Final Workshop:
Climate Change Resilient Farming in Vermont Program

March 23rd, 2015

Hosted by the University of Vermont
Vermont Farm Resilience in a Changing Climate Initiative

Photo by Sam Mayfield
Presenters & Facilitators

- UVM Agroecology & Rural Livelihoods Group
  - Kate Westdijk, M.S., Food Systems Research Specialist
  - Martha Caswell, M.P.P., Research & Outreach Coordinator
  - Rachel Schattman, PhD. Candidate and Farmer

- UVM Center for Sustainable Agriculture
  - Joshua Faulkner, PhD., Farming & Climate Change Coordinator
  - Jennifer Colby, M.S., Pasture Program Coordinator
  - Linda Berlin, PhD., Director
  - Ginger Nickerson, PhD., GAPS Program Coordinator
Climate Change Resilient Farming in Vermont Program 2014-15

Participant Introductions

- Name, affiliation, primary expertise
- What are your remaining questions that you hope to have answered through this program?
Workshop Outline

- Welcome, VAR Initiative Updates, Program Review
- Review Observed and Projected Climate Impacts
- Discuss Key Strategies: CC Adaptation on VT Farms
  - Preliminary Results from the VT Ag Resilience in a Changing Climate Initiative
  - Report out from Participants (winter professional development)
- Practice Tools: Communicating these to VT Farmers
- Participant Goal Setting for 2015 Field Season
- Feedback to us on this New Program
Climate Change Resilient Farming in Vermont Program 2014-15

Our Goals for Participants

- Deepened relationships with peers
- Increased ability to:
  - conduct holistic farm climate change resilience assessment including recommendations for the farm and a tool kit of strategies
  - assess farmer knowledge and desire to learn about CC implications for their farm
- Increased understanding of climate change adaptation and/or mitigation strategies
- Increased number of farms they serve implementing recommended strategies
Climate Change Resilient Farming in Vermont Program 2014-15

Our Goals

♦ Increased understanding of participant goals—specifically what they need to be better able to serve farmers.

♦ Validate perceived outcomes that participants want based on past research with stakeholders.

♦ Broaden network of service-providers aware of our initiative and prepared to translate our findings to on-farm management decisions.

♦ Evaluate and improve program for future offering.
Climate Change Resilient Farming in Vermont Program 2014-15

Our Goals for Vermont Farmers

Farmers served by program participants, not farm field day hosts

- Increased adoption of appropriate farm management practices by VT farmers to enhance climate change resilience *(requires understanding their farm context and which BMPs are a good fit)*

- Increased understanding of climate change adaptation and/or mitigation strategies
Participant Generated Key Words: Farm Resilience

Wordle.com; October 2014
October 30th Farm Day

Islandacre Farm

Health Hero Farm
Climate Change Resilient Farming in Vermont Program 2014-15

- Webinar
- Farm Day (10/30) - CEC eligible
- November- March: Attend self-identified professional development opportunities (mini-grants available)
- Workshop (March 2015) - CEC eligible
- Share with Farmers (Season 2015 and beyond)

Program made possible by the High Meadows Fund
The Vermont Farm Resilience in a Changing Climate Initiative
An action-oriented approach.
Working with farmers, extensionists and researchers
to face the challenges of climate change.
Farm Practices Being Evaluated:

Focus for Farm Sampling:
1. Cover Crops
2. No Till
3. Stormwater runoff management
4. Wetland conservation
5. Rotational grazing

Considering broadly:
1. Hoop houses/high tunnels
2. Green manure
3. Timely manure incorporation
4. Pest/disease management
5. Invasive species management
6. Irrigation
7. Nutrient Management Plans
8. Conservation buffer strips
9. Drainage tile
10. Animal diversity
11. Animal feed management
12. Agroforestry
13. Alternative energy
14. Insurance
**Phase 1**
- Literature Review
- Stratified Survey
- Key Informant Interviews

**Phase 2**
- On-Farm Research *(components include: social, economic, agroecological, and mapping/visualization)*
  - Focus Groups

**Phase 3**
- Farmer-to-Farmer Workshops *(CCBMP recommendations)*
- Farmer/Service Provider Exchanges *(CCBMP recommendations)*
- Policy Workshops *(ABM & CCBMP recommendations)*

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**Progress**

- ABM *(design)*
- CCBMPs *(selection)*
- ABM *(calibration)*
- CCBMPs *(verification of climate impact & feasibility)*

**Stakeholders**

- Research Team
- Farmers
- Service Providers
- Policymakers
- Farmers
- Extensionists
- Service Providers
- Researchers
"Frankly, I'm not sure this whole idea-sharing thing is working."
Research Integration
Research Validation & Sharing

