MANAGING RISK AND CLIMATE VARIATION AMONG GEORGIA ORGANIC FARMERS

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ABSTRACT

Research documenting the impacts of seasonal climate variability on crop performance has generated considerable optimism about the potential of climate forecasts for improving farmers' capacity to manage risk and optimize gains. Through an analysis of the social and cultural contexts of information management and decision making strategies, previous research conducted by the Southeast Climate Consortium (SECC) among conventional producers in the southeastern USA has explored the potentials and constraints for the application of seasonal climate forecasts in agriculture. This report complements this previous research by focusing on organic farmers in Georgia where the market potential for organic products, especially around urban centers, far exceeds the cropland designated for its production. The research approach combines quantitative and qualitative methods. Quantitative data were collected through an online survey completed by 40 respondents. Semi-structured interviews with 31 participants yielded qualitative data. Research questions focused on participants' agricultural management systems, how they perceive climate change, and their knowledge, use, perceptions, and attitudes toward weather and climate predictions. Organic farmers, due to the small-scale diversified nature of their farms, differ from conventional producers in the southeastern USA in important ways that have implications for how they may access, understand, use, and assess climate information. Organic farmers tend to be relatively young and new to farming, and therefore, less able than conventional producers to rely on accumulated experience and knowledge from prior generations of farmers and family members. Our findings show that weather and climate factors are among the most important drivers that shape their agricultural decisions. Organic farmers use multiple strategies to manage climate risk. Production strategies for risk management include crop diversification, staggered planting, hoop or green houses, and irrigation technologies. This study recommends how research and extension programs may better reach and serve this clientele, for example, through providing tools that predict and monitor weather and climate extremes, such as freezes, droughts, and hurricanes, as well as tools with information on climate related threats such as pests and diseases. It is imperative that climate information is presented and packaged into decision support systems in a way that reflects an understanding of the social practices of information processing and risk management that are embraced by organic farmers.

KEYWORDS: Agricultural decision making, climate forecasts, climate variability, organic farming, risk management, southeast USA

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INTRODUCTION

During the last decade, significant advances in climate predictions have occurred, centered on the correlation between sea surface temperatures (SSTs) in the Pacific Ocean and seasonal climate variability around the world, the phenomenon known as El Niño-Southern Oscillation (ENSO) (1996; Goddard et al., 2001). Research documenting impacts of ENSO phase on crop performance (Hansen et al., 1998; Hammer et al., 2001; Phillips et al., 2002) has generated considerable optimism about the potential of ENSO-based climate forecasts for improving farmers' capacity to manage risk and optimize gains (Hammer et al., 2001; Hansen, 2002; Meinke and Stone, 2005). The Southeast Climate Consortium (SECC), a collaborative, interdisciplinary research project including universities in Georgia, Florida, Alabama, and North Carolina, endeavors to apply climate and agricultural research to develop climate-based decision-support tools for application in agriculture and natural resource management in the southeast USA. For example, El Niño conditions, characterized by above average Pacific SSTs, typically bring more rainfall and cooler temperatures to the southeastern USA in the fall and winter months, whereas La Niña, characterized by below average Pacific SSTs, brings warmer and drier conditions in the fall, winter, and spring (Baigorria et al., 2008). Neutral years are characterized by greater frequency of sever winter freezes. The SECC's main outreach mechanism is an interactive website, *AgroClimate*[1], which provides seasonal climate outlooks, agricultural decision support tools, and other information (Fraisse et al., 2006). Central to the SECC approach is the integration of end-users into research agendas and tool development through close partnership with agricultural extension in assessment and outreach efforts (Jagtap et al., 2002; Breuer et al., 2008; Crane et al., 2008; Rohmsdahl and Pyke, In press).

Previous research on conventional producers in Georgia (Crane et al., 2008) and the southeastern USA (Breuer et al., 2008) explored the potentials and constraints for the application of seasonal climate forecasts in agriculture, through an analysis of the social and cultural contexts of information management and decision making strategies. This research found that, rather than simply promoting climate forecasts as technical inputs, climate application efforts must build on an understanding of farmers' risk management strategies and on partnerships with farmers' trusted social networks. In the present report, we seek to complement this previous research by focusing on organic farmers, a group that has distinctive decision making strategies, knowledge management processes, and values and goals that drive agricultural decisions. Unlike conventional producers, organic farmers gear their production toward niche markets, have small landholdings, and are a more diverse farming population, including a greater percentage of women and minorities than conventional producers in the southeast USA[2].

Organic farming has been one of the fastest growing agricultural sectors in the USA for more than a decade and is now present in all 50 states[3]. Organic sales are the fastest growing sector in the food industry (Auburn, 2008). According to the 2007 Agricultural Census, organic food sales more than tripled, from $393 million in 2002 to $1.7 billion in 2007. In Georgia organic farming has experienced gradual growth, with an estimated 3,081 acres under organic production[4]. However, the market potential for organic products in Georgia, especially around urban centers, far exceeds the cropland currently under production[5]. Seasonal climate outlooks

[1] http://AgroClimate.org
[2] See Breuer et al. (2006) for a review of the multiple definitions used to refer to underrepresented farmers.
[3] http://www.ers.usda.gov/data/organic
4 ftp://ftp-fc.sc.egov.usda.gov/AG/PI/Releases/Georgia_Organic_Fact_Sheet.pdf
[5] http://newfarm.rodaleinstitute.org/features/0603/glover2.shtml

and decision support tools offered by the SECC can help organic farmers cope with climate variability, thereby avoiding fluctuations in production and better satisfying the expanding market demand for organic products. However, there is virtually no information on how organic farmers understand and use weather and climate information in managing their agricultural operations.

This report describes a study that constitutes a first step toward developing communication strategies to reach this increasingly important clientele for the SECC. Following an overview of the research methods employed, this report describes the social profile of selected organic farmers that participated in the study, how they define their operations, what motivates them to farm organically, the main features of their farming operations, and their marketing strategies. The next section discusses the factors that shape their agricultural decisions and the farming and marketing practices that help them manage climate risk. We then describe how farmers access and assess agricultural and technical information, with particular attention to weather and climate forecasts. This report also addresses the perceptions and concerns these farmers expressed about climate change. Based on these data, we then outline recommendations for the production and dissemination of climate information by the SECC. The conclusion highlights opportunities and challenges that climate application efforts, such as those of the SECC, face in reaching this particular clientele.

METHODOLOGY

Research approach

The research approach combines quantitative and qualitative methods. Quantitative data were collected through an online survey conducted in January 2009. Semi-structured interviews conducted during January and February 2009 yielded qualitative information. The timeframe for the study was selected based on the availability of farmers, given that farm work is more demanding in the spring and summer months.

Efforts to communicate scientific climate information to lay audiences have revealed the importance of intermediary (boundary) organizations that facilitate the translation and transmission of messages to target audiences (Cash et al. 2006). Therefore, in order to gain entry and to ensure a greater level of credibility and legitimacy among organic farmers, we partnered with a key boundary organization, *Georgia Organics*[6], a non-profit organization that includes producers, consumers, and food-related businesses in Georgia. Their mission is to educate and integrate healthy, sustainable, and locally-grown food into the diets of residents of the State of Georgia. Georgia Organics has compiled the largest database of organic and sustainable farmers in the State and was instrumental in recruiting participants for this study and implementing the online survey. For this study, "organic" refers to producers that are certified organic, in transition to certification, or farmers who practice sustainable agriculture and organic farming without certification.

Survey

The survey aimed to obtain contextual information on Georgia's organic farmers, including background data, what participants know about weather and climate, whether and how they use weather and climate information systems, and how they perceive climate change. We

[6] http://www.georgiaorganics.org

limited the survey length so that it could be completed in 15 minutes to avoid losing participants to lack of time or fatigue. The survey was administered with Survey Monkey[7] and sent out to members of Georgia Organics via an email notification. The questionnaire could only be completed after the participant electronically signed a consent form. An indicator question was added to the first page of the survey to insure that we gathered information from only those members who are active producers, albeit not necessarily full-time. We received 40 responses to this survey from different parts of the state (Figure 1). Responses to the entire survey are found in appendix A of the on-line version of the paper only[8].

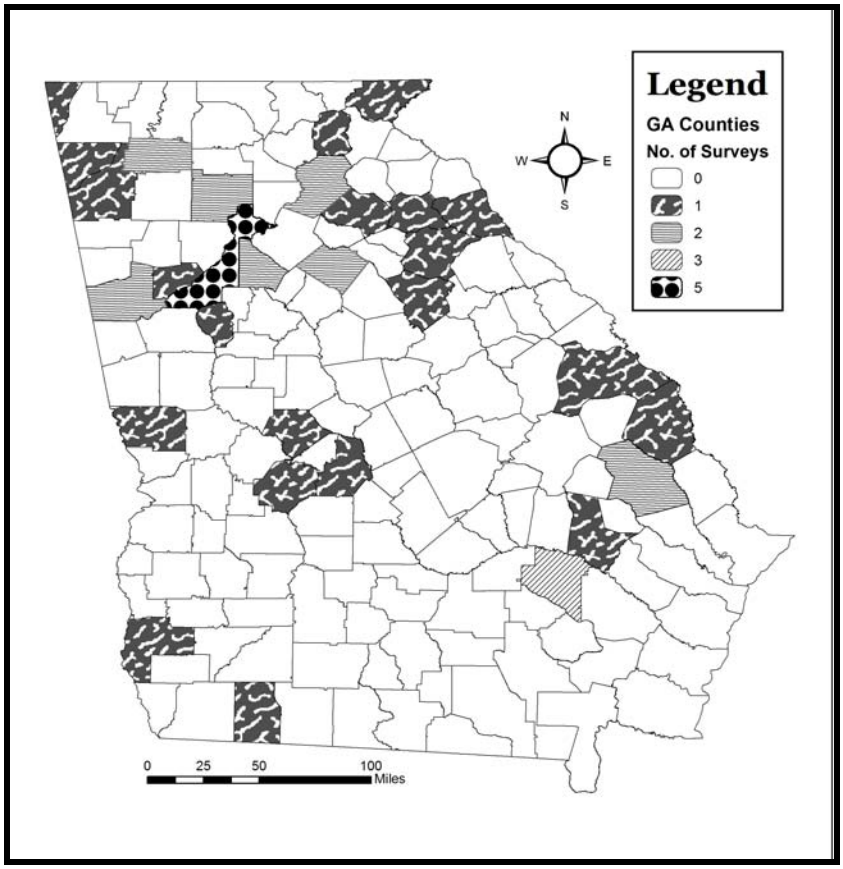

Figure 1: Map of Georgia showing number of survey responses per county.

Interviews

Face-to-face interviews were conducted with 31 farming members of Georgia Organics. Of those interviewed four participants also completed the above-mentioned survey. Georgia Organics lists 123 farms in their 2009-2010 Local Food Guide[9]. These farms are spread across five geographic regions in Georgia: Piedmont Region (40 farms), Atlanta Metropolitan region (33 farms), Mountain Region (20 farms), East Coast Plain (18 farms), and West Coast Plain (10 farms). Having excluded the Mountain Region, where the ENSO signal is weak, most interviews (24) were conducted in the regions with the most organic farms, including Piedmont and Metropolitan regions (Figure 2). Additional interviews (7) were conducted in the East Coast

[7] http://www.surveymonkey.com

[8] http://elnino.agen.ufl.edu/secc/pdfpubs/SECC_09_003.pdf

[9] http://www.georgiaorganics.org/foodguide/LFGguide.pdf

Plain where the ENSO signal is strongest, but the West Coast Plain was excluded because it has few organic farms. Interviews were arranged by a consultant with prior connections to Georgia Organics and conducted by Dr. Carrie Furman who was accompanied by the consultant. Interviews were audio-recorded after participants signed their consent. In addition, five informal interviews at farmer's markets and one day of participant observation on a working organic farm were conducted to collect further contextual information.

