Areas of Opportunities and Needs for Climate Adaptation: Puerto Rican Farmers' Reported Obstacles and Strategies after Maria

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USFS International Institute of Tropical Forestry
NRCS State Technical Meeting| May 19, 2022

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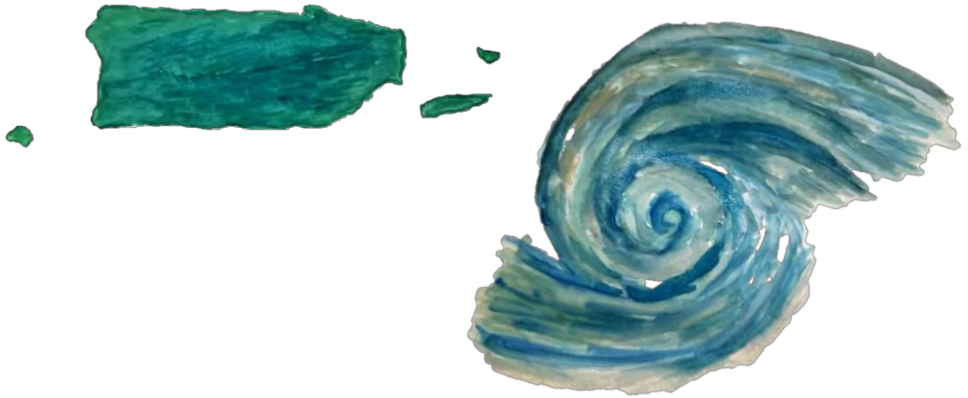

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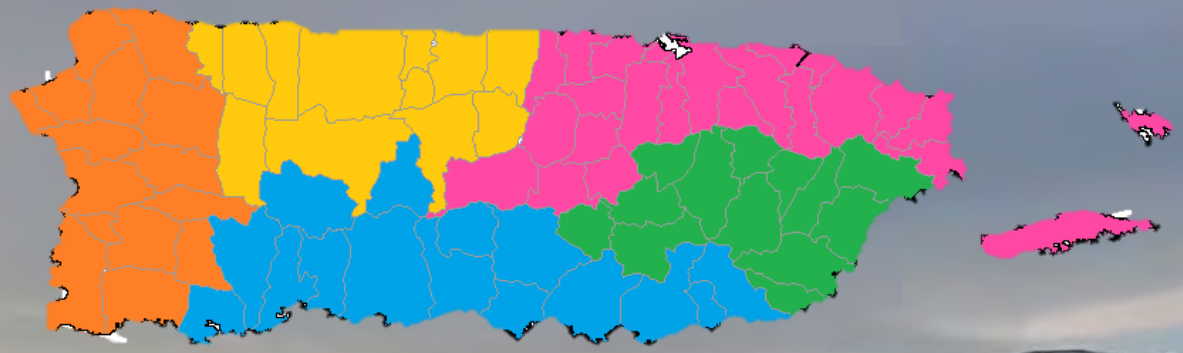
- Farmland production
- Climate change
- Food security
- Hurricane María
- Public policy
- Adoption
- Networks
- Demographics

405 respondents,
87% response rate

Extension Service's regions of Puerto Rico



Experience, Challenges, and Perceptions

Luis Alexis Rodríguez Cruz & Dr. Meredith T. Niles
Food Systems Program, The University of Vermont

Background

2017's Hurricane Maria struck the United States unincorporated territory of Puerto Rico as a category 4 hurricane, causing 2,975 deaths [1]. The archipelago's agriculture, which was experiencing production improvement during Puerto Rico's financial crisis, was decimated [2]. Damages to production were estimated to reach approximately 200 million dollars, and 80% of its crop value was devastated [3]. Hurricanes in the Atlantic are likely to become more intense and persistent in the upcoming years due to climate change, which will have profound impacts in island countries and territories, especially in their agricultural systems and food security [4]. Thus, understanding how farmers prepare for and are affected by hurricanes, as well as what strategies they may use to increase their resiliency in the future, is critical for future adaptation. This research explores Puerto Rican farmers' experience with Hurricane Maria and climate change perceptions, and its relationship to farm management, food security, policies and sociodemographic factors. The objective of the present brief is to highlight key basic results, and provide an overview of our findings.

Data Collection

This research was carried out in collaboration with the Extension Service of the University of Puerto Rico at Mayagüez (UPRM). Ethics approval was obtained from the University of Vermont Institutional Review Board prior to research. A survey was developed and piloted with a small sample (n=32) of farmers between January and March 2018. Then, the survey was deployed by Extension agents of UPRM between May and June 2018 throughout Puerto Rico. A total of 405 farmers participated out of 440 surveyed for a response rate of 87.7%. Surveys were distributed according to the Extension Service's regions.

Key Descriptive Results

Farm and Farmer Characteristics

- 14% female and 86% male farmers, with an average age of 54 (SD = 13.5), participated in this research project.
- 52.8% of our respondents are participants of the *Bonafide* farmers program of the Puerto Rico Department of Agriculture, which provides several benefits and incentives to farmers who qualify.
- On average, farmers work 56 acres (SD = 96), and own 72.4% of the land they farm.
- 56.4% of respondents have an overall income less than $20,000 a year, and 33.0% earn between $20,000 and $40,999 a year. On average, 58.7% of their income comes from farming.

Agricultural Production

- In total, the top five agricultural products produced among respondents were plantains (55.2%), sweet peppers (37.6%), aromatic herbs (30.8%), root vegetables (29.5%), and tropical squash (28.4%).
- Data suggests that farm diversity decreased after Hurricane Maria. Farmers produced an average of 3.15 (SD = 2.5) products before the hurricane, 2.29 products (SD = 2.0) at the time of the study (eight months after Maria), and indicated that in the upcoming three months they will produce an average 2.01 products (SD = 2.3).

Distribution of Respondents' Farms Among Extension Service's Regions

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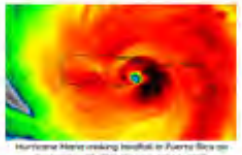
Hurricane Maria's Impact on Puerto Rican Farmers: Understanding their Experience, Challenges, and Perceptions

Farmers' Reported Damage

Farmers' Climate Change Perceptions

Hurricane Maria

- The great majority of farmers had significant losses due to the hurricane. 42.5% reported a total loss, 45.5% significant damages, and 10.5% reported moderate damages. The top reported damages were to crops (77.6%), infrastructure (69.4%), and livestock (27.1%).
- 89.8% of our respondents faced at least one obstacle towards recovering from Hurricane Maria. The most common obstacles included:
  - 43.7% reported farm-related obstacles (e.g. infrastructure damages, lack of laborers, etc.)
  - 31.5% reported government-related obstacles (e.g. lack of aid/assistance, etc.)
  - 23.0% reported utility-related obstacles (e.g. no power, water).



Hurricane Maria making landfall in Puerto Rico on September 20, 2017 (Source: NOAA, 2017)

Climate Change Perceptions

- Data suggest that Puerto Rican farmers are psychologically close to climate change. Meaning that they are aware of how vulnerable they are to impacts related to it (see graph above). 94.7% of our respondents agreed or strongly agreed (hereafter collectively "agreed") that the global climate is changing, and 95.2% agreed that average global temperatures are increasing.
- 86.8% agreed that anthropogenic activities are a significant cause of climate change, and 94.4% of farmers agreed that the effects of climate change are being felt today. While 94.1% agreed that Puerto Rico will be affected by climate change, and 85.9% agreed with the statement that climate change will mostly affect places far away from Puerto Rico.
- 34.4% of farmers agreed that there is scientific uncertainty about climate change's potential impacts to agriculture.
- 23.1% of the participants felt uncertain that the occurrence of strong hurricanes in the Atlantic is related to climate change.