- Publications
- Farmer Conferences
- All of you!
- Initiative Advisory Committee:
  - VT Grass Farmers Association
  - VT Vegetable and Berry Association
  - Friends of Northern Lake Champlain
  - VT Agency of Agriculture
  - SARE/Extension
  - VT NRCS
  - Stone Environmental
  - VT Farm to Plate Initiative
  - VT State Climatologist
  - UNH Assistant Professor of Agroecology
Future Interests of ARLG in Vermont and New England

- Expanding and deepening On-Farm work with BMPs
- Outreach and Action for Research Impact
  - Repeat this Program in Vermont?
- Sharing Our Approach with other Northeast Land-grant Universities (with USDA Hub)
Questions?

www.vtfarmresilience.org
Review of VT Climate Change Impacts and Projections

Joshua Faulkner, PhD.
Precipitation in Northeastern Vermont (1983-2013)

Vermont, Climate Division 1, Precipitation, January-December

Northeastern VT: 9”
Western VT: 7”
Southeastern VT: 5”
Why Vermont Crops Fail (2001-10)
Since 1988, Crop Ins. provided
$213 Bil. of Protection and Paid $15 Million
in Loss Payments to VT Farmers

- Cold Wet, 1%
- Wind, 1%
- Frost, 2%
- Drought, 7%
- Hail, 26%
- All Other, 2%
- Excess Moisture, 60%
Trend in 1-day Very Heavy Precipitation (1958-2010)

NOAA/NCDC
‘In general, erosion increases at a rate 1.7 times annual rainfall increases’

(Nearing et al., 2004)
Erosion Predictions

Western Illinois
S. Western Wisconsin
S. Western Indiana
Southern Illinois
S. Central Michigan/Northern Indiana
N. Western Ohio/S. Eastern Michigan
Michigan Thumb
Eastern Wisconsin
Eastern Illinois
E. Central Indiana/W. Central Ohio
Central Wisconsin

Soil Loss Change, %

(O’Neal et al., 2005)
Sediment input to the Hudson R. due to Lee and Irene was 5 times long-term annual average (Ralston et al., 2013)
Modeled Total P: Six Climate Scenarios

(Tetra Tech, 2013)
Warming receiving waters
### Projections in Vermont (LCB)

Guilbert et al., 2014: *Impacts of projected climate change over the Lake Champlain basin in VT*

<table>
<thead>
<tr>
<th>Metric</th>
<th>Season</th>
<th>Base Avg</th>
<th>2040–69</th>
<th>2070–99</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.5%</td>
<td>50%</td>
<td>97.5%</td>
</tr>
<tr>
<td>Freezing days (day)</td>
<td>Annual</td>
<td>117</td>
<td>83</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Nov–Dec</td>
<td>38</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Jan–Feb</td>
<td>53</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Mar–Apr</td>
<td>24</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Snowfall (cm)</td>
<td>Annual</td>
<td>676</td>
<td>413</td>
<td>432</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>68</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>477</td>
<td>305</td>
<td>328</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>131</td>
<td>64</td>
<td>72</td>
</tr>
<tr>
<td>Above 32.2°C (day)</td>
<td>Annual</td>
<td>6</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>Heat index (°C day⁻¹)</td>
<td>Annual</td>
<td>130</td>
<td>449</td>
<td>475</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>118</td>
<td>389</td>
<td>416</td>
</tr>
<tr>
<td>Growing season (day)</td>
<td>Annual</td>
<td>141</td>
<td>166</td>
<td>169</td>
</tr>
<tr>
<td>Maple sap production (day)</td>
<td>Annual</td>
<td>60</td>
<td>52</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>19</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>14</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>27</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Heating requirements (°C day⁻¹)</td>
<td>Annual</td>
<td>5294</td>
<td>4216</td>
<td>4307</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>1153</td>
<td>897</td>
<td>916</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>2527</td>
<td>2159</td>
<td>2197</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>1395</td>
<td>1078</td>
<td>1106</td>
</tr>
<tr>
<td>Cooling requirements (°C day⁻¹)</td>
<td>Annual</td>
<td>0</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>0</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>rPPET (ratio)</td>
<td>Summer</td>
<td>1.14</td>
<td>1.10</td>
<td>1.15</td>
</tr>
</tbody>
</table>
How does climate change impact crops? (VT)

- Cool-season crops will be of lower yield or quality
  - Sweet corn
- Reduced grain yield (rapid maturation and moisture)
  - Field corn, nutrient content...
- Reduced vernalization lower some fruit yields; increased frost risk?
  - Apples
- New pests are able to over-winter, emerge early; increased pesticides
  - Flea beetle, SWD?
- Some warmer season crops will do better
  - Red wine grape, peaches, watermelon
- Water stress in crops...
How does climate change impact livestock?