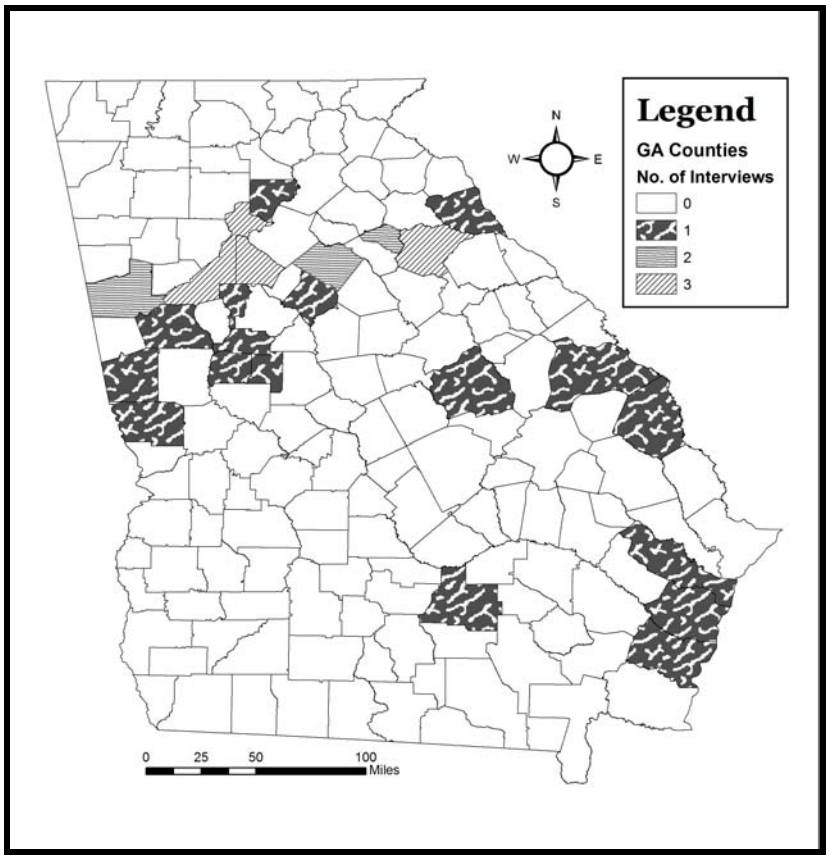

Figure 2: Map of Georgia showing number of interviews per county.

The purpose of these interviews was to gain an in-depth understanding of farmers' knowledge, perceptions, and attitudes toward weather and climate predictions, and to acquire more detail about their agricultural production systems and risk management strategies. The interview protocol was designed to elicit information on farmers' production systems, climate-sensitive management decisions, use of weather and climate information systems, and potential application of seasonal climate forecasts. This protocol was followed loosely, allowing the conversation to be partly guided by the thought process of the interviewees. Such an approach is crucial as it allowed us to beyond simple dichotomies (e.g. use/not use, trust/not trust) to elicit a more qualified (e.g. how, why, to what extent) understanding of the role of predictive information in management decisions (Hayman et al., 2007). Open-ended interviews also permit unanticipated salient issues and insights to emerge spontaneously. The resulting dataset, however, does not cover all topics in every interview, thus limiting the quantitative representation of interview data. Therefore, for quantitative analysis we rely mostly on survey data.

CHARACTERISTICS OF PARTICIPANTS AND THEIR OPERATIONS

Social profile

Organic farmers are more diverse than the general farming population, particularly in terms of age and gender. Participants in a previous SECC study among conventional producers in Georgia were mostly Caucasian, middle-aged, and male (Crane et al., 2008). In the research reported here, most respondents were also Caucasian (90%) but one-third (35%) of survey respondents and two-thirds (68%) of interviewees were between 20 and 40 years of age (Figure 3). Further, more than one-third of those surveyed (38%) and interviewed (39%) were female. However, interviews revealed that only half of women were the primary farm operators, while the other half shared the farm work with their husbands, managed marketing, equipment, volunteers, and kept financial records.

Compared with the general farming population, organic farmers have more education, with 75% of those interviewed and 80% of those surveyed having at least a bachelors' degree (Figure 3). Among farmers studied, 40% of interviewees and 46% of survey respondents had studied agriculture, while others studied related subjects, such as ecology, biology, and geography. The rest of them exhibited a considerable diversity of background, including social sciences, business, and engineering.

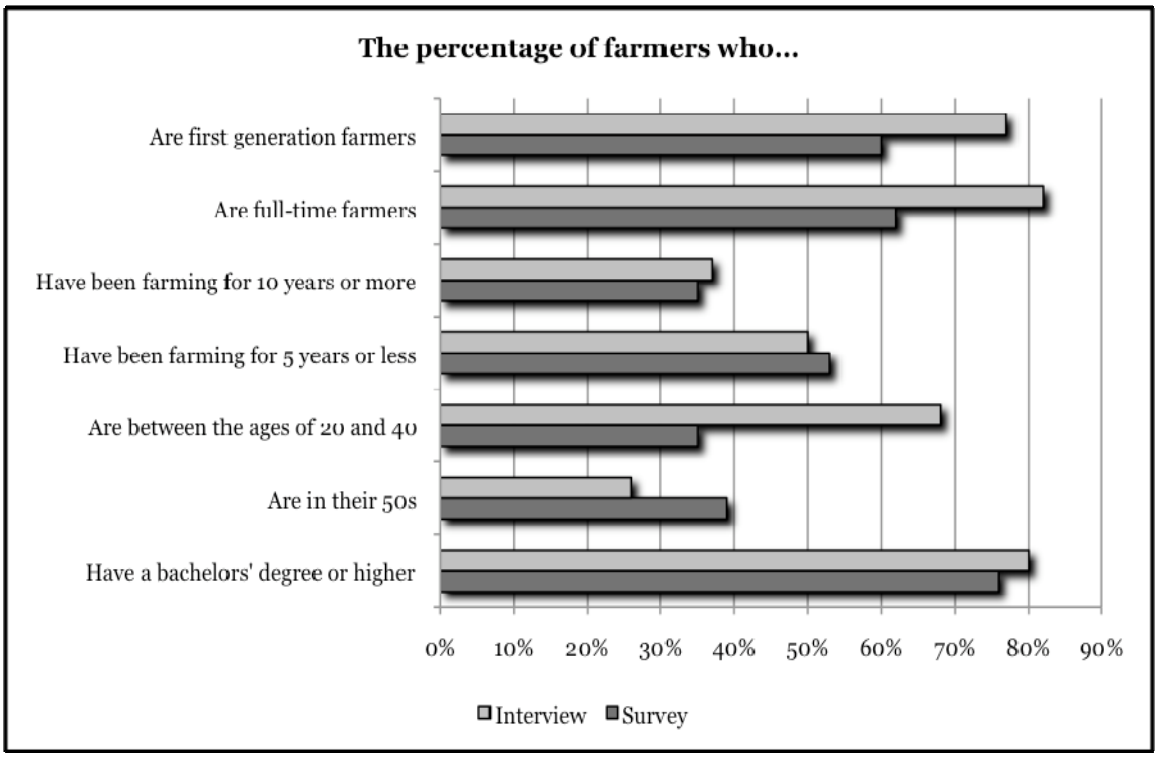

Figure 3: Graph showing background information of organic farmers that participated in the interview and the survey.

With respect to conventional producers in the southeastern USA, organic farmers tend be less likely to come from farming families or to have grown up on a farm. Half of those surveyed and 55% of those interviewed have been farming for five years or less (Figure 3). The median age of survey respondents that have been farming for 5 years or less is 30 (50%, 21-30 years old; 17%, 41-50 years old; 8%, 61-70 years old). The median age of interviewees that have been

farming for five year or less is 35 (25%, 21-30 years old; 20%, 31-40 years old; 20%, 41-50 years old; and 30%, 51-60 years old). Some of them had taken up farming after college or after a career in a different sector. Among interviewees, 84% were full-time producers. Part-timers included a university professor, restaurant buyer, landscaper, carpenter, and restaurant owner.

The social profiles of survey respondents and interviewees differed to some extent. The latter were generally younger and more likely to be first generation, full-time farmers. A possible explanation may be that such farmers might have been more motivated to participate in a research project, especially one pertaining to climate. They also may have been simply more available for an interview, given that they are full-time producers and therefore less busy during the winter months. The discrepancy, however, did not seem to significantly affect research results, as interview responses did not diverge significantly from survey responses.

Definitions and motivations

Not all research participants embraced the same definition of sustainable agriculture or motivations for growing organically. Farms in this study were certified organic (23%), organic non-certified (32%), certified naturally-grown (17%), certified biodynamic (3%), sustainable (22%), or a combination of classes (3%). Although all use organic practices, such as avoidance of chemical fertilizers, herbicides, pesticides, and fungicides, and agro-ecological principles, such as crop rotation and cover cropping, not all were certified organic. In fact, less than one-fourth (23%) of the farms in the survey and interviews had attained organic certification. Various factors explain why farmers choose not to pursue this certification. First and foremost, the certification process is very expensive. Certification costs are determined by the size and scale of the farming operation and vary from a few hundred to a few thousand dollars annually. Many interviewees complained about the time it takes to attend to the paperwork required to maintain certification. For example, producers are required to have an organic farm management plan, perform environmental monitoring, and have records of all purchases, material inputs, and sales. Some participants complained that the regulations for organic certification are not strict enough and, consequently, do not adequately reflect their ethics and goals. The personal relationships these organic farmers have with their customers enable some of them to operate without official certification. As Farmer 5[10] explained, "I used to be certified organic, but it got too expensive. But my customers have been here [to the farm] and they know that I don't use chemicals…they know I grow organic produce." As an alternative farmers have opted to be certified naturally-grown. Organic farmers started this certification process, which uses the standards for organic certification as a starting point. The main difference is that this system of certification is run by organic farmers and aims to ensure the integrity of organic farming practices without the need for expensive fees or the type of tedious record keeping needed for organic certification.

Whether certified or not, organic farmers are motivated by various factors. Given the great expansion in the popularity of and demand for organic food over the last decade, one might expect economic incentives to be the primary driver, but in fact, they trailed health, environmental, and spiritual concerns (Figure 4). Many interviewees explained that preserving their own health and the health of their customers was the primary driver that prompted them to become organic farmers. While a few farmers had experienced personal health problems that induced them to eat organic food, most of those interviewed were simply averse to eating and selling food laden with chemicals that they deemed unsafe or poisonous. Environmental

[10] To protect the identity of individual farmers, we use numbers to represent different individuals. All farmer quotes are from interviews, rather than the survey.

concerns also feature prominently in farmers' decisions to farm organically: these include the perception of organic farming as being more sustainable as well as the belief that it has potential for mitigating climate change. Participants also invoked spiritual and moral values relative to environmental ethics and social responsibility. Tradition and family heritage were less influential in their decisions to grow organically, which is not surprising given that 60% of those surveyed and 80% of those interviewed are first generation farmers (Figure 3).