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Hurricane Maria's Impact on Puerto Rican Farmers: Understanding their Experience, Challenges, and Perceptions

Percentage of Farmers' Who Reported Food Insecurity by Month

Food Security

- Farmers were asked to report the months in which they faced a struggle to acquire food or a shortage of it. Data suggests that in the year before the survey, between May 2017 and April 2018, farmers faced an average of 2.15 months of food insecurity, with 70.1% reporting at least one month of food insecurity.
- Data indicates food insecurity increases are associated with Hurricane Maria. In the months prior to the hurricane, fewer than 10% of respondents reported being food insecure in any given month (see graph above).
- During and after Hurricane Maria, food insecurity rates increased significantly. 41.9% reported food insecurity in September, 59.1% in October, 48.6% in November, and 30.7% in December 2017.

Preparedness

- 93.2% agreed that their farms are vulnerable to future extreme weather events such as Maria.
- 75.6% of farmers feel that they have the capacity to modify their agricultural practices to prepare for potential future events like Hurricane Maria, and 82.9% feel motivated to do so.
- 66.6% of our respondents agreed that they prepared for Hurricane Maria.
- 53.0% reported having insurance to cover their farms.

Current & Future Agricultural and Management Practices

- The most frequent agricultural practices currently in use by farmers are: integrated disease management (24.4%), crop rotation (21.2%), and diversifying crops (19.6%).
- The agricultural/management practices that farmers indicated they would be very likely or likely to adopt in the near future are: Diversify crops (78.2%), integrated disease management (74.8%), and acquire insurance or improve the insurance plan they have (67.2%).

Public Policy

- 61% of participants agreed that the Puerto Rican government provides sufficient funds to help farmers prepare for extreme weather-related events.
- 13.5% agreed that Puerto Rico has the necessary policies to protect and support local agriculture, and 11.8% agreed that food imports in Puerto Rico are not an obstacle for local agriculture to increase its access to the Puerto Rican market.

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Hurricane Maria's Impact on Puerto Rican Farmers: Understanding their Experience, Challenges, and Perceptions

Farmer's Informational Sources Regarding Climate Change Adaptation

Farmer Information Sources

- Farmers received climate-related information most frequently from Extension Services of UPRM (62.1%). Other sources include the Natural Resources Conservation Service (NRCS) (34.4%), the Department of Agriculture of Puerto Rico (33.9%), and the United States Department of Agriculture (USDA) (24.6%).
- Farmers indicated they would like to receive climate change information from a different set of organizations, including the Puerto Rican Association of Farmers (47.0%), *Colegio de Agrónomos de Puerto Rico* (46.2%), the Department of Natural Resources of Puerto Rico (43.7%), and *Organización Boricuá de Agricultura Ecológica* (a Puerto Rican agroecological organization) (43.2%).

Further Steps in our Analysis

Future research will explore the statistical relationship between drivers and barriers to adoption of adaptation practices, climate perceptions, hurricane resilience and food security outcomes. Furthermore, an analysis of the impacts' extent on specific agricultural sectors in Puerto Rico will be carried out. Future surveys are planned to continue to work with the UPRM Extension Service and these farmers over time.

This research will also contribute to a nascent body of literature focusing on how islands' agricultural systems can become more resilient and resistant to future and ongoing impacts related to climate change.

Acknowledgements

The authors thank all farmers that participated in the survey, and the several extension agents that carried them out. The authors also thank Prof. Aníbal R Ruiz Lugo, Assistant Dean of UPRM's Extension Service, for his invaluable help to carry out this research. Special thanks to Ms. Maritzabel Morales, Ms. Carmen González Toro, Dean Eric Irizarry Otaño, Dr. María del Carmen Rodríguez Rodríguez, Dr. Robinson Rodríguez Perez, Dr. Fernando Perez Muñoz, and the administration of the University of Puerto Rico at Mayagüez for their collaboration. This research was funded by the University of Vermont's College of Agriculture and Life Sciences, and Food Systems Program.

Notes
[1] Table 1 in Kishore, N., Marqués, D., Mahmud, A., Kiang, M. V., Rodriguez, I., Fuller, A., Ebner, P., Orenstein, C., Silver, R., Murray, C., Bogoch, W., Waldman, R., Elkinton, J., Lessler, J., Stoddard, M., Santos-Burgoa, C., Barnoya, J., Patz, J., Emanuel, K., Ernst, K. (2018). Mortality in Puerto Rico after Hurricane Maria. New England Journal of Medicine, 379(162), 162–170. https://doi.org/10.1056/NEJMsa1803972
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[3] Sec. 11 Hurricane Recovery in Agriculture Service. (2017, October). Department of Agriculture of Puerto Rico. http://www.drna.pr.gov/wp-content/uploads/2017/10/Sec.-11-Hurricane-Recovery-in-Agriculture-Service.pdf
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[6] Rodríguez Cruz, L. A., Niles, M. T. (2019). Farmers' Experience with Hurricane Maria and Climate Change Perceptions in Puerto Rico. Food Systems Program, The University of Vermont. https://www.uvm.edu/sites/default/files/Food-Systems-Program/Farmers-Experience-with-Hurricane-Maria-and-Climate-Change-Perceptions-in-Puerto-Rico.pdf

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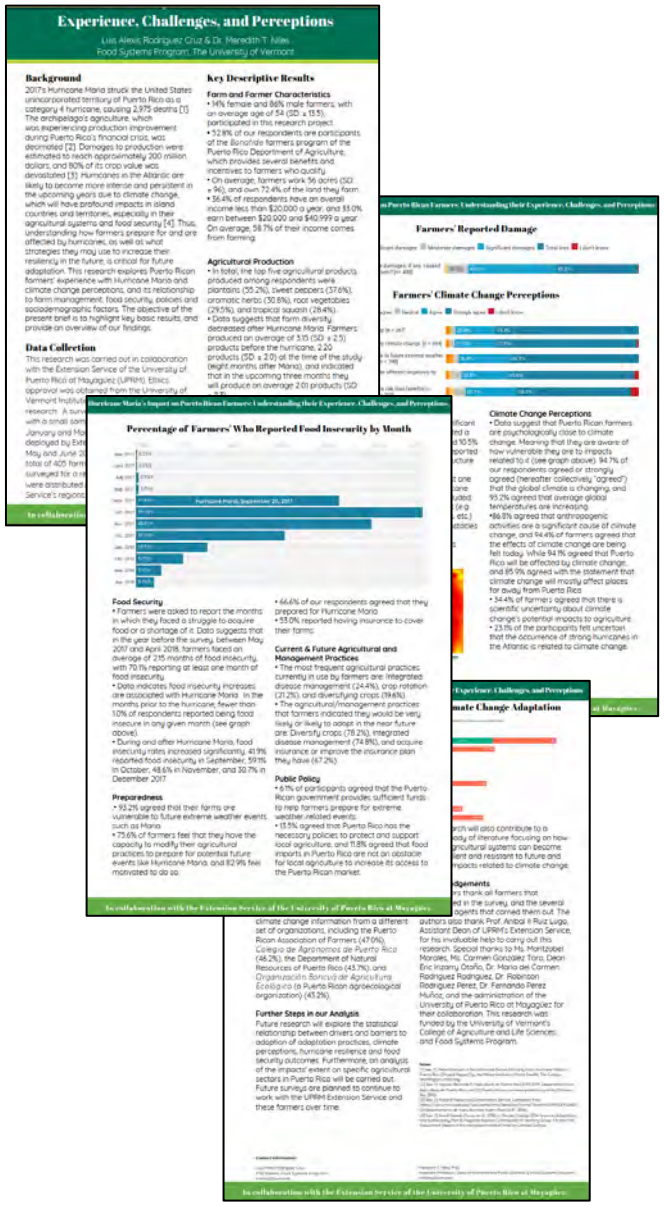
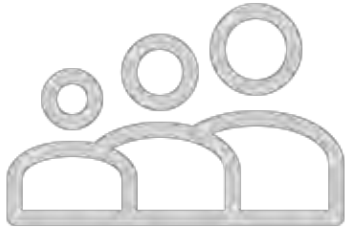
Quick stats from survey respondents



