10.1126/science.267.5201.1117

Pimentel, D., Hepperly, P., Hanson, J., Douds, D., & Seidel, R. (2005). Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *BioScience*, *55*(7), 573–582. https://doi.org/10.1641/0006-3568(2005)055[0573:EEAECO]2.0.CO;2

Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., Opazo, C. M., Owoo, N., Page, J. R., Prager, S. D., & Torero, M. (2020). A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. *Nature Sustainability*, *3*(10), Article 10. https://doi.org/10.1038/s41893-020-00617-y

Prokopy, L. S., Floress, K., Arbuckle, J. G., Church, S. P., Eanes, F. R., Gao, Y., Gramig, B. M., Ranjan, P., & Singh, A. S. (2019). Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature. *Journal of Soil and Water Conservation*, *74*(5), Article 5. https://doi.org/10.2489/jswc.74.5.520

Rashed, A. (2023, February 7). *Arash Rashed—Director, Southern Piedmont Virginia Agricultural Research and Extension Centers* [Phone].

Rice, K. (2023, March 17). *Kevin Rice, Director Alson H. Smith Agricultural Research and Extension Center* [Phone call].

Roaming Hunger. (2023, February 14). *How Much Does Catering a Party Cost? (2023 Guide)*. https://roaminghunger.com/blog/14922/how-much-does-catering-a-party-cost
Robertson, G. P., Paul, E. A., & Harwood, R. R. (2000). Greenhouse Gases in Intensive Agriculture: Contributions of Individual Gases to the Radiative Forcing of the Atmosphere. *Science*, *289*(5486), 1922–1925. https://doi.org/10.1126/science.289.5486.1922
Rodale Institute. (2022). *Farming Systems Trial 40-Year Report* (p. 36). Rodale Institute. https://rodaleinstitute.org/wp-content/uploads/FST_40YearReport_RodaleInstitute-1.pdf
Salary.com, S. built by: (2023, January 26). *Extension Agent Salary in Virginia*. Salary.Com. https://www.salary.com/research/salary/recruiting/extension-agent-salary/va
SARE. (2016). *The Farmer Field Day Toolkit*. Sustainable Agriculture Research and Education. https://www.sare.org/resources/the-farmer-field-day-toolkit/
SARE. (2023a). *Building Soils for Better Crops*. Sustainable Agriculture Research and Education. https://www.sare.org/resources/building-soils-for-better-crops/
SARE. (2023b). *Sustainable Agriculture Research and Education*. SARE. https://www.sare.org/
Schaller, N. (1993). The concept of agricultural sustainability. *Agriculture, Ecosystems & Environment*, *46*(1), 89–97. https://doi.org/10.1016/0167-8809(93)90016-I
Skevas, T., Oude Lansink, A. G. J. M., & Stefanou, S. E. (2013). Designing the emerging EU pesticide policy: A literature review. *NJAS - Wageningen Journal of Life Sciences*, *64–65*, 95–103. https://doi.org/10.1016/j.njas.2012.09.001
Smith, D. (2023, January 17). *Drew Smith, COO Rodale Institute* [Zoom].
Sponsler, D. B., Grozinger, C. M., Hitaj, C., Rundlöf, M., Botías, C., Code, A., Lonsdorf, E. V., Melathopoulos, A. P., Smith, D. J., Suryanarayanan, S., Thogmartin, W. E., Williams, N. M., Zhang, M., & Douglas, M. R. (2019). Pesticides and pollinators: A socioecological synthesis. *Science of The Total Environment*, *662*, 1012–1027. https://doi.org/10.1016/j.scitotenv.2019.01.016
Stovall, F. N. (2022). *Department of Conservation and Recreation's Fiscal Year 2022 Semi-Annual Agricultural Cost-Share and Administration/Technical Assistance Funding Allocations Report* (p. 6). Commonwealth of Virginia Department of Conservation and Recreation. https://rga.lis.virginia.gov/Published/2022/RD148/PDF
Tisdell, C., Wilson, C., & Tisdell, C. (2001). Why Farmers Continue to Use Pesticides Despite Environmental, Health and Sustainability Costs. *Ecological Economics*, *39*, 449–462. https://doi.org/10.1016/S0921-8009(01)00238-5
TJSWCD. (2022). *Thomas Jefferson Soil & Water Conservation District, 2022 Annual Report*. Thomas Jefferson Soil and Water Conservation District. https://www.tjswcd.org/wp-content/uploads/2022/09/TJSWCD-2022-Annual-Report.pdf
Traoré, N., Landry, R., & Amara, N. (1998). On-Farm Adoption of Conservation Practices: The Role of Farm and Farmer Characteristics, Perceptions, and Health Hazards. *Land Economics*, *74*(1), 114–127. https://doi.org/10.2307/3147217
US EPA, O. (2014, September 18). *Glyphosate* [Overviews and Factsheets]. https://www.epa.gov/ingredients-used-pesticide-products/glyphosate