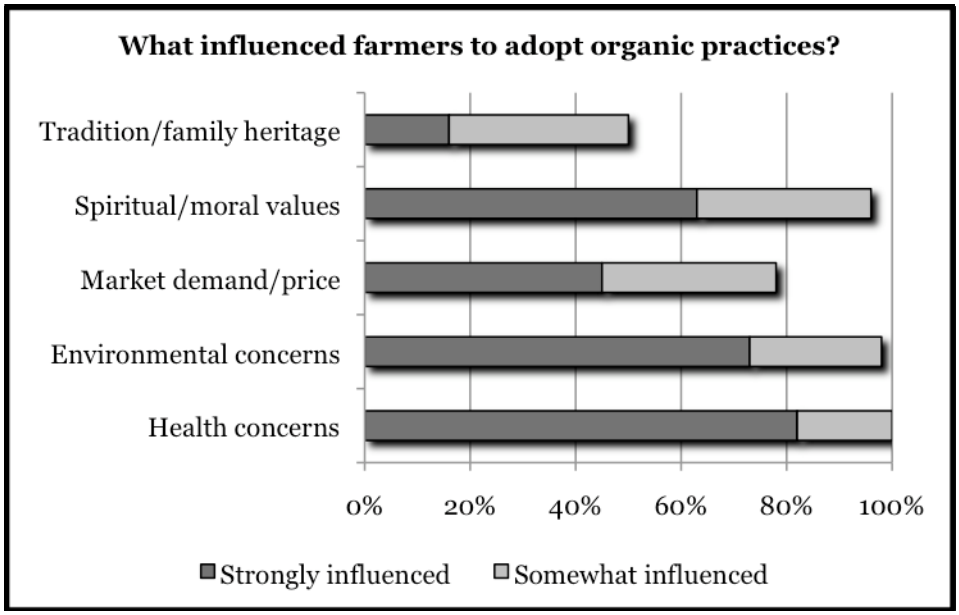

Figure 4: Graph comparing factors that influenced the survey participants' decision to farm organically. (N=40)

More than half (54%) of interviewees began organic farming as a second career. Previous careers included airplane mechanics, engineering, international business, banking, education, and community development. Reasons for their career shifts include a desire to move their families out of the city, to start a profitable 'hobby' to rely on during retirement, or to simply get back to their 'roots' and to a natural way of life, as illustrated by the following account:

> Well, it is sort of an age thing. You start to think about your roots and I was tired of being in the corporate world. My mother died. My dad had Parkinson's and was getting to a point where he couldn't actually farm. The real catalyst was a book called "This Organic Life" by Joan Guessow…She was one of the real original food activists and I was inspired. It kinda connected the dots with all of the other things going on in my life, you know, so I just decided to come down and convert some of my dad's land to direct marketing produce and then maybe organic. Then after I got started I became like…NO…I don't want to use any chemicals. (Farmer 25)

Those that came to farming as a second career acknowledged bringing to their farming pursuits the skill sets they developed in their previous professions. For example, the former mechanic modifies equipment used by conventional farmers to increase his farm's efficiency, the former teacher runs on-farm workshops, and others employ their finance and marketing backgrounds to better run the business aspects of their farms. Indeed the past experiences of these farmers shape their agricultural operations.

Agricultural operations

Contrary to the widespread perception that many organic producers are 'lifestyle' farmers, who farm in their leisure time but derive their income from other sources, revenues from agriculture are central to the livelihood of many organic farmers. For about half (46%) of the survey respondents and three-fourths (77%) of those interviewed, farming is their only occupation and almost half (45%) of them derive most (80-100%) of their household income from farming.

Most of the farms in this study are family owned and managed. However, many of the farmers interviewed do not own the land they cultivate, but lease land (16%), borrow land (6%), or run farms for a company or institution (13%). Some landowners also lease land to acquire access to water, to diversify their soil and land types, to rotate their crops, or to graze livestock. Typically, farmers owned more land than they cultivated during any given season, using the rest for crop rotations or kept as natural areas. Total farm landholdings range in size from 0.5 to 100 acres of productive land the median being 8 acres. More than half (59%) of the farmers surveyed and three-fourths (74%) of those interviewed operated 10 acres of land or less (Figure 4). Interviewees estimated 10 acres of land to be sufficient to sustain one full-time farmer, but some expressed interest in acquiring more land to meet the demands of the growing market for organic produce. Most of the research participants from both the survey and interviews (70%) grew a variety of fresh produce, including vegetables, berries, and orchard crops. A few also produced flowers (17%), herbs (5%), ornamentals (3%), winter pasture (19%), or raised livestock (21%). Farmers also produced specialty or value added items, such as honey, mushrooms, jam, and grits (7%). All of those interviewed grew vegetables and fruits, but only two grew row crops. The majority of those surveyed also grew fruits and vegetables primarily, but two focused only on animals and one grew only flowers.

Most of the farms visited for interviews are operated by one person with help from family members. Some farmers have full-time year-round workers, while most rely on occasional hired or volunteer help during planting and harvesting. Spouses often are employed off-farm full-time and their income contributes to the farm's capital requirements and provides some financial stability, as has been noted by other studies of family farming in the southeastern USA (Crane et al. in press, Breuer et al. 2008). These spouses also contribute to farm operations by performing administrative duties, selling produce at farmers' markets, and providing farm labor in their spare time. Of the farmers interviewed, three work as farm managers for new eco-development communities. The community generally subsidizes the farm for at least the first few years of its operation, after which farm managers are expected to make the farm into a self-sustaining enterprise.

Marketing channels

The same value systems that prompted farmers' decision to embrace organic farming also influence how and where they market their products (Figure 5). With growing consumer interest in organic products, new market venues are opening in local and national supermarkets. Some farmers sell to these chains directly, while others do so through brokers, although the latter usually offer lower prices. Despite these new market opportunities, many organic farmers market their products directly to consumers, such as farmers' markets. Many explained this choice in terms of the high value they place on personal interaction and community building, but the better prices fetched in those markets might also be a motivating factor.

Many interviewees commented on the remarkable growth in demand for organic products that has recently occurred over the last few years. Farmers participating in urban markets noted that customers are more willing to pay higher prices for organic produce and meat, which they

attribute to greater exposure to the organic food movement. On the other hand those who sell at rural farmers' markets must compete against prices offered by conventional producers in adjacent stalls, and therefore sell lower prices. The farmers interviewed found that the organic movement has made fewer in-roads in these rural areas and therefore customers are less willing to pay higher prices for pesticide free food.

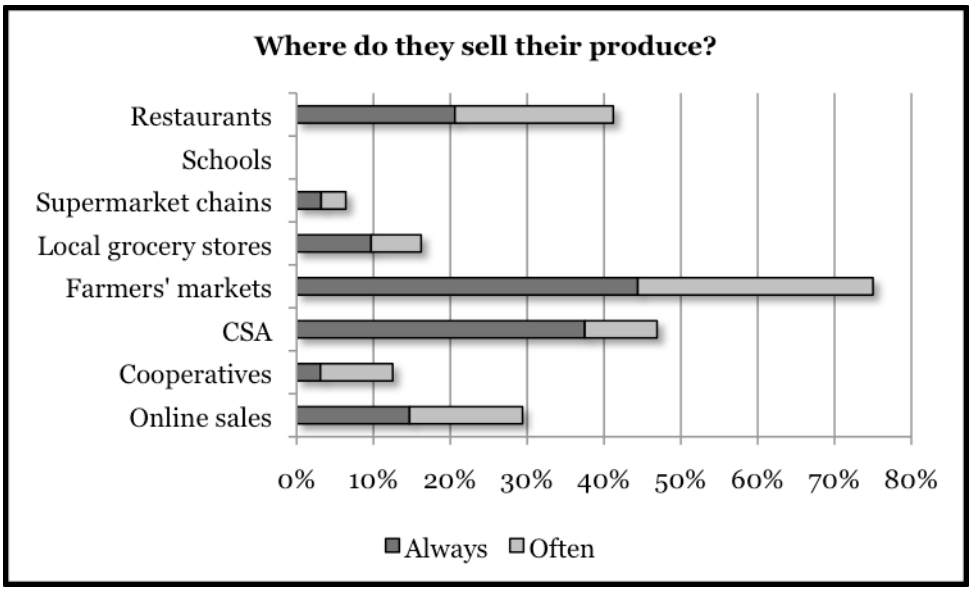

Figure 5: Graph showing locations were survey respondents market their produce. (N=38)

Community Supported Agriculture (CSA) is the second most important marketing outlet for organic farmers. A CSA market consists of a network of individuals who commit to support a farm operation for a season or a year. Farmers use CSA for start-up capital, which enables them to avoid taking out bank loans. Members pay 'dues' in advance, which helps cover farm expenses. In return, members receive weekly baskets of products, typically ranging from 6 to 10 items per box. "CSA differs from direct marketing in that members commit to a full-season price in the spring [or other times of the year] sharing the risks of production" (Wells and Gradwell, 2001: 39). The premise behind CSA is that members, or shareholders, pay the real cost of food production, including a share of the risks that farmers face (Cone and Myhre, 2000). In 2008 there were more than 2,000 CSA markets in the USA[11] and the USDA agricultural census lists 339 farms participating in CSA markets in GA[12]. Numbers are expected to grow in coming years.

The literature on CSA suggests that, in addition to providing a marketing alternative for small producers, CSA constitutes a social commitment that binds groups with shared interests (Durrenberger, 2002). Both farmers and members value the face-to-face interaction that is possible with CSA and other direct marketing mechanisms, such as U-Pick, which 13% of interviewees employ. However, this bond does not preclude social tensions. One farmer reported that CSA is more difficult to operate in a small town because pre-existing relationships among people who know each other may foster ill feelings, for example, if one customer feels that he or she receives less than another customer. Even in urban settings, not all farmers are comfortable

[11] http://www.ces.ncsu.edu/chatham/ag/SustAg/csaguide.html
[12] http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_044_044.pdf

with CSA. Farmer 7 argued that CSA cheats the shareholders because there is no guarantee that there will be a successful harvest; "It's like selling futures in the market…what kind of business plan is that…I prefer to sell on a weekly basis, then I know, and my customers know, what they are going to get." Despite these tensions, CSA is increasingly popular, offering customers an experience of connectedness and authenticity, as the following quote illustrates:

> We had a 150-person CSA and sent recipes every week [with] information about what the farms are doing and what type of challenges they are going through. That was the critical part of being in a CSA, because if you just get the box of vegetables, it is just a box of vegetables. But if you know a story about a farm, where it was grown or if you have a neat little recipe to try out, you are much more likely to enjoy it. The story is one of the biggest parts of it. (Farmer 6)

In most cases, membership in CSA requires or allows members to participate in farm activities. Inviting customers to participate in farm work is also a way for them to learn about how much time and effort is invested into organic farming and, therefore, why organic products are more expensive than conventional ones. A farmer explained:

> People say you charge too much for the organic food…but once they come out here, put the plant on the tray, plant, and go pull weeds…we don't do things mechanically…then they have an appreciation of why we charge that amount. They say 'y'all should charge more for that.' So we are trying to educate [people] if they see where it comes from and how hard it really is then they will develop an appreciation for it and be more apt to buy it. (Farmer 1)