43%
Farmers who reported total loss of farms

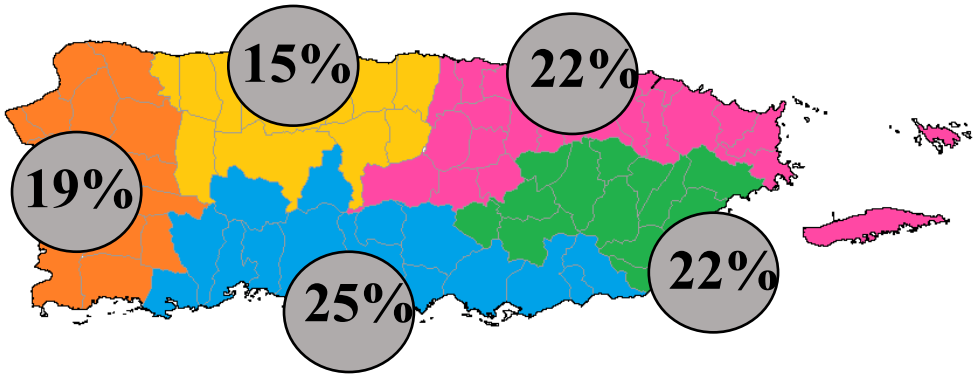


Avg. age: 54 (census: 61) 86% male

Avg. size: 56 acres in cuerdas (census: 57) 82% < 100

Decline of agricultural diversity after Maria

53%
Farmers who identified as *bona fide* farmers



PLOS ONE

RESEARCH ARTICLE

Awareness of climate change's impacts and motivation to adapt are not enough to drive action: A look of Puerto Rican farmers after Hurricane Maria

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Abstract

Understanding how perceptions around motivation, capacity, and climate change's impacts relate to the adoption of adaptation practices in light of experiences with extreme weather events is important in assessing farmers' adaptive capacity. However, very little of this work has occurred in islands, which may have different vulnerabilities and capacities for adaptation. Data of surveyed farmers throughout Puerto Rico after Hurricane Maria (n = 405, 87% response rate) were used in a structural equation model to explore the extent to which their adoption of agricultural practices and management strategies was driven by perceptions of motivation, vulnerability, and capacity as a function of their psychological distance of climate change. Our results show that half of farmers did not adopt any practice or strategy, even though the majority perceived themselves capable and motivated to adapt to climate change, and understood their farms to be vulnerable to future extreme events. Furthermore, adoption was neither linked to these adaptation perceptions, nor to their psychological distance of climate change, which we found to be both near and far. Puerto Rican farmers' showed a broad awareness of climate change's impacts both locally and globally in different dimensions (temporal, spatial, and social), and climate distance was not linked to reported damages from Hurricane Maria or to previous extreme weather events. These results suggest that we may be reaching a tipping point for extreme events as a driver for climate belief and action, especially in places where there is a high level of climate change awareness and continued experience of compounded impacts. Further, high perceived capacity and motivation are not linked to actual adaptation behaviors, suggesting that broadening adaptation analyses beyond individual perceptions and capacities as drivers of climate adaptation may give us a better understanding of the determinants to strengthen farmers' adaptive capacity.

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Data Availability Statement: Data cannot be shared publicly because only a portion of the data was used in the reported study, the de-identified data used in this paper can be accessed at the

frontiers in Sustainable Food Systems

Puerto Rican Farmers' Obstacles Toward Recovery and Adaptation Strategies After Hurricane Maria: A Mixed-Methods Approach to Understanding Adaptive Capacity

Luis Alexis Rodríguez-Cruz, Maya Moore and Meredith T. Niles

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Farmers across the globe are experiencing compounding shocks that make evident the need to better understand potential drivers and barriers to strengthen adaptive capacity. This is especially true in the context of a disaster, where a disruption in the natural and built environment hinders livelihood strategies and exposes the underlying dynamics that perpetuate vulnerability to natural hazards. As such, the interconnections of structural and individual attributes must be considered when evaluating adaptive capacity. This paper uses a convergent mixed-methods approach to assess Puerto Rican farmers' actual and intended adoption of adaptation practices, in light of the obstacles they faced toward recovery after 2017's category four Hurricane Maria, in contribute to better understanding adaptive capacity. This study uses data from 405 farmers across Puerto Rico (87% response rate), surveyed 8 months after Maria by agricultural agents of the Extension Service of the University of Puerto Rico at Mayaguez. Quantitative data was assessed through negative binomial regression (actual adoption) and generalized linear models (intended adoption), while qualitative data (open-ended responses) were analyzed through thematic analysis. This study found that almost half of farmers adopted an adaptation practice after Maria, and that in many cases, broader structural, such as systems of governance, farmers' social networks, and infrastructure, affect adaptive capacity more than individual perceptions of capacity. Future adaptation strategies and interventions, especially in the context of disaster, should consider the extent to which structural factors hinder individuals' ability to prepare for, respond, and recover from the impacts of these shocks. Our results show that there might be opportunity to erect new systems in light of catastrophic events, but this does not solely depend on individual actions. The mixed-methods approach used can inform future studies in better assessing adaptive capacity from a framework that incorporates individual and structural components.

Keywords: climate change, disaster and archipelagos, food systems, farmers' decision-making, disaster and climate risk reduction

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LETTER

Social-ecological interactions in a disaster context: Puerto Rican farmer households' food security after Hurricane Maria

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Keywords: small island developing states, food insecurity, extreme weather events, vulnerability, adaptive capacity

Abstract

Islands are uniquely vulnerable to extreme weather events and food insecurity, and have additional response challenges due to their limited landmasses and economies, isolation, colonial legacies, and high dependence of food imports. Domestic farmers have a key role in producing food for island communities like Puerto Rico, which can safeguard food security when food importation may be challenging. Nevertheless, in the context of disaster, farmers themselves may be vulnerable to food insecurity and unable to contribute to domestic markets. This paper examines Puerto Rican farmers households' food security in the aftermath of 2017's Hurricane Maria using a social-ecological lens. Survey data from 405 farmers gathered eight months after Maria, coupled with biophysical data from the hurricane's impacts (winds, rains, and landslides), were analyzed. Overall, 69% of farmers experienced at least one month of food insecurity in the aftermath of Hurricane Maria, and 38% reported persistent food insecurity (three months or more). A multinomial logistic regression suggests that biophysical impacts, but especially social factors, such as age and constraint access to external sources of support, are linked with persistent food insecurity. This suggests that the biophysical impacts of the hurricane interact with existing infrastructure and social resources to affect farmer vulnerability and the food environment in different ways. Thus, strengthening adaptive capacity in multiple domains can help farmers and vulnerable populations better navigate the disruptions faced during disasters to alleviate food insecurity.