- **Warming Temperatures**
  - Livestock
    - Heat stress in dairy cattle
  - Higher body temperatures
  - Increased respiration rates
  - Less activity
  - Increased water intake

- **Performance**
  - Dry matter intake down by 10-20%
  - Milk production down by 10-25%
  - Reproductive processes decrease
Adaptation from a Soil and Water Perspective

1. Landscape Storage/Flood Mitigation
2. Floodplain Strategies
3. Water Management for Production
4. Soil Conservation and Nutrient BMPs

Agricultural Resilience

Education
Outreach
Research
Technical Assistance
1. Management for Landscape Storage

Shift focus from treating runoff, to promoting infiltration

- Reduces runoff volumes
- Reduces peak flow and flooding risk
- Helps prevent erosion and nutrient loss
- Allows for nutrient cycling to occur
- Reduces drought risk
Soil Cover: Residue, mulch, or cover crops

- Physically prevents raindrop impact
- Slows runoff down, allowing more time to infiltrate

(Adapted from Ruedell, 1994)
Figure 2. Averaged over 10 years and three vegetable cropping systems, a winter rye cover crop reduced runoff throughout the year on a Freehold loamy sand with 3% slope in New Jersey (Brill and Neal 1950)

(Dubney, 1998)
Reduced Tillage and Infiltration

- No-, zone-, strip-, ridge-till, etc.
- Less macro-fauna disturbance (i.e., earthworms)

(Source: Herbek, AGR-101; www2.ca.uky.edu, Dan Brainard, msue.anr.msu.edu)
Organic Matter and Infiltration

(Colla et al., 2000)

Minutes

Cum. Infiltration (m$^3$/m$^2$)

High O.M.

Low O.M.
Structural Approaches to Landscape Storage
(Wright et al., 2013)
Controlled Drainage

Coordinated networks for flood regulation? Drought protection?

(Cooke and Verma, 2012)
2. Floodplain Strategies

AP Photo: Toby Talbot
Multifunctional Riparian Buffers

Reduce flood risk

Produce economic return

Ecosystem services

(Photo: NRCS)
3. Water Management for Production

(McDonald and Girvetz, 2013)
Drought Resilience

- Crops can’t use water that doesn’t infiltrate
- Organic matter
  - For every 1% increase in OM, another inch of water available (Emerson, 1995)
- Avoiding compaction
  - Deep moisture
  - Increased storage
  - Increased conductivity
- Role for moisture sensors
  - Drought and compaction prevention

(Courtesy USDA-NRCS)
Subsurface Drainage

Anecdotally: “All the gullies I used to have, they’re gone, now that I put in tile drainage”
### 4. Nutrient Management Strategies

<table>
<thead>
<tr>
<th>Climate Stressor</th>
<th>Nutrient Management Vulnerability and Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing temperatures</td>
<td>• Increased volatilization of N, leading to increased need for incorporation</td>
</tr>
<tr>
<td></td>
<td>• More rapid nitrification, leading to increased leaching and need to manage</td>
</tr>
<tr>
<td>Drought</td>
<td>• Reduced nutrient use efficiency, leading to residual P and N in soil in winter</td>
</tr>
<tr>
<td>Extreme rainfall events</td>
<td>• Increased runoff and nutrient/sediment transport</td>
</tr>
<tr>
<td></td>
<td>• Manure storage structures potential overflow</td>
</tr>
<tr>
<td></td>
<td>• Stressing of all BMPs linked to water cycle</td>
</tr>
</tbody>
</table>

Adapted from: Delaware Climate Change Impact Assessment: Ch. 7, Agriculture. 2014
Questions?

Joshua.faulkner@uvm.edu

Additional Resources:
http://www.uvm.edu/~susagctr/
15 farmers, 12 technical service providers

Three categories of BMPs:

1. Diversification
2. Water management
3. New cropping systems
Do farmers adopt BMPs to mitigate climate change impacts?
Results: 2013 Farmer Survey

**In your opinion, are there more extreme weather events now than 10 years ago?**
- Yes: 76%
- No: 13%
- Not sure: 11%

**In your opinion, is the climate changing?**
- Yes: 80%
- No: 7%
- Not sure: 13%

If you believe the climate is changing, do you believe this will affect your farm in a negative way?
- Yes: 56%
- No: 13%
- Not sure: 31%
Results: 2013 Farmer Survey

How often do you make management decisions is response to:

- Weather events?
- A changing climate?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Weather Events</th>
<th>A Changing Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>43</td>
<td>8</td>
</tr>
<tr>
<td>Weekly</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Monthly</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Yearly</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Seasonally</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>Not Sure</td>
<td>2</td>
<td>23</td>
</tr>
</tbody>
</table>
## Towards a Resilient Farmer Typology