Some farmers interviewed struggled with the fact that their products were too costly for working class families. Marketing through the Women Infant and Children (WIC) Farmers' Market Nutrition Program (FMNP) gives organic farmers the opportunity to accept WIC food stamps at specified farmers' markets. The result provides local, healthy, and fresh food to economically disadvantaged populations. Interviewees often stressed the social role that organic farmers play by teaching people about the importance of preserving natural resources and providing families and communities with healthy nutritious food, as articulated in the following quote:

> You are not selling organic [produce]; you are selling the experience and the benefit of farming organically. We have to take into considerations the ideas that surround [organic farming] so we talk about the benefits environmentally. We talk about how the food is healthier. We talk about how it creates a sense of community. That is the whole purpose of organic. You are not just growing food for a commodity market. You are not just moving boxes of produce; you are growing nutritious food for people. That is what you have to concentrate on. (Farmer 6)

RISK MANAGEMENT

Decision drivers

As shown in Figure 6, land and soil qualities are lead factors that drive agricultural decisions, so much so, that farmers choose to enhance soil health at the expense of increasing their production. For example, when starting a new farm, instead of putting all or most of their land into cultivation, organic farmers clear only one or two small fields. The remaining fields are then treated with compost and cover crops to improve soil quality. Only after these fields reach the desired level of organic matter will the farmers expand their operations. Farmer 4 said, "I will

have six acres in total, but this year I am only going to clear a quarter acre. The rest I am going to treat with cover crops and fertilize with chicken manure from my chicken tractor." For Farmer 24, the "soil is key, if you don't have good soil, you don't have anything." High quality soil reduces the need for chemical fertilizers and pest control, which are petroleum-based, transported long distances, and expensive. Small-scale producers are particularly concerned with avoiding these costs since their profits are too modest to offset them. Likewise, equipment and infrastructure influence the crops farmers grow, as the initial cost plus that of fuel and maintenance may exceed the returns. As such, farmers reported that they limit or avoid practices that require tractors or other farm equipment.

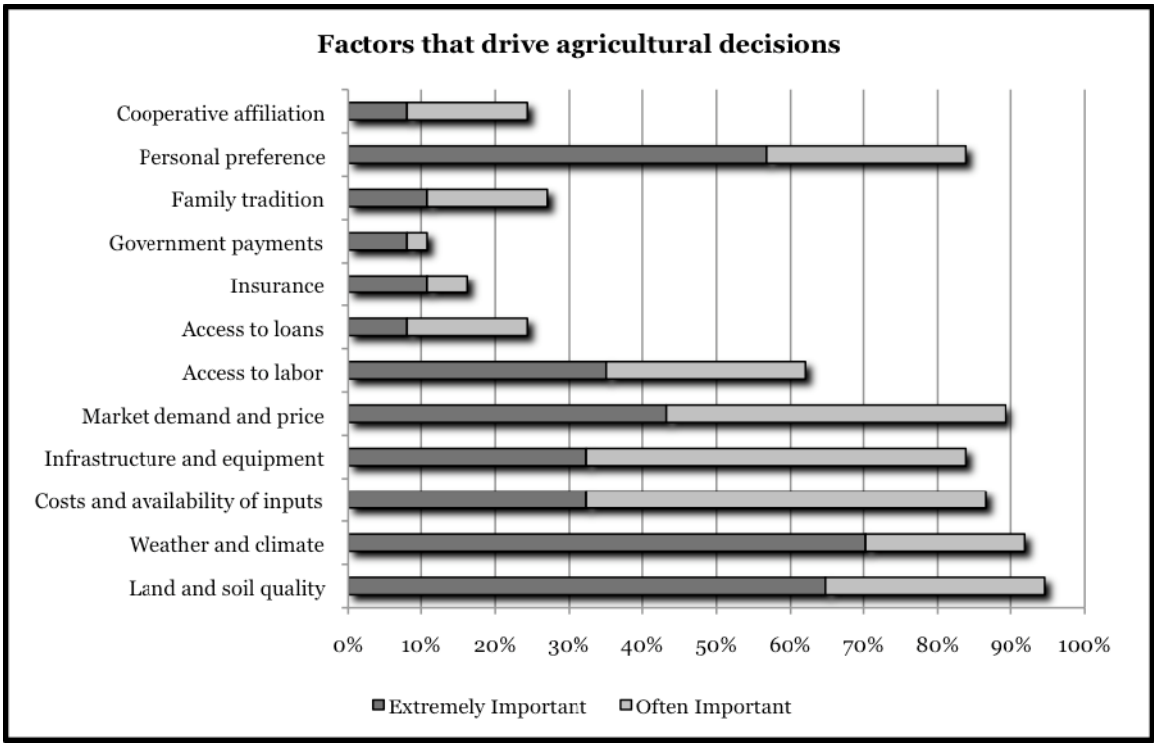

Figure 6: Graph comparing the factors that drive agricultural decisions among survey respondents. (N=37)

Market demand also shapes crop choices, although it is not always the primary driver and is weighed against other factors, including personal preference. For example, farmers may opt not to grow things they do not like to eat or that are difficult to harvest or process even if the price is good. Organic farmers prefer crop varieties that can be easily planted and harvested with manual tools or shared equipment. Even as they respond to price, farmers also seek to have a wide variety of produce to complete CSA baskets or to attract customers at farmers markets. For this reason, and given their general orientation toward innovation and experimentation, they also like to try out new crops and varieties, particularly products that are new on the market and those that other producers may not have. One farmer interviewed explained that typically 70% of the crops she grows are the same as those she planted the year before, while 30% are new.

Most survey respondents deemed weather and climate factors to be "extremely important" in shaping decisions. This importance may be due to the fact that many organic farmers grow produce, which is highly vulnerable to climate extremes. At the same time, organic

farmers use a wide range of technologies and practices that provide them with a level of resilience which, they argue, is far above that of conventional producers. Well over half (61%) of survey respondents felt that organic farming is much more adaptive than conventional farming to weather and climate variability, and another 28% felt it was a little more adaptive.

Agricultural strategies

The farmers interviewed stressed that the small-scale nature of their farms is key to their adaptive capacity. Their small acreage, reliance on manual tools, and on integrated pest management allows organic farmers to be intimately involved with their operations so that they are able to observe subtle signals in their fields and in their environment that forewarn them of crop stress or disease. It also allows them to make rapid adjustments based on actual or expected weather patterns, such as delaying planting or switching to a different crop or variety at the last minute.

To enhance their adaptive capacity, organic farmers in Georgia invest in a wide range of technologies including row covers, hoop houses, green houses, mulch, and drip irrigation. Row covers are fabric sheets that shield the crops from pests, cold, and heat. They are less expensive than greenhouses and hoop houses but offer less protection. Green houses, on the other hand, offer the best defense but are costly and few farmers can afford them. As a compromise, many interviewees reported using hoop houses, which serve as unheated green houses. Green houses and hoop houses are also used to extend the growing season by warming the soil and protecting plants from early and late freezes.

Most (90%) of the farmers interviewed irrigate most (75% to 100%) of the land they cultivate. Only 22% of the survey respondents irrigate 75% to 100% their land. This discrepancy is likely due to the way the question was phrased in the survey, as the question did not distinguish between land under cultivation and all land owned by the farmer. Drip irrigation is used most often in produce beds, with sprinkler being used for cover crops primarily. Recharge rate, pressure levels, and well depth determine the extent to which farmers may rely on irrigation to cope with drought. Mulch is used to retain soil moisture and suppress weeds. The type of mulch used varied, with choices depending on practical and ethical concerns. Drawbacks include the cost of materials and the labor required for installation. Ethical concerns that may also be taken into account are the biodegradability of the mulch and the environmental impact of transporting mulch from afar.

In addition to these technologies, producers seek to reduce their vulnerability to climate risk through crop diversification, as exemplified by the following account:

> I try to hedge my bets and have back-ups in case an unexpected event happens. Now if I needed to start over in a spot, I would loose a couple of weeks generally. A couple of weeks in the fall means that you're done. But a couple of weeks in the spring is ok because the days get longer… that is why I have a lot of diversity. When I loose something that is OK because I have something else… I [also] have chickens and mushrooms. So if a thunderstorm comes, I have mushrooms. Whatever happens, I have got something that will work; I can go to market with something. (Farmer 4)

Crop diversification manages risk at multiple levels and in ways that also integrate market considerations. By combining different crops, farmers can stagger planting over several weeks. Staggered planting dates reduce the risk of losing an entire crop in the event of a freeze, hail, or other climate shock as not all of the beds are planted at the same time and not all plants are in their most vulnerable stages at the same time. This approach also ensures a constant supply of produce for sale over a number of weeks.

However, staggered planting is more labor intensive, so some producers prefer a single planting period with a mix of crops and crop varieties that mature at different rates. In this case the farmer saves on labor costs as hired labor is needed for only one day, but this strategy is less effective in safeguarding against climate extremes because all plants are in the fields at the same time. Most organic farmers use a combination of these two strategies, as one may be more suitable for certain crops than the other.

Despite their adaptability, study participants remain highly concerned with weather and climate conditions and, especially, with the possibility that climate change might include more severe droughts and higher temperatures. The 2008 drought in the southeast USA caused difficulties for most of the farmers interviewed. Producers in northeast Georgia suffered the most during the drought. Over one-fourth (26%) of the study respondents had recently updated their wells and irrigation systems or were in the process of doing so because of the recent drought. One farmer considered closing operations because of lack of water.

> Actually my well went dry this year, the one I use for my crops, in October. So I don't have water right now. My well only goes down 15 feet and is fed off of springheads. I have been using it the whole time I have been farming and I have never had a problem with shortages of water. And then it went dry…I could run it for a little bit but it is not going to sustain the season unless we get a bunch more water. (Farmer 18)

Marketing strategies

The special relationships that producers have with some of their customers offer unique ways of coping with the risks associated with farming. Many farmers explained that customers, particularly those who are more knowledgeable about farming, are sometimes willing to offset occasional shortfalls due to bad weather by paying more for produce. A farmer provided the following example:

> When … the frost killed [all of] our blueberries, we had only about 100 pints and [the customers] paid $8 for them. But they really had to think [about why]. The $8 wasn't because we didn't have any; it was because it took so long to pick those pints…there was one [berry] here, one over there, etcetera. While not everyone knew about the situation, and some did find that too expensive, they were just so glad to get them that they bought 4 or 5 pints. It is because our customers are so passionate to help us out during those times. It is like [that with] our CSA members. They know that, yes, we did have that loss on, say, the cauliflower. They are [just] more in tune to what to takes to do organic. They are just as passionate about us growing as [they are about] what they are buying (Farmer 1).

In particular, CSA provides farmers with social networks that allow them to share risks, including those associated with climate variability. Shared risk is a fundamental aspect of the CSA agreement, as CSA members must be willing to accept fewer items or items of lesser quality if a farmer suffers an unexpected loss. The following quote elaborate on this aspect:

> The [CSA] community-based model allows you to be more flexible because they sign up before they get a vegetable and so they are already invested in that farm. So if a catastrophe happens, like we had several issues with the drought during my CSA [agreement], we weren't able to get out the amount of food that we wanted to, but through communication with our members we were able to say "we can't control the weather" and they understood. (Farmer 6)

However, not all farmers rely on CSA to manage risk in this way and not all customers are as willing to share losses. For example, producers who have other sale outlets besides CSA might offset losses in ways that are different from those who only market through CSA. Larger CSA groups, those that have been in operation for many years and those that have long waiting lists may allow farmers to offset losses more easily than smaller CSA groups, those that are just being established, or those that do not attract many customers. The degree to which beliefs in the causes and impacts of climate change are shared may also induce customers to be more forgiving in the event of losses caused by weather anomalies. Further research is underway to explore which factors affect farmers' ability to use their CSA to manage climate risk.