1. Introduction

Extreme weather events, such as hurricanes, are becoming more intense in the growing climate crisis [1, 2]. These events can trigger disasters, often prompting disruptions in the built and natural environments affecting livelihood activities [3–6]. Such disruptions can generate a period of transitory or episodic food insecurity, where people's consecutive access to adequate food that supports their wellbeing is hindered [7, 8]. During these periods, often unexpected or seasonal [9–11], people lack or have difficulty accessing nutritious and culturally-appropriate foods [7]. The length of these effects on people's food security may vary, due to the magnitude of the impact, coupled with an affected populations' vulnerability stemming from social-ecological characteristics, such as race, sex, geography, economics, politics, ecosystem services, and biophysical aspects of a place, among others. Social-ecological characteristics may predispose some populations to be at higher risk of harm, and may reduce their ability to recover from disaster impacts [5, 12–14]. This assertion is increasingly true of small island developing island states (SIDS) and territories (as well as low-income societies), which have higher exposure and sensitivity to extreme weather events [1, 15–18].

In island systems, physical and economic access to food at all times is often challenging due to several characteristics: high dependence on imports and

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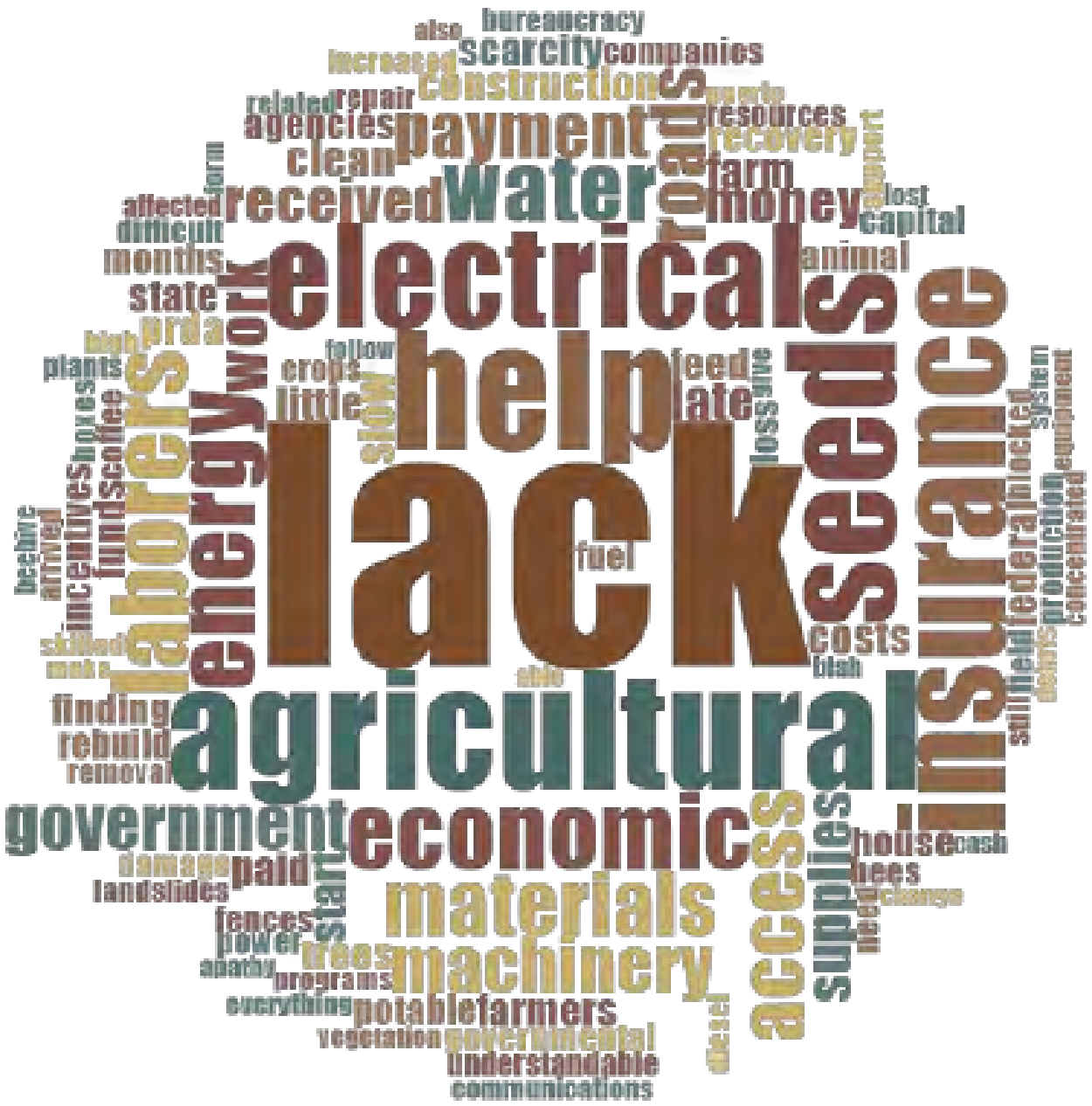
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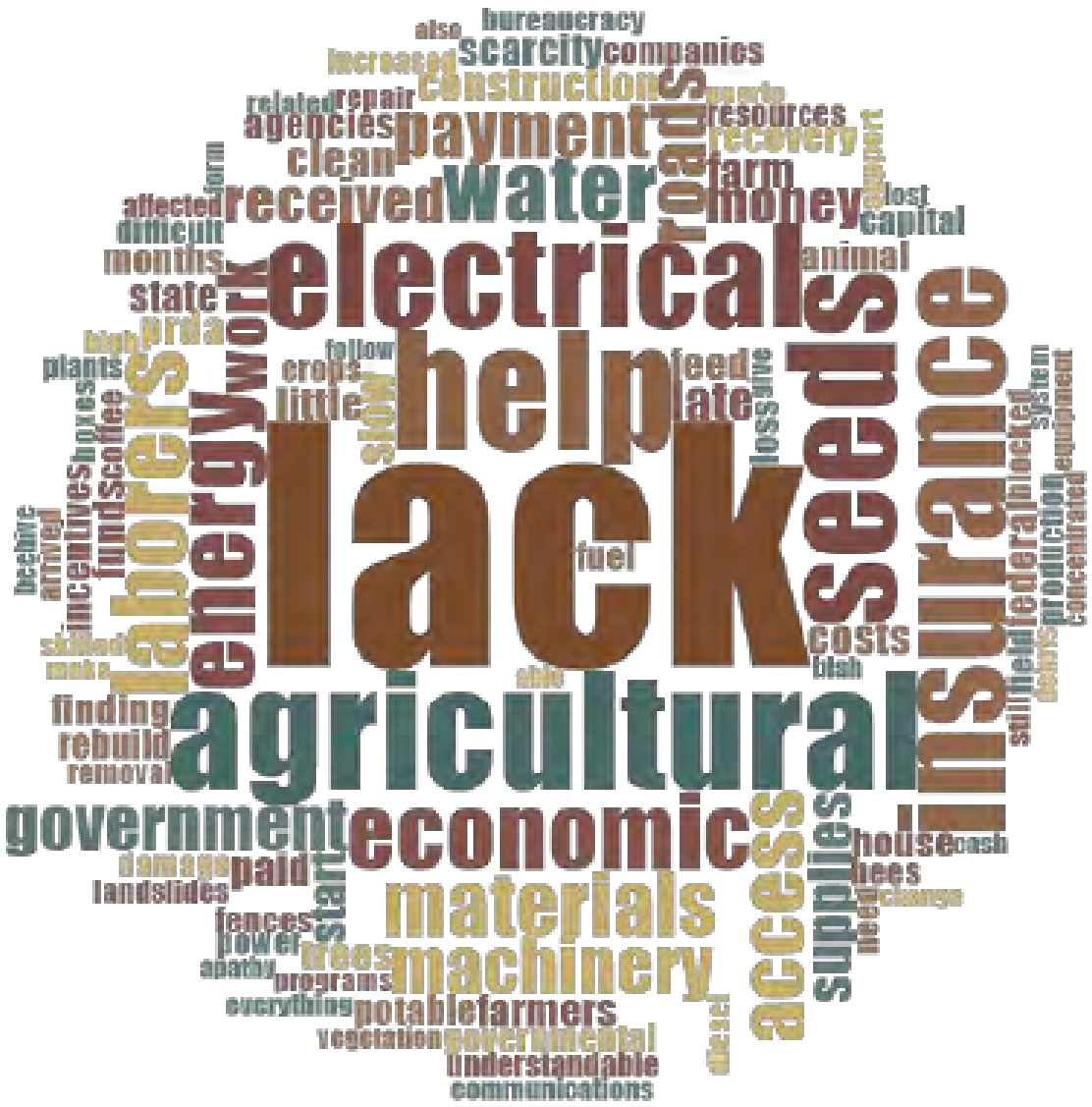