<table>
<thead>
<tr>
<th>Grower types</th>
<th>Grower Characteristics</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilient Farmer</td>
<td>Strategic, educated, nimble, long-term</td>
<td>Educated</td>
<td>Either formal or informal. The farmer seeks out information specifically related to agriculture and climate change.</td>
</tr>
<tr>
<td></td>
<td>planner</td>
<td>Nimble</td>
<td>Farmer is able to change course quickly, incorporate new information, flexibility in the farm system.</td>
</tr>
<tr>
<td>Adaptive Farmer</td>
<td>Strategic, educated, nimble</td>
<td>Strategic</td>
<td>Farmer has accurate foresights and ability to plan several steps out. Ability to evaluate potential risks and gains, and sees the steps needed.</td>
</tr>
<tr>
<td>Reactive Farmer</td>
<td>Incremental changes, short term planner,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mid-term adopter</td>
<td>Long-term</td>
<td>Farmer makes investments (including physical infrastructure, land, education, retirement, etc.) in the future of the farm business or their personal livelihood.</td>
</tr>
<tr>
<td>Vulnerable Farmer</td>
<td>Incremental changes, short term planner,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Towards a *Resilient Farmer Typology*
What factors influence farmer decisions to adapt to climate change?

2013 Farmer Survey

• Anonymous survey of commercial farms
  – >10K income; Mississquoi & Lamoille Watersheds
• All farms were invited, 80 farmers completed full questionnaire (7% response)
### Who responded?

<table>
<thead>
<tr>
<th>Farm Type</th>
<th>Our Sample</th>
<th>USDA 2007 Census for the Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>72% (n=58)</td>
<td>86% (n=1100)</td>
</tr>
<tr>
<td>Organic</td>
<td>27% (n=22)</td>
<td>14% (n=178)</td>
</tr>
<tr>
<td>Small</td>
<td>23% (n=18)</td>
<td>28% (n=361)</td>
</tr>
<tr>
<td>Medium</td>
<td>74% (n=57)</td>
<td>69% (n=885)</td>
</tr>
<tr>
<td>Large</td>
<td>2% (n=2)</td>
<td>2% (n=32)</td>
</tr>
</tbody>
</table>

Results were weighted for analysis based on 2007 farmer census for these regions.
Who responded?

- Majority (79%) of respondents were between the ages of 45 and 74.
- Majority (55%) had been farming for 20-40 years.
- Level of education varied, with the largest proportion (36%) having achieved a Bachelor’s degree.
We asked about...

• Farmer level of adoption and intent to adopt
• Factors that influence farmer intent to adopt a particular BMP
  – Attitudes, norms, perceived ability to implement
• *Focus on NMPs versus CCBMPs*
  – NMPs are a subset of BMPs
  – NMPs allow farmers to offset the negative impacts of climate change in addition to other benefits
Farm Practices Being Investigated:

Focus for Farm Sampling:
1. Cover Crops
2. No Till
3. Stormwater runoff management
4. Wetland conservation
5. Rotational grazing

Considered in this Survey:
1. Planned Crop Rotations
2. Strip Cropping
3. Cover Cropping
4. Reduced Tillage
5. Conservation buffer strips
6. Soil Test Every 3 Years
7. N, P, & K application at rates recommended by soil tests
8. Timely manure and fertilizer incorporation
9. Applying fertilizer at recommended rates
10. Applying manure at recommended rates and times
11. Manure spreading setbacks
Selected Results

• Conservation easements significantly affect farmer behavior related to the adoption of nutrient management plans

• Farmer age and education level did not have a significant effect on adoption

• Net financial loss showed significant reduction in nutrient/manure application and planned crop rotations
Selected Results

• All NMPs- perceived behavioral control directly influences intent to adopt
  – PBC= better knowledge, skill set, and control of implementation
  – suggests technical assistance will make a difference!

• In 7 of 10 NMPs- past adoption predicts future intent to adopt
  – Planned crop rotations, Strip Cropping, Buffers, Cover Cropping, Reduced Tillage, Timely manure incorporation, Manure spreading setbacks
Key Takeaways

• Willingness to adopt a new practice is most likely if farmers feel skilled and in control to implement it

• Understanding and helping a farmer navigate these barriers is key to influencing implementation

• Does this align with your experience?
Participant Goal Setting: 2015

• Specific, measurable

• Examples:
  – “Talk with 5 farmers about riparian buffers and CC adaptation.”
  – “Support 2 farmers to adopt buffers on their farms.”
THANK YOU for being a willing first cohort in this experiment!

www.vtfarmresilience.org

www.uvm.edu/sustainableagriculture/