INFORMATION MANAGEMENT

Information sources

The diverse social backgrounds and worldviews of organic farmers translate into an eclectic style of knowledge management. On one hand, their philosophical orientation, environmental ethic, and intimate involvement with the land translate into a particular appreciation for local, practical knowledge, attention to natural signs, and reliance on intuition, instinct, and inner voice. Of those interviewed 30% specifically referred to rules of thumb, such as planting tomatoes after Easter, and to environmental clues, such as planting spring produce when daffodils emerge and Bradford pear trees bloom or watching birds to predict cold weather. Moon phases are also used to guide planting: for example, one farmer mentioned planting above-ground plants with the waxing moon, and root plants with the waning moon. Farmers interviewed also mentioned relying on either the Farmer's Almanac (10%) or the biodynamic calendar (12%). By definition, biodynamic farmers employ a more intensive form of organic farming. The biodynamic calendar incorporates all practices required for organic certification and adds a close attention to soil building and enrichment. Attention is placed on both above and below-ground processes and all farming practices, such as pruning, planting, and the application of preparations, correspond to lunar cycles[13].

Being both highly educated and operating in an emerging sector, organic farmers also value technical expertise, empirical observation, and on-farm experimentation. Some interviewees reported keeping careful notes on their operations, tracking weather patterns, water use, market demand, and crop performance and using their records to learn and adapt to ever changing circumstances. Organic farmers are always interested in new technologies and techniques. However before adopting new technologies and techniques, farmers cross-check the suitability of these technologies and techniques against their specific circumstances and against the experience of other farmers who might have used them.

Farmers interviewed indicated that the most trusted sources of information are other producers because they have specialized and localized knowledge concerning organic practices. These exchanges also include conventional producers, who are respected and consulted for their long-term, place-based experience and knowledge. Organic farmers have a strong sense of community, 33% of those interviewed noted frequently collaborating and sharing information on weather patterns, growing techniques, and marketing opportunities. Some organic farmers, who distinguish themselves for their innovation, leadership, economic success, commitment to the

[13] http://biodynamicsforum.com/biodynamics.html

organic movement, and willingness to help other organic farmers, function as "information nodes" and mentor those who are new to the business. Occasionally, information sharing entails risks, as not all organic farmers share the same values and motives. One interviewee reported suffering losses as a result of mentoring some conventional producers as they transitioned part of their fields to organic production. Being buffered by profits from conventional operations, these producers were able to offer lower prices for their organic produce and out-compete their mentor, who was unable to sell profitably at the same prices.

Most farmers (80%) use organizations such as Georgia Organics as a conduit to share information either at conferences or online via the "Growers' Exchange." The latter is venue for farmers to ask questions and share information on issues associated with organic farming, such as direct marketing, equipment, and certification. Study participants mentioned conferences and workshops (73% among those surveyed and 40% among those interviewed) among sources of agricultural and technical information that are most often trusted and used, because they provide opportunities for group interactions and asking questions (Figures 7 and 8). Internet resources are also widely used and trusted. Of those interviewed 50% specifically mentioned doing internet searches, citing ATTRA (The National Sustainable Agriculture Information Service) as among the websites most often visited. However, not all organic farmers are computer literate and not all like to spend time working on a computer. Some farmers who reside in rural areas do not have access to high-speed internet and still use slow dial-up connections, which make it difficult to use interactive sites. Farmers also trust information from printed media, especially the farm press, agricultural associations, including Georgia Organics, customers, and suppliers.

Agricultural extension, a key outreach mechanism for the SECC, was mentioned by more than one-third (38%) of survey respondents as being trusted completely or, at least, most of the time, while one-fourth (24%) reported trusting it half of the time. Actual use was somewhat less, with about half (51%) of farmers surveyed reporting rarely getting information from extension, and a few (11%) never doing so. Of those interviewed, interaction with extension ranged from having no contact (50%) to farmers educating county agents in organic practices (16%), to agents being quite helpful (31%) and even establishing local farmers' markets and facilitating participation in workshops or conferences (3%). Research participants recognized that a minority of extension agents are involved in or informed about organic farming, but some still consult extension for other issues, such as pests and diseases. To improve the ability of the Cooperative Agricultural Extension Service to meet the technical needs of organic farmers, the University of Georgia, Fort Valley State University, and Georgia Organics are currently working in tandem to train county agents on organic farming techniques.

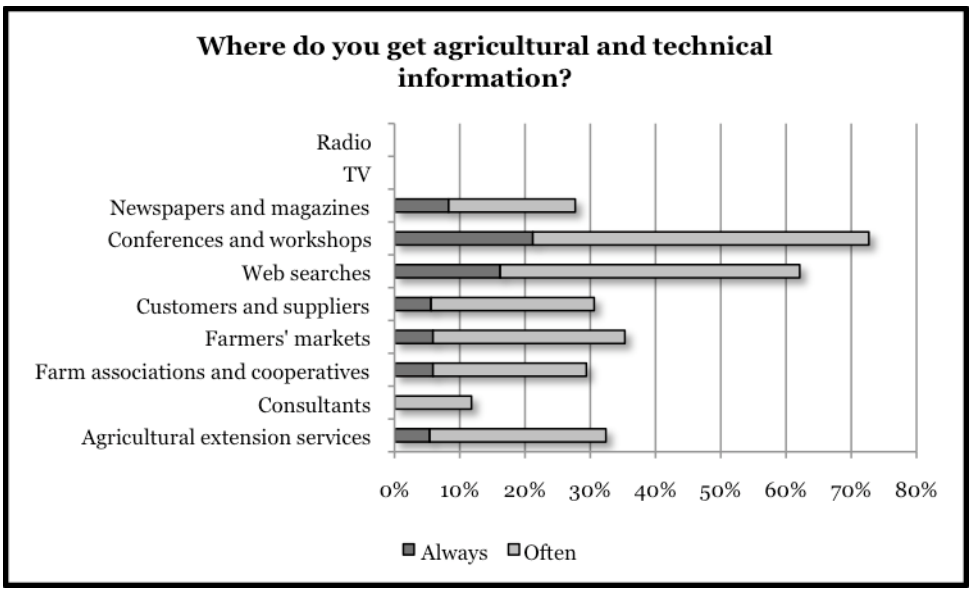

Figure 7: Graph comparing different sources of information used by survey respondents. (N= 38)

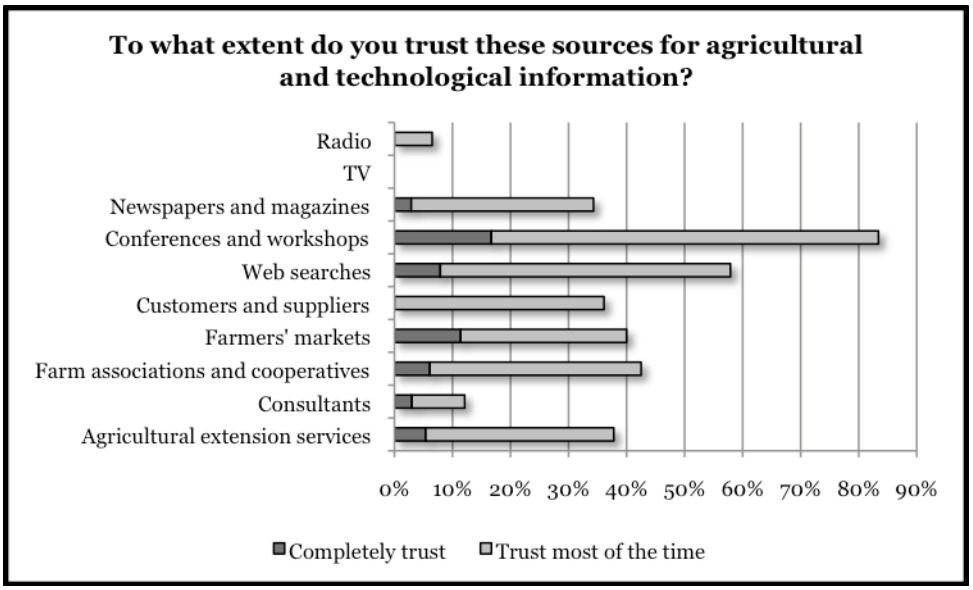

Figure 8: Graph comparing the degree to which survey respondents trust these sources of information. (N=38)

Whatever the source of information, many organic farmers are critical thinkers and often triangulate among different sources, as exemplified in the following quote:

> I have done lots of workshops and been to many small farmers' conferences. I have been to Missouri, Missouri has the national small farm conference…Been to several Southern SAWG [Southern Sustainable Agriculture Working Group] conferences, SAWG is great. Did a lot of workshops at those conferences, picked things that were pertinent for me to learn how to do organic, …a lot of the season extension stuff. I am also known by my friends as the research king…I am online, reading books. I get like 10 different trade magazines right now. And I like to stay

current on both sides of the street. I look into conventional stuff too. I get magazines that don't have any organic agriculture, because I like to know what is happening on the other side too. It is not because I do conventional agriculture, you just never know what little piece of information you are going to find that is going to make a difference on your farm. (Farmer 8)

Weather and climate forecasts

Because weather and climate are among the main drivers of agricultural decisions, it is not surprising that farmers seek and use meteorological information on a regular basis. Among organic farmers, as well as conventional producers (Crane et al. in press), weather is far more salient than climate. Survey results demonstrate that all farmers seek weather information frequently and most of them use it when making agricultural decisions frequently (Figure 9). Among sources of information, the Weather Channel and Weather.com were the ones most often mentioned by farmers interviewed. Some also reported visiting NOAA's website for weather forecasts and other information, including water vapor and jet streams, and *Georgiaweather*[14] for real-time weather information. Some farmers used their personal digital assistants when in their fields. As one farmer explained:

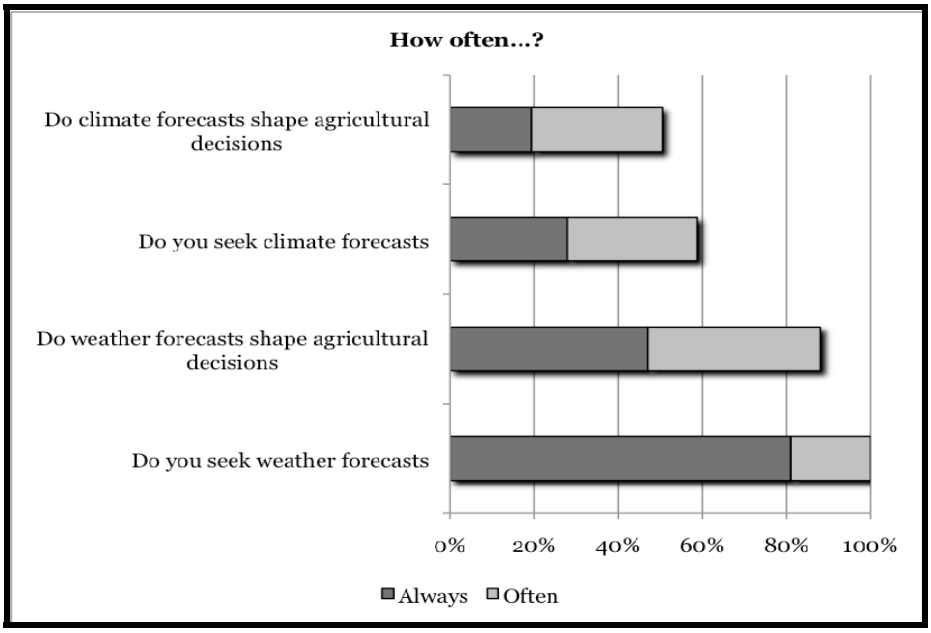

Figure 9: Graph illustrating how often survey respondents utilize and seek weather and climate forecasts. (N=36)