Obstacles were related to:

27% institutions

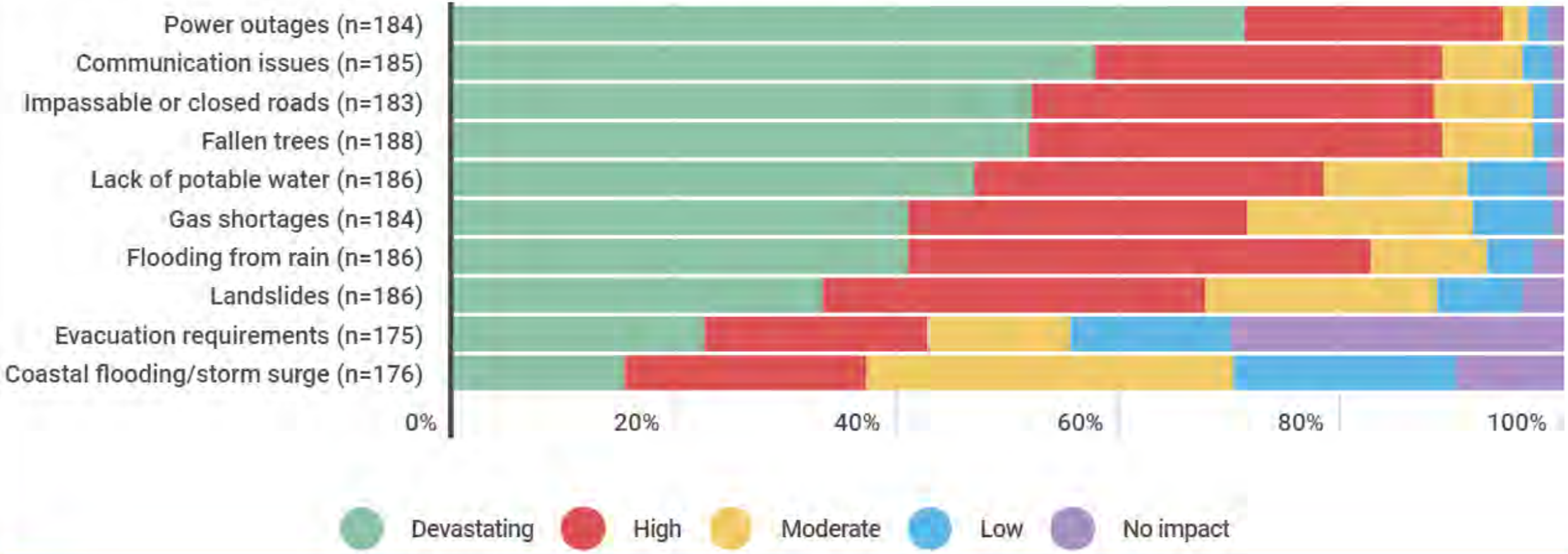
26% economic

26% materials and tech

23% ag resources

Impacts of hurricanes on agricultural land as observed by advisors

Most of the advisors identified power outages (71%), communication issues (58%), impassable or closed roads (52%), and fallen trees (52%) as the most devastating effects on agricultural land