USDA. (2017). *National Agricultural Statistics Service—2017 Census of Agriculture—Volume 1, Chapter 2: State Level Data—Table 4. Net Cash Farm Income of the Operations and Producers* [Government]. United States Department of Agriculture National Agricultural Statistics Service. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_US_State_Level/

USDA NASS. (2017). *2017 US Census of Agriculture—Highlights, Farm Producers* (p. 2). United States Department of Agriculture National Agricultural Statistics Service. https://www.nass.usda.gov/Publications/Highlights/2019/2017Census_Farm_Producers.pdf

USDA NRCS. (2023a, March 21). *Natural Resources Conservation Service—Conservation Stewardship Program* [Government]. Natural Resources Conservation Service. http://www.nrcs.usda.gov/programs-initiatives/csp-conservation-stewardship-program

USDA NRCS. (2023b, March 21). *Natural Resources Conservation Service—EQIP* [Government]. Natural Resources Conservation Service. http://www.nrcs.usda.gov/programs-initiatives/csp-conservation-stewardship-program

VA Soil & Water Conservation Districts. (2011, October 14). *Districts by SWCD Area—Virginia Association of Soil and Water Conservation Districts*. VA Association of Soil & Water Conservation Districts. https://vaswcd.org/districts-by-swcd-area/

van den Berg, H., Phillips, S., Poisot, A.-S., Dicke, M., & Fredrix, M. (2021). Leading issues in implementation of farmer field schools: A global survey. *The Journal of Agricultural Education and Extension*, *27*(3), 341–353. https://doi.org/10.1080/1389224X.2020.1858891

VASWCD. (2023). *Employment* [Government]. Virginia Soil and Water Conservation Districts. https://vaswcd.org/employment

VDACS. (2017). *Agriculture Facts and Figures*. Virginia Department of Agriculture and Consumer Services. https://www.vdacs.virginia.gov/markets-and-finance-agriculture-facts-and-figures.shtml

VDACS. (2023). *Becoming a Certified Pesticide Applicator* [Government]. Virginia Department of Agriculture and Consumer Services. https://www.vdacs.virginia.gov/pesticide-applicator-certification.shtml

Virginia Cooperative Extension. (2021). *Virginia Cooperative Extension 2021 Pesticide Application Certification Prep Course*. https://www.pwcva.gov/assets/2021-10/Pesticide%20Core%20and%20ROW%20Training%20Brochure.pdf

Virginia Cooperative Extension. (2023). *About Virginia Cooperative Extension*. https:///www.ext.vt.edu/content/ext_vt_edu/en/about.html

Virginia Tech. (2021). *RD391 (Published 2021)—Cooperative Extension/Agricultural Experiment Station Division Annual Report of Actual Expenditures by Fund Source and Program 2020-21* (p. 3). Virginia Tech, Office of Budget and Financial Planning. https://rga.lis.virginia.gov/Published/2021/RD391

Virginia Tech. (2023a). *Agency 229 | Virginia Tech College of Agriculture and Life Sciences*. Virginia Tech Agency 229. https://www.agency229.cals.vt.edu/

Virginia Tech. (2023b). *Agricultural Research and Extension Centers*. Virginia Agricultural Research and Extension Centers. https:///www.arec.vaes.vt.edu/content/arec_vaes_vt_edu/en/arec.html

Virginia Tech. (2023c). *AREC Video Summaries*. Virginia Agricultural Research and Extension Centers. https:////www.arec.vaes.vt.edu/content/arec_vaes_vt_edu/en/arec/arec-video-summaries.html

Virginia Tech. (2023d). *People, Eastern Shore Agricultural Research and Extension Center*. Virginia Agricultural Research and Extension Centers - Eastern Shore. https:////www.arec.vaes.vt.edu/content/arec_vaes_vt_edu/en/arec/eastern-shore/people.html

Wang, T., Jin, H., Kasu, B. B., Jacquet, J., & Kumar, S. (2019). Soil Conservation Practice Adoption in the Northern Great Plains: Economic versus Stewardship Motivations. *Journal of Agricultural and Resource Economics*, *44*(2), 404–421.

Weigel, C., Paul, L. A., Ferraro, P. J., & Messer, K. D. (2021). Challenges in Recruiting U.S. Farmers for Policy-Relevant Economic Field Experiments. *Applied Economic Perspectives and Policy*, *43*(2), 556–572. https://doi.org/10.1002/aepp.13066

Young, S. D. (2023). *Memorandum for the Heads of Executive Departments and Agencies*. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/2023/02/M-23-12-Appendix-C-Update_Discount-Rates.pdf

The Budget Bill, Communication from the Governor, no. HB1400, General Assembly, Governor of Virginia (2022). https://budget.lis.virginia.gov/get/budget/4653/HB1400/

Report Background Photo Credit:

Lancaster, M. (2019). *Nickelsville, VA, USA*. https://unsplash.com/photos/-nVhhrnQvSU