In terms of weather, I have got my iPhone. I am checking radar when I am in the field. When I am on the tractor I am looking at the clouds coming and I want to know how long I have until the rain hits. And that is really important. And I am looking at 10-day forecasts constantly; the highs and lows. But the climate… long-term predictions? Not so much. (Farmer 4)

Farmers' level of trust in weather and climate forecasts diminishes according to the

[14] http://georgiaweather.net/

predictive timeframe. Farmers have greater confidence in a next day forecast than in a three-day forecast, and place more trust in the latter than in a five-day forecast. Interviewees expressed doubts about predictions beyond 10 days and, therefore, were skeptical about seasonal climate forecasts, even though the latter are based on a different forecasting methodology. Among survey respondents, more than half (58%) mentioned seeking climate forecasts often or always, and about half (50%) reported using them often or always in making agricultural decisions. In light of the interview data, we suspect that this finding overestimates the extent to which farmers seek or use climate forecasts, probably a result of confusion between seasonal climate outlooks, such as those based on ENSO phase, and shorter-term weather forecasts.

Farmers often plan around a ten-day forecast and then adjust their activities as shorter-term forecasts and real-time information become available. Weather forecasts help producers decide when to plant, where to irrigate, and whether and when to hire labor. Climate information, when used, may be integrated into yearly management plans. Examples of these longer-term strategies are decisions about when seeds are planted in green houses or hoop houses and about which beds need irrigation infrastructure.

The extent to which survey respondents understood different aspects of ENSO, which is the basis of seasonal climate outlooks issued by the SECC, varied. Few (9%) farmers responded that they were very familiar with ENSO phases, while almost half (44%) responded that they were 'somewhat familiar' and one-third (34%) had heard of it but were not familiar with the ideas. However, about two-thirds (64%) of them strongly agree or somewhat agree that El Niño and La Niña phases affect agriculture in Georgia. Most farmers surveyed could correctly identify the rainfall variability effects of El Niño (70%) and La Niña (73%) in Georgia, but were less familiar with its temperature effects. Almost half (44%) of the respondents expected higher temperatures than normal during El Niño and more than one-third (38%) expected lower temperatures than normal during La Niña, the opposite of probable ENSO effects in Georgia. This discrepancy in knowledge of rainfall and temperature effect may be attributed to possible biases in how media and public discourse cover different ENSO effects, with rainfall getting more attention than temperature.

CLIMATE CHANGE

Interviews revealed that organic farmers do not make a clear-cut distinction between climate variability and climate change, as was also noted among conventional producers (Crane et al. in press). Discussions of climate variability invariably evolved into discussions of climate change, and anomalous weather events, such as early or late frost or temperature swings, which were also sometimes attributed to climate change. In general, research participants expressed high levels of concern with climate change, not surprisingly given the environmental orientation of many organic farmers. This concern about climate change provides an important entry point for communicating other kinds of climate information, such as seasonal climate outlooks.

More than half (60%) of the respondents strongly agree that climate change is happening, and another one-third (31%) somewhat agree. Among weather phenomena, drought and temperature extremes were mentioned by most farmers surveyed (92% and 89% respectively) as being always or often affected by climate change. This perception might have been partly due to the fact that the survey was implemented at the end of a year characterized by very dry and hot weather.

As for the causes of climate change, the majority of survey respondents (72%) attributed it to a combination of both human activities and normal cycles. However, interviews revealed that there are differences in what participants know or believe: some are not entirely clear on or convinced about all aspects or effects of climate change. Of the farmers interviewed, four (all over the age of 50) voiced skepticism about the role humans play in climate change. For one farming family interviewed, the topic of climate change was a point of contention between the parents, who ascribe it to natural cycles, and the children, who blame human action. As such, we were politely asked to change the subject soon after our mention of climate change.

Farmers' concerns about climate change affect decisions, particularly in matters of production and lifestyle (Figure 10). Most (90%) interviewees reported using farming practices that seek to reduce their own carbon footprint. Many producers strive to make their farms semi-closed systems, wherein all of their inputs come from the farm and all of their outputs except what is sold stay on the farm (Pearson, 2007). The goal of a semi-closed system is to apply only those amendments that can be produced on their farms, avoid inputs that must be transported over large distances, limit use of heavy machinery, and market their products locally. Other practices include the use of cover crops, composting, manual tools, biodiesel, and chicken tractors that provide an on-farm source of fertilizer, weed, and pest control. The ability to implement practices that reduce emissions and sequester carbon varies among farmers. For example, smaller farms are easier to manage with manual tools than larger farms and new farmers may be less likely to afford the extra labor and costs required by strategies that seek to reduce carbon emissions. Some organic management strategies, particularly those to improve soils and conserve moisture, merge climate mitigation and adaptation efforts and these two aspects are frequently integrated in farmers' discourses on climate change.

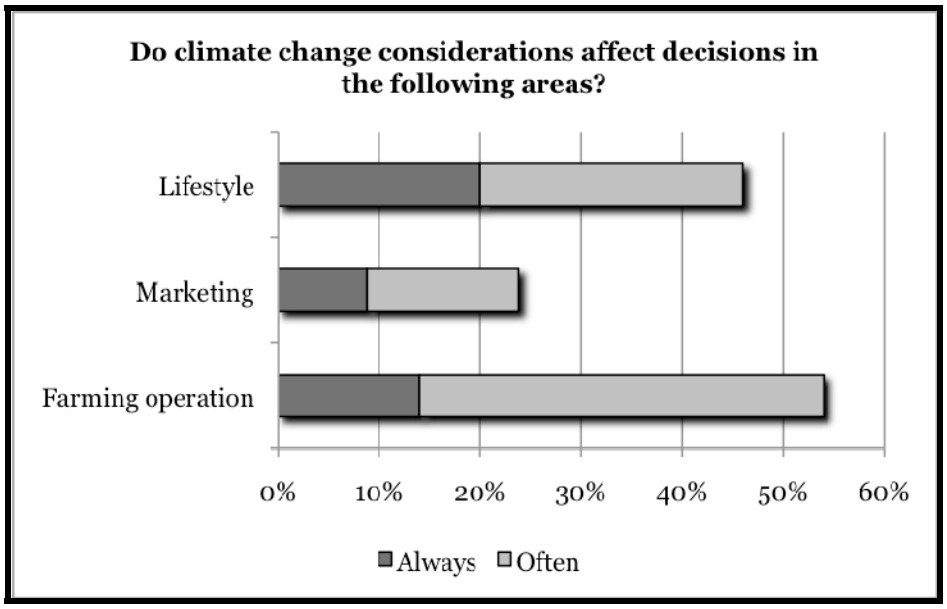

Figure 10: Survey responses on decisions farmers make that consider climate change. (N=35)

In addition to environmental considerations, awareness is growing among organic farmers about the potential economic incentive offered by the emerging markets for carbon credits, as the following quote exemplifies:

> I am trying very actively to reduce my off-farm inputs. I will use the woodlot to create wood mulch. Between that and cover crops my goal is to not have any off-farm soil amendments in the next couple of years. And then that gets it down to fuel and plastic mulch. With plastic mulch, I am moving to corn-based this year.
>
> Biodegradable corn-based is about three times as expensive. The big advantage of it is that you don't have to take it up in the field. It takes more labor to get the plastic out of the field then it does to put it down. And you just till [the mulch] it in [as it] will break down into a simple carbohydrate molecule. I am working at it from both sides. I am improving my resilience to deal with climate change as well as reducing my contribution to climate change. And there will be markets for sequestration. If that adds a couple hundred dollars a year to my bottom line, then there is a value in that. (Farmer 2)

Climate change considerations influence marketing strategies to a lesser extent than farming and lifestyle decisions according to survey respondents. However, climate change concerns constitute an important connection between organic farmers and some of their customers. In fact, environmental concerns partially drive the growing demand for organic products, particularly from local farms. Some studies indicate that, when just taking food miles into account, buying local food does not necessarily lower one's carbon emissions (Weber and Matthews, 2008; Coley et al., 2009), others argue that buying local lowers carbon emissions if sustainable production practices are factored into the analysis (Engelhupt, 2008). One of the farmers interviewed elaborated on this theme:

> The fossil fuel theme is really playing out. And people are realizing that the food they buy in the grocery store comes from something like 1,500 miles away. The meeting we had at the local church… that was something that people were saying. They said, 'It just isn't wise to go to the grocery store and buy food that is shipped from California when we have farmers right here.' That was on their mind, that was talked about…For a lot of people, just going to a farmer market, it's an easy way to be green. (Farmer 15)

RECOMMENDATIONS FOR THE SECC

Information needs

The organic farmers interviewed expressed interest in both practical and analytical tools. The former can help them make farming decisions, while the latter can assist them in better understanding weather and climate patterns in their areas, comparing their own observations with scientific records and outlooks. The following suggestions were also offered:

- Post easy to follow fact-sheets that explain climate variability and climate change.
- Create a weather-climate history link that allows farmers to see values of meteorological variables, such as air temperature, rainfall, soil temperature, for a specific day in the past.
- Show regional average temperatures in 10-year blocks for tracking historic trends.
- Link seasonal climate forecasts to probabilities of rain at a local scale, taking into account local-scale climatic variation.
- Specify how many hours in a day or week temperatures are expected to dip below or rise above an optimum range or reach freezing levels.

- Link climate forecasts to yields of crops or families of crops that that are important to organic farmers, such as *Brassicaceae, Solanaceae,* and *Cucurbitaceae.*
- Link seasonal climate outlooks to a possible rise or fall in pest or disease outbreaks. One farmer asked that growing degree-days be linked with pest outbreaks.
- Offer an irrigation tool that shows how much rainfall is expected for the coming year in their region and how much irrigation water would be needed to grow specific crops.
- Show soil temperatures as predictions as well as in real-time.
- Post a jet stream monitor.
- Create a carbon footprint tool for farmers to assess whether their farms can be registered as carbon sinks.