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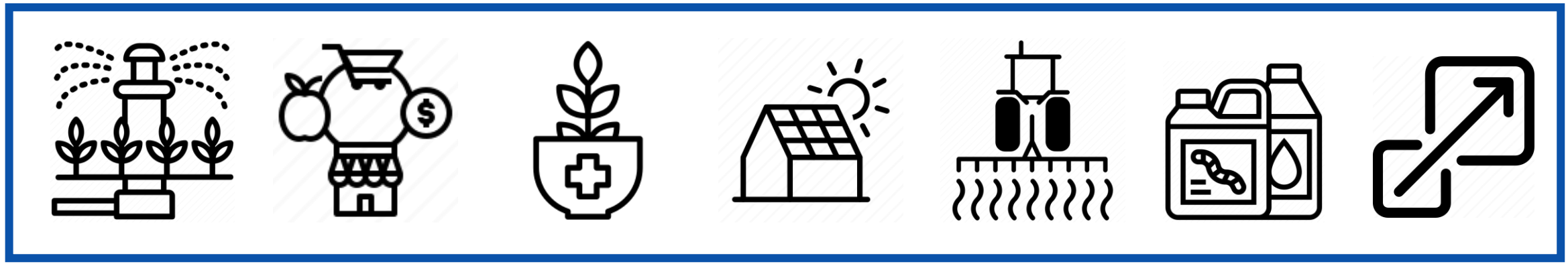
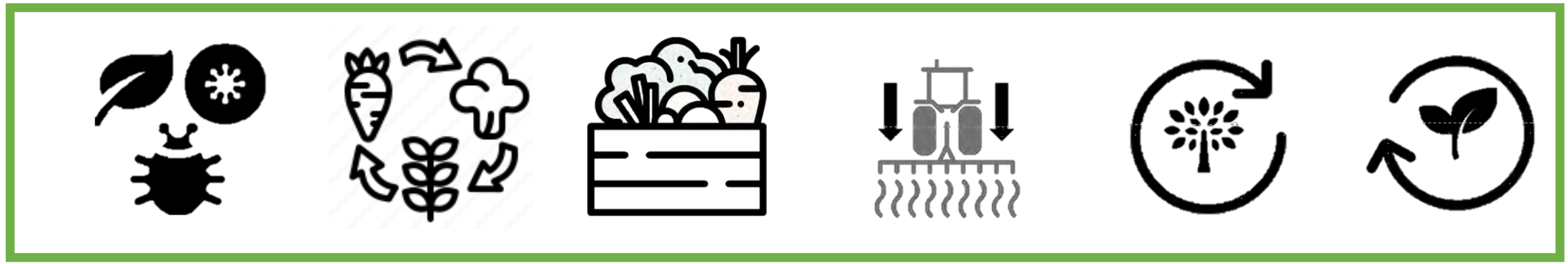
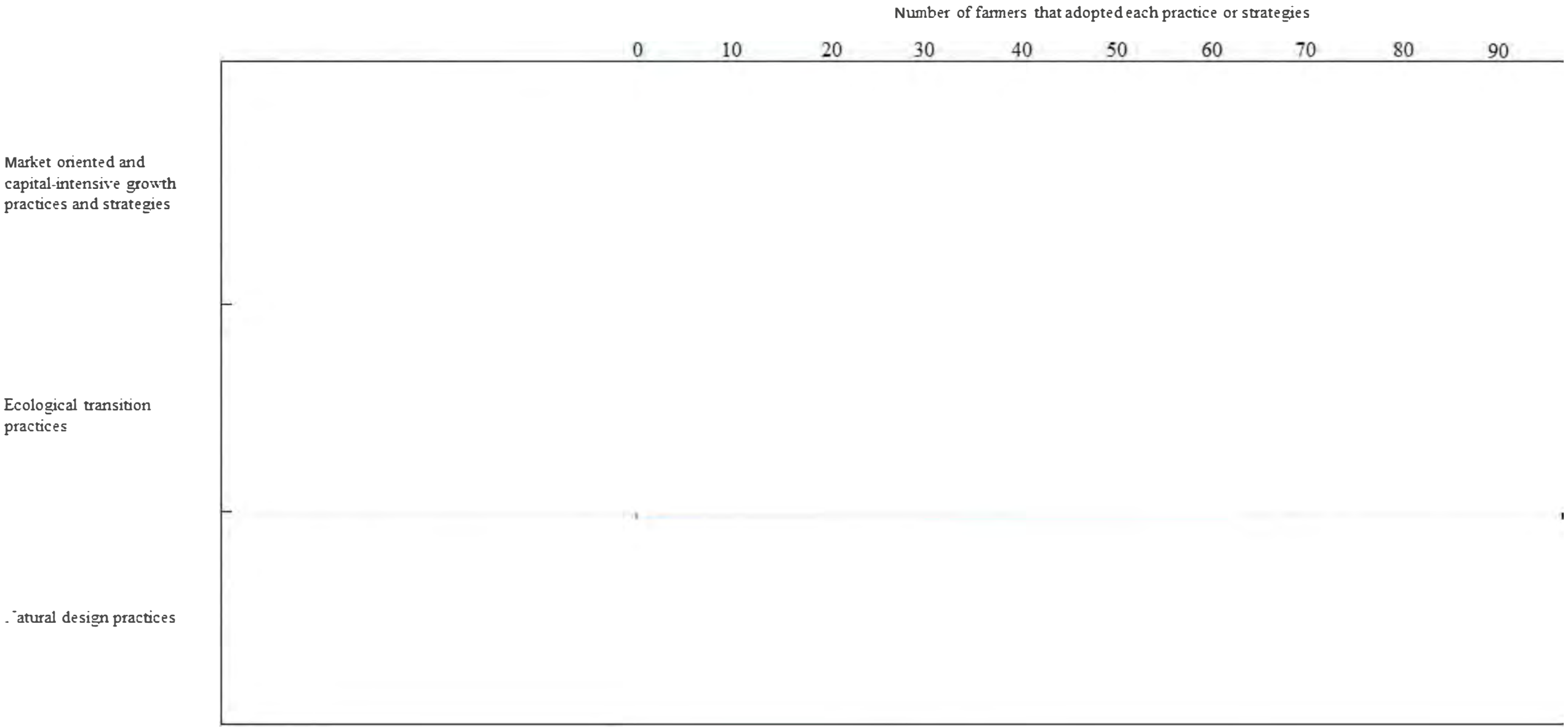




Most common new practices adopted after Maria:

(26%) integrated pest management
(21%) crop rotations
(19%) diversification
(17%) contouring
(16%) composting

Level of formal education and reporting total loss due to the hurricane were linked to count outcomes of new practices


Number of farmers that adopted each practice or strategies
0
10
20
30
40
50
60
70
80
90
Market oriented and capital-intensive growth practices and strategies
Ecological transition practices
.'atural design practices

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

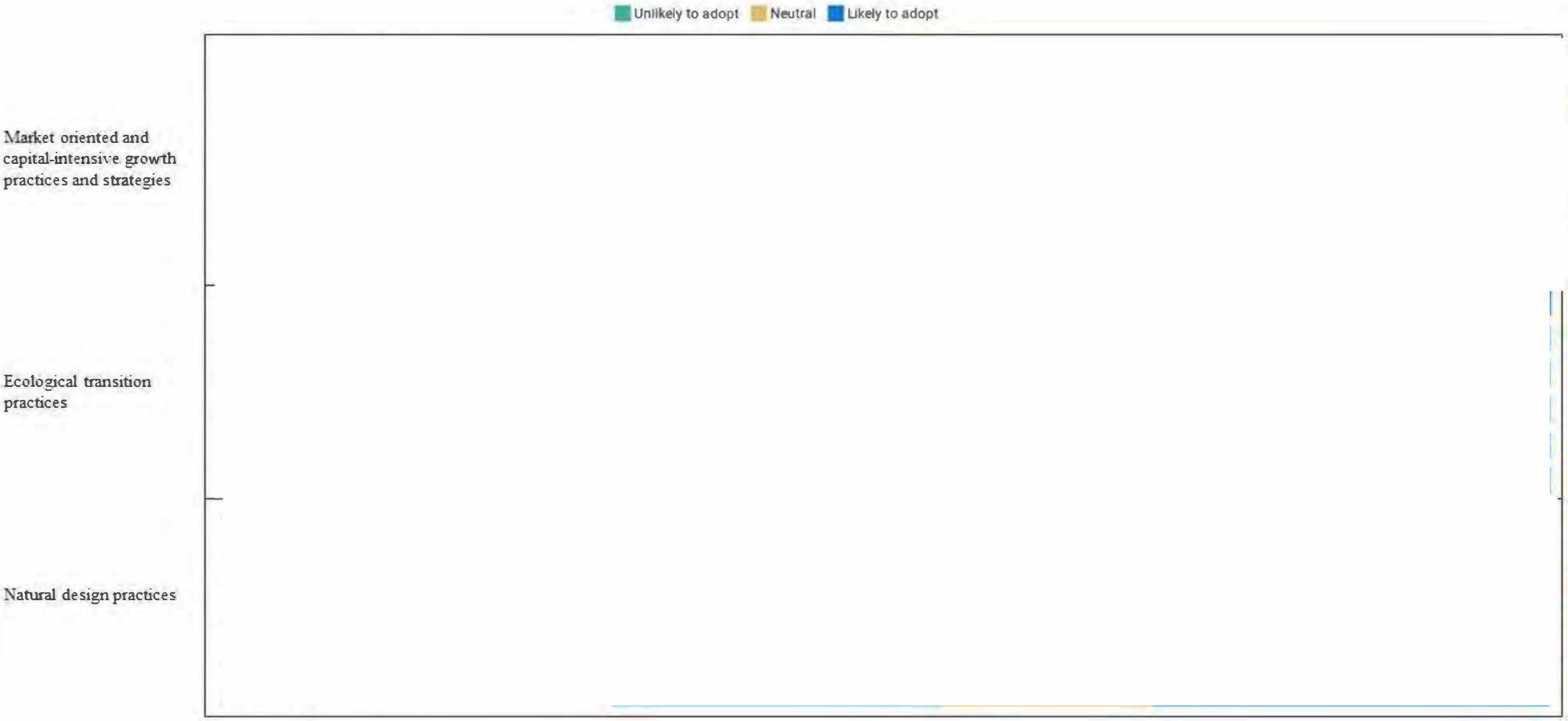
34% have received services from NRCS

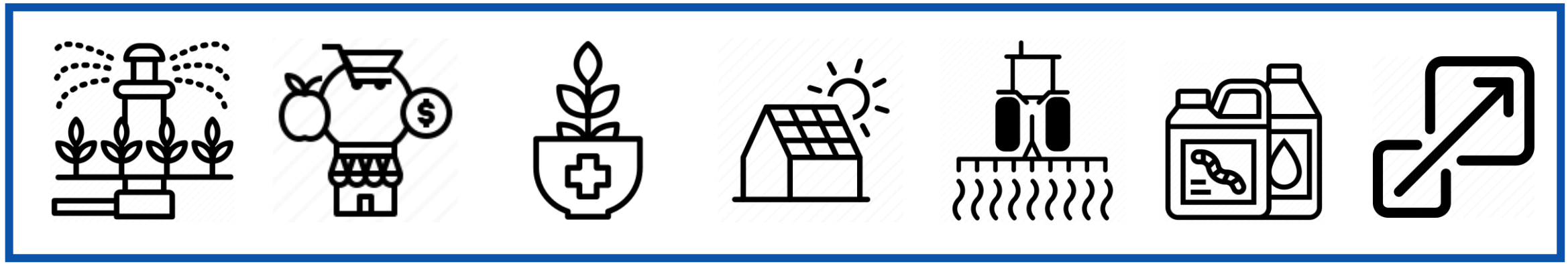
37% would like to receive services

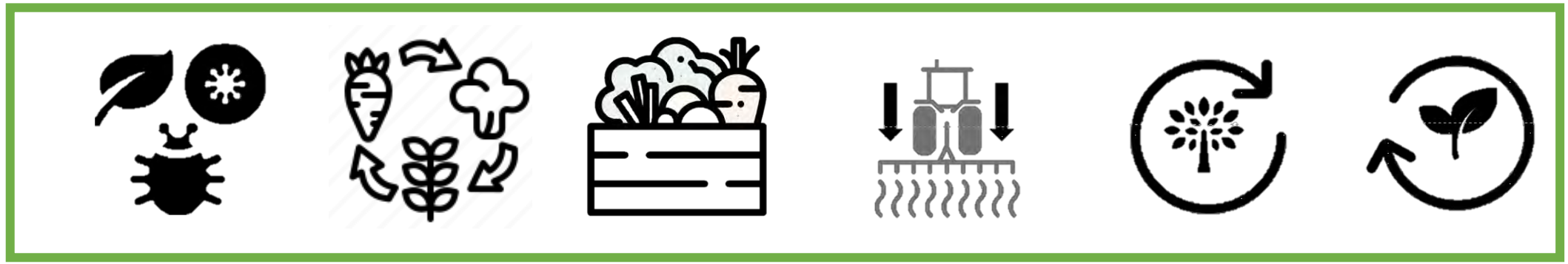
Most common practices farmers intended to adopted after Maria:

(81%) integrated pest management
(78%) diversification
(75%) seek new agricultural markets
(72%) acquire or improve ag insurance
(71%) crop rotation

No variable was linked to general likelihood of adopting new practices.


Unlikely to adopt
Neutral
Likely to adopt
Market oriented and capital-intensive growth practices and strategies
Ecological transition practices
Natural design practices





frontiers in Sustainable Food Systems

Puerto Rican Farmers' Obstacles Toward Recovery and Adaptation Strategies After Hurricane Maria: A Mixed-Methods Approach to Understanding Adaptive Capacity

Lini Alexis Rodríguez-Cruz, Maya Moore and Meredith T. Niles

OPEN ACCESS

Key takeaways:

A mixed-methods approach provides a richer understanding

New systems may arise in crisis, but is dependent on broader structures of support

Better understand how coupled local and federal policies (in the case of PR) shapes farmers' decision-making

NIFA

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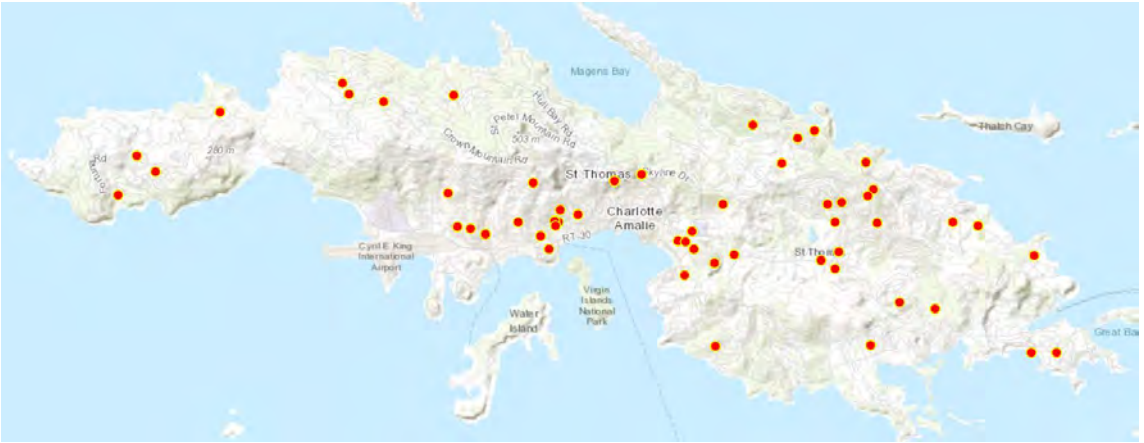
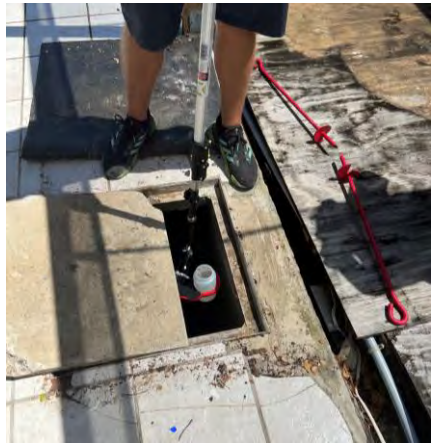
CARIBBEAN CLIMATE HUB
for Tropical Forestry and Agriculture

INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY

St Croix Water Quality Sampling Locations 2018



St Thomas Water Quality Sampling Locations 2018



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***'Enabling climate-smart decisions for agriculture and forestry in the U.S. Caribbean' (funded by* NIFA)**

- Climate Change-focused OneUSDA Workshops for Farmers and Forest Managers
- Climate Kids Caribbean Pilot Project
- Climate Change Adaptation Module for USDA and University Extension Staff
- Dairy-focused Adaptation Educational Modules
- Soil Health Learning Network
- Climate-smart Reforestation Planning Workshops

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Adaptation Guidelines for Tropical Forestry and Agriculture (pilot project funded by NRCS)

- Improve stakeholders' access to available cross-sector resources, tools, and services that may allow and support them in achieving sustainable adaptation levels.
- Contextualize existing tools unavalaible to PR and USVI