Response applications

Farmers interviewed stressed that in order for them to feel confident enough to use seasonal climate forecasts in making agricultural decisions they would have to experiment with the information and determine what works for them in their particular location. Presently, they do not trust such information enough to change practices that have proven to be reliable. If confidence was established, farmers identified the following potential applications for seasonal climate outlooks:

- To plan whether, where, and how much to plan for irrigation. For example, farmers may be able to plan which plots will need drip tape, which is expensive and time consuming to install. If a wetter than average season is predicted, farmers may be able to save money and time by not setting up irrigation lines on beds that are planted with more drought resilient crops and varieties. If a drier than average season is predicted, farmers may invest more money in irrigation infrastructure and roll out drip tape before planting when it is less time consuming to do so as mature plants are harder to work around.
- To assess how much irrigation water they will need to budget for during the growing season, as some farmers draw on expensive municipal water supplies.
- To decide when and how much winter grass to plant and whether to buy extra hay for their animals, as they might not have enough water to grow it if there is a drought.
- To decide when they should plant: farmers are always keen on getting a head start on the growing season to be able to market produce early and at more competitive prices. If cold temperatures are predicted they may postpone planting to avoid the risk of late freezes.
- To select what types of crops they should focus on during a particular season. For example, if a cooler than average spring is predicted farmers may keep the lettuce out longer, keeping tomato plants in pots to allow the lettuce to stay in the ground. If a warmer than average season is predicted, they may harvest lettuce and plant tomato earlier, which would enable them to sell tomatoes when they are scarcer on the market.
- To decide whether they should set aside money to buy additional produce from other farmers or wholesalers to supply their CSA members, or whether they should reduce their number of CSA members for that season.
- To decide whether they should invest money and time in growing high value specialty crops, which may require more water or be more vulnerable to extreme weather events.
- To lay drainage ditches and other infrastructure to channel water and prevent flooding and water logging in case of higher than average rainfall.
- To build cold frames if very cold temperatures and the chance of early or late freezes are predicted.

Information dissemination

Organic farmers are always seeking innovative and up-to-date information, which they can use to better adapt to climate variability and change. However, for them to act on information received, it must come from a trusted source, in a timely fashion, and in an accessible, understandable format. Interviewees offered the following suggestions:

- Working with boundary organizations, such as Georgia Organics and the Southern SAWG, is essential to establishing credibility and legitimacy. Linking *AgroClimate* to websites of these organizations will also enhance its visibility.
- Key farmers, who are well known as leaders and mentors, need to be identified and involved in outreach and assessment efforts. Tools and technologies should be tested and vetted by these producers before dissemination to others. Once these opinion leaders are on board, they will serve as information nodes to link other producers with climate application efforts.
- Workshops or online classes should be organized to enable farmers to learn hands-on and experiment with SECC tools and outlooks. These opportunities should be offered during the winter months when farmers have more free time.
- The most salient information, such as seasonal outlooks, should be up-front and easy to find: farmers are busy and tend to opt out of websites if they require too much time to search for and figure out information.
- Farmers prefer to access a complete webpage that brings together real-time weather as well as climate information, such as seasonal climate outlooks, rather than searching for weather and climate information separately.
- Organic farmers are frequent internet users and would like to receive email alerts and updates for both weather and climate information. But outlooks should also be distributed in other ways those who do not have access to online sources.
- For farmers to be able to integrate climate outlooks into their agricultural decisions, they need to be provided with sufficient lead time, between December and February for produce farmers, before October for winter grasses.

***AgroClimate* feedback**

When interviews were scheduled, participants were asked to visit the *AgroClimate* website so that they would be prepared to provide reactions and recommendations. Of those who did, we received 5 negative responses and 10 positive responses. The following quote is one such positive response that was emailed to us:

> …I checked out the [*AgroClimate*] website this morning, and find it very informative. Lots of good info in one place. I liked the discussion page on climate change as well, and found myself agreeing with a lot of the conclusions drawn there. I will use this site in the future, as we discussed, to help with decision making along with other observations of my own. (Farmer 8)

Some farmers also expressed interest in learning more about climate, even though they were not sure information could be applied, as the following quote indicates:

> …It is really interesting to learn about the cycling, the cycling reports, and El Niño/La Niña. I had known some of that before but the reports and the summaries are very clear and very easy to read. That was helpful. But being able to translate that into crop information would be great… (Farmer 6)

Not all farmers who visited the website found it useful or easy to use. The following are a few quotes that exemplify these reactions:

> Not everything looked the most current …I think what I saw was last years information…it wasn't super outdated, but I saw the forecast, but it was last year's forecast. (Farmer 4)
>
> There are many confusing things like growing degree days. Took me some time to figure out what the information is. (Farmer 6)
>
> There was interesting stuff, but I found some of it hard to figure out what they saying. They say El Niño years, but what years what are they talking about? (Farmer 17)
>
> The gripe I have with most of these weather websites it that they are working off of averages, but averages don't help me because nothing is ever average… (Farmer 2)

CONCLUSIONS

Organic farmers constitute an important target group for the SECC because of the growing importance of the sector and because of the unique characteristics of the population. Because many of them are relatively new to agriculture, they do not have the accumulated knowledge of prior generations of farmers and family members to rely upon. Therefore, the ability to access reliable technical information is crucial to the viability of their operations. Being younger, highly educated, computer literate, and innovation-oriented, they are interested in learning and experimenting with new ideas and tools. At the same time they are also keenly attuned to the environment, committed to land stewardship, and concerned about climate change.

Three attributes of scientific climate information have been identified as critical to its uptake by end-users: 1) salience, or perceived relevance and usefulness; 2) credibility, or perceived reliability and accuracy; and 3) legitimacy, or perceived objectivity and authority (Cash et al., 2006; Stone and Meinke, 2006). These attributes transcend the scientific validity of climate-based information and tools, being embedded in users' values, beliefs, goals, and habits. As with conventional producers, in order for the SECC to effectively serve organic farmers will require particular attention to these aspects.

Salience refers to the degree to which information corresponds with what farmers want to know and are able to use. Salience, therefore, depends on information being delivered on time and in ways that facilitate its interpretation and practical application. For organic farmers, climate change and carbon footprint concerns constitute important entry points to capture their attention and channel climate information. A focus on crops and crop families that are popular among organic farmers will also attract their interest and draw them to *AgroClimate*. The ability to predict and monitor key climatic threats, such as freezes, droughts, or hurricanes, as well as tools to cope with associated threats, such as pests and diseases, will increase the relevance of SECC efforts to organic farmers. Salience also requires understanding organic farming practices and the time scales at which they work. This understanding entails integrating information across temporal scales, such as real-time weather information, short-term weather forecasts, seasonal climate predictions, and climate change projections.

Credibility refers to the extent to which farmers perceive information as trustworthy, while legitimacy relates to the degree to which they believe that their interests are well served. Both are linked to salience in that the production of relevant, useful information enhances the credibility and legitimacy of information providers among users. Collaborating with key boundary organizations that have established credentials among organic farmers will help build credibility and legitimacy. Just as the Cooperative Agricultural Extension Services have been

instrumental in reaching conventional producers, cooperation with organizations such as Georgia Organics and Southern SAWG will be essential to serve organic farmers. In addition, our research revealed the key roles that farmers themselves play in information processing and transmission. To be incorporated into organic farmers' portfolio of risk management practices, climate-based decision support tools will require vetting by fellow farmers and testing against farmers' experience. Publishing a track record for climate predictions will allow farmers and others to compare climate predictions with their own observations and to assess them in relation to their own circumstances.

In order to integrate seasonal climate forecasts into the risk management strategies of organic farmers, a number of challenges remain. Organic farmers employ a double-pronged planning strategy, wherein a seasonal planting schedule is modified by short-term tactical adjustments. Due to this integration of seasonal and short-term planning in managing risk, the distinction between climate and weather forecasts that is common in the scientific community has little meaning to organic farmers. Rather, they would benefit if forecasts for different temporal scales were given at the same time. In addition, the high level of diversification and whole-farm approach that characterizes their agricultural management means that they need predictive information to be presented in ways that link various options and outcomes rather than as disconnected tools. The adaptive nature of their production strategies, which include a wide range of soil and water conservation technologies, makes their operations less vulnerable to seasonal climate risks; therefore, climate forecasts are less salient.

Conversely this adaptive capability affords organic farmers time to respond to and benefit from seasonal climate forecasts, although the credibility of the forecasts must be established. Credibility is established in different ways for organic farmers than it is in scientific circles, as organic farmers rely on intuitive practice, place-based knowledge, shared wisdom, and experiential learning. Detailed explanations of theoretical assumptions and research methods on which tools are based are less convincing than evidence of commitment to environmental sustainability, community building, and participatory processes. As they embrace an explicit value-based practice and a holistic vision of earth life, where climate is understood as inseparable from land, water, and health, organic farmers may be put off by approaches that oversell technical, specialized expertise.

Legitimacy is threatened by the politicization of climate change debates where one side exaggerates the risks and the other amplifies the unknowns. In this context, even seasonal climate forecasts could be easily dismissed if climate science in general is perceived to be so clouded by uncertainty that it is simply a matter of personal opinion or political ideology. Providing information that is vetted by international scientific consensus, such as the IPCC Technical Assessment Reports, may be a way to avoid this pitfall, although the scale of such assessments is too broad to provide effective guidance to management decisions. In sum, to serve this increasingly important clientele, it is imperative that climate-based decision support systems be firmly grounded in an understanding of the social practices, philosophical principles, ethical considerations, and political claims that define the ways scientific knowledge is assessed and translated into management decisions.

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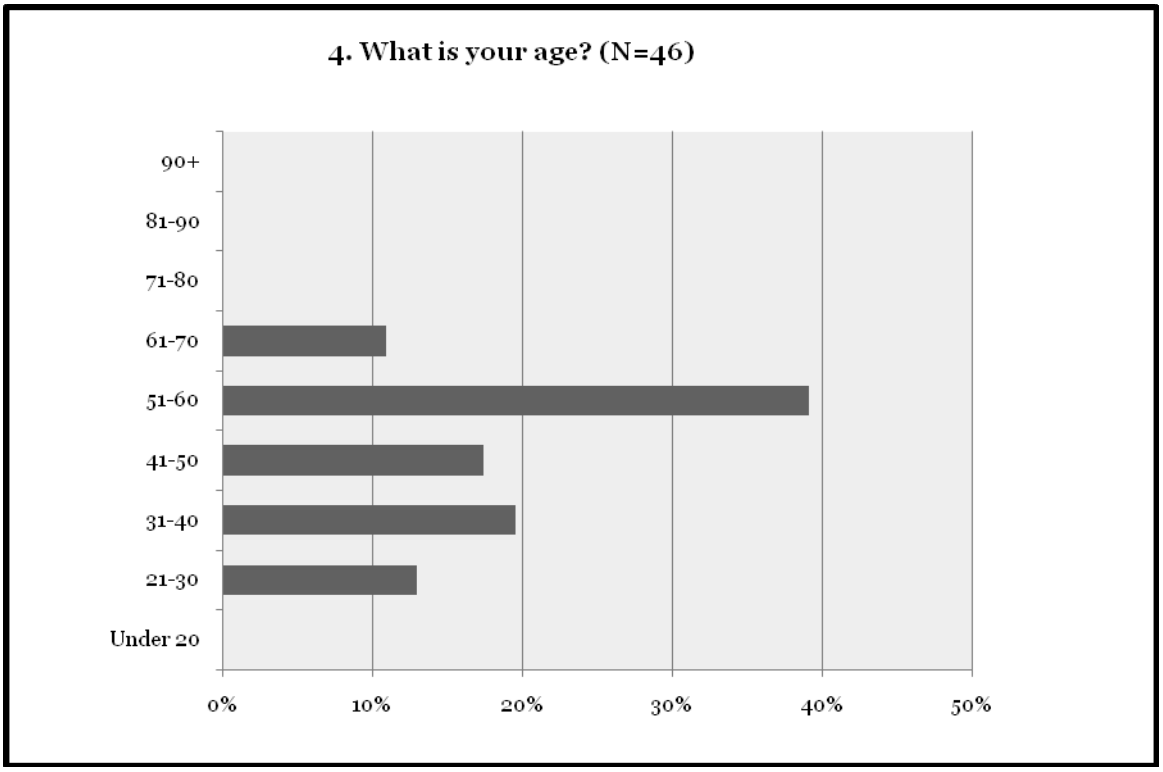
APPENDIX A

1. The signed consent form

GENERAL INFORMATION

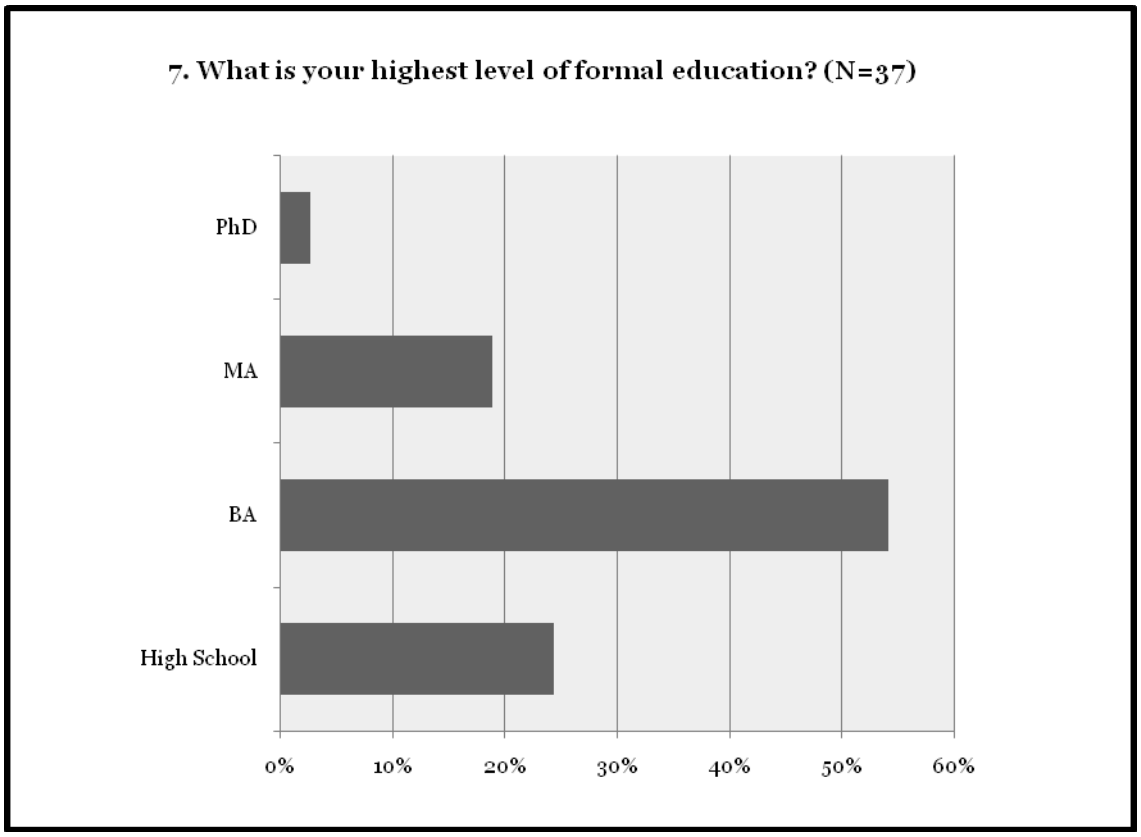
2. Email	
Answer Options	**Response Count**
	48
answered question	**48**
skipped question	**8**

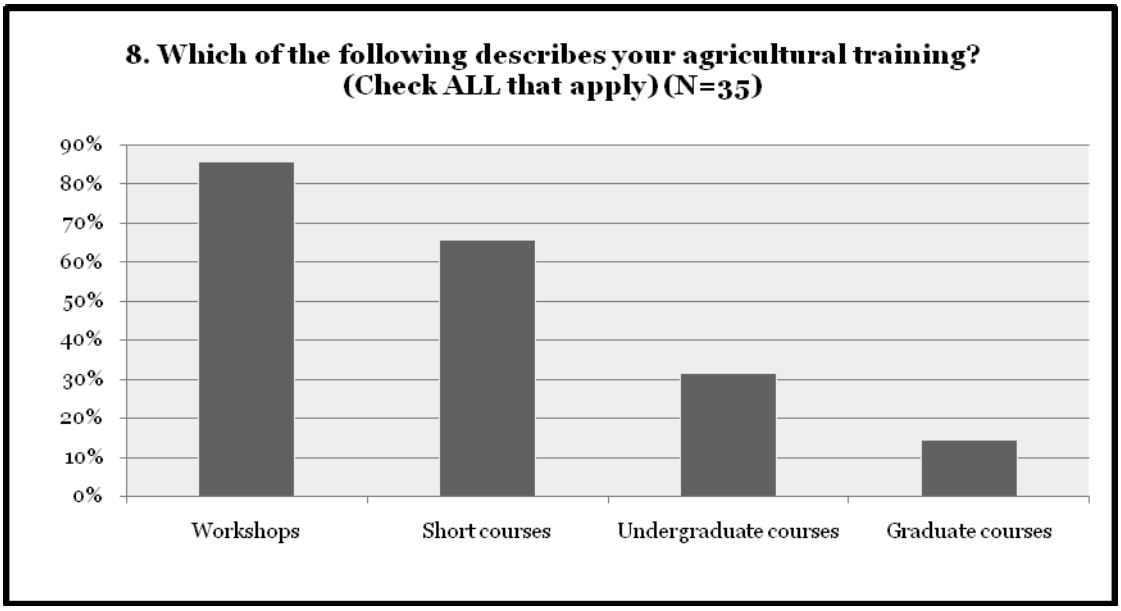
3. Your name (optional)	
Answer Options	**Response Count**
	40
answered question	**40**
skipped question	**16**



5. County(s) where you live- please specify state if it is not GA	
Answer Options	**Response Count**
	47
answered question	**47**
skipped question	**9**

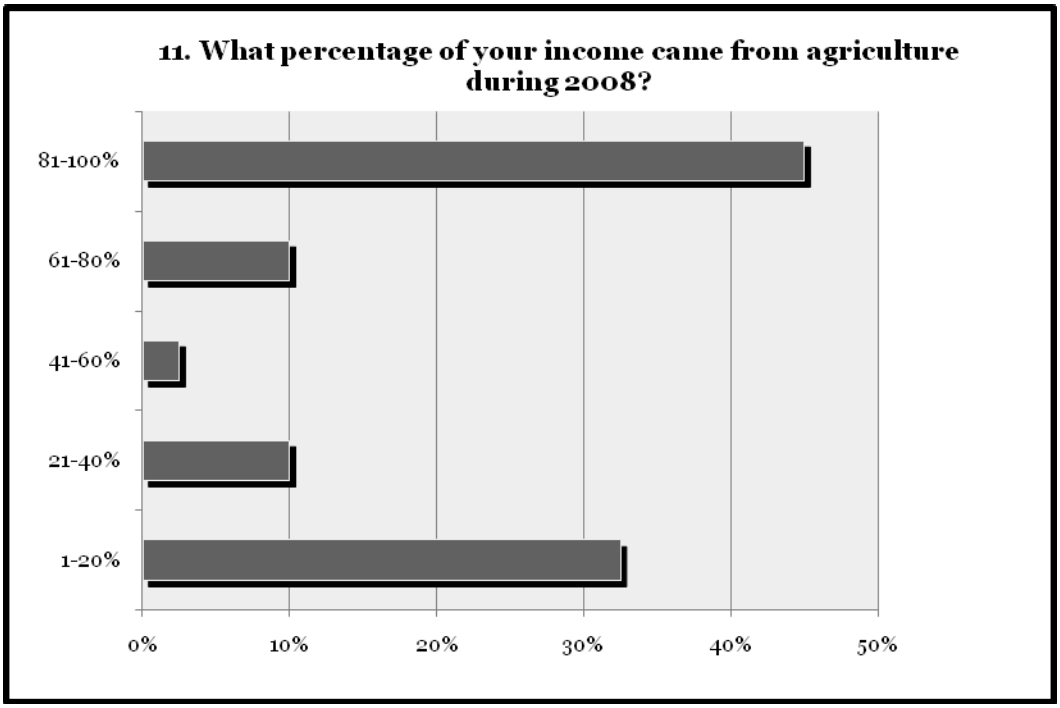
6. County(s) where you farm-please specify state if it is not GA	
Answer Options	**Response Count**
	46
answered question	**46**
skipped question	**10**

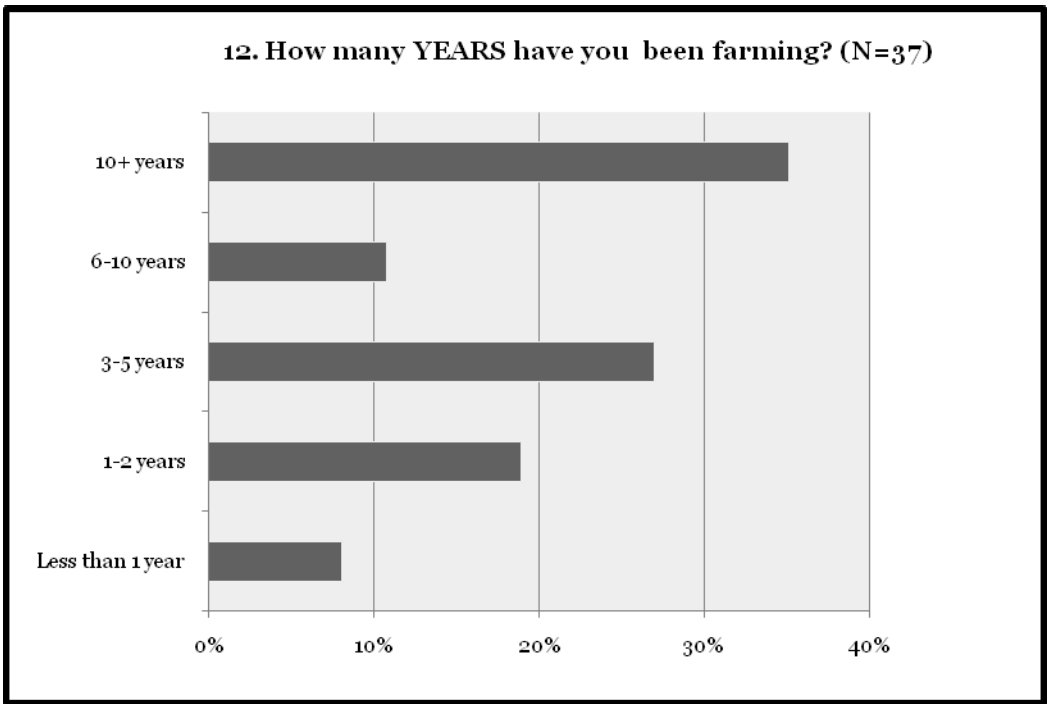