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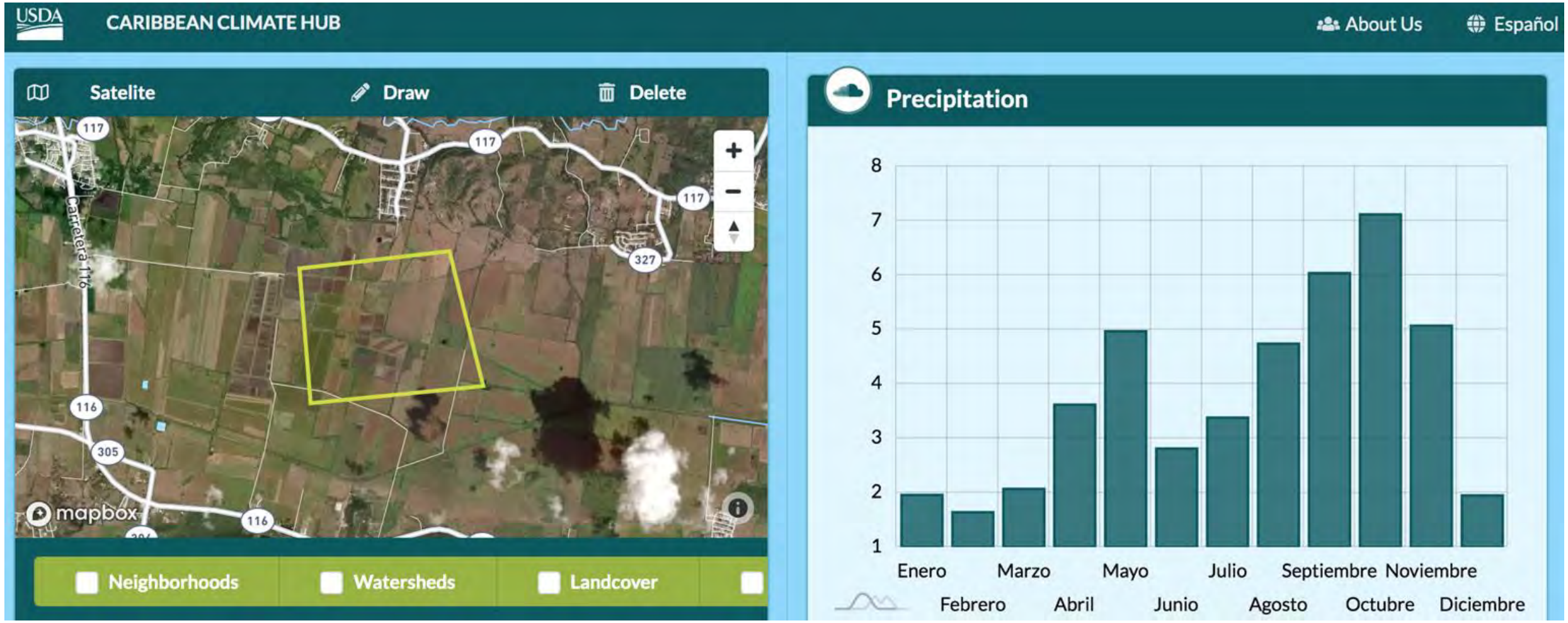
USFS International Institute of Tropical Forestry
NRCS State Technical Meeting| May 18, 2022

caribbeanclimatehub.org

HERRAMIENTA DE PLANIFICACIÓN AGRÍCOLA



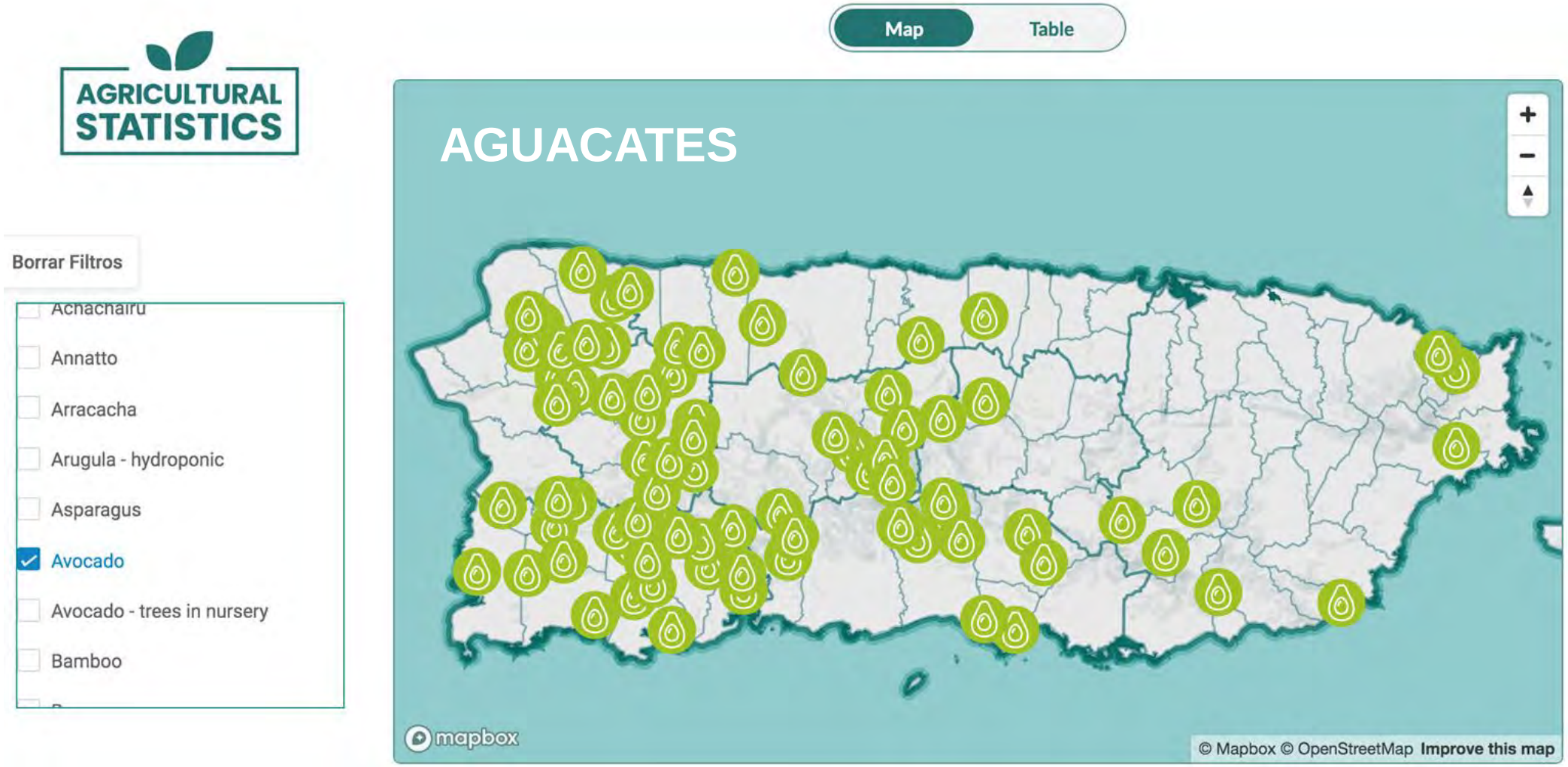
El propietario especifica un área de interés en el mapa

Enlace https://caribbeanclimatehub.org/farmtool/

Informe: variables geofísicas y climáticas que describen la zona de interés

Información sobre la marcha para la toma de decisiones y la planificación

AGRICULTURAL STATISTICS TOOL



Información sobre la producción de cultivos de la Oficina de Estadísticas Agrícolas del Departamento de Agricultura de Puerto Rico. Escala de barrio; 2013-2016; interfaz de mapa o

https://ea.caribbeanclimatehub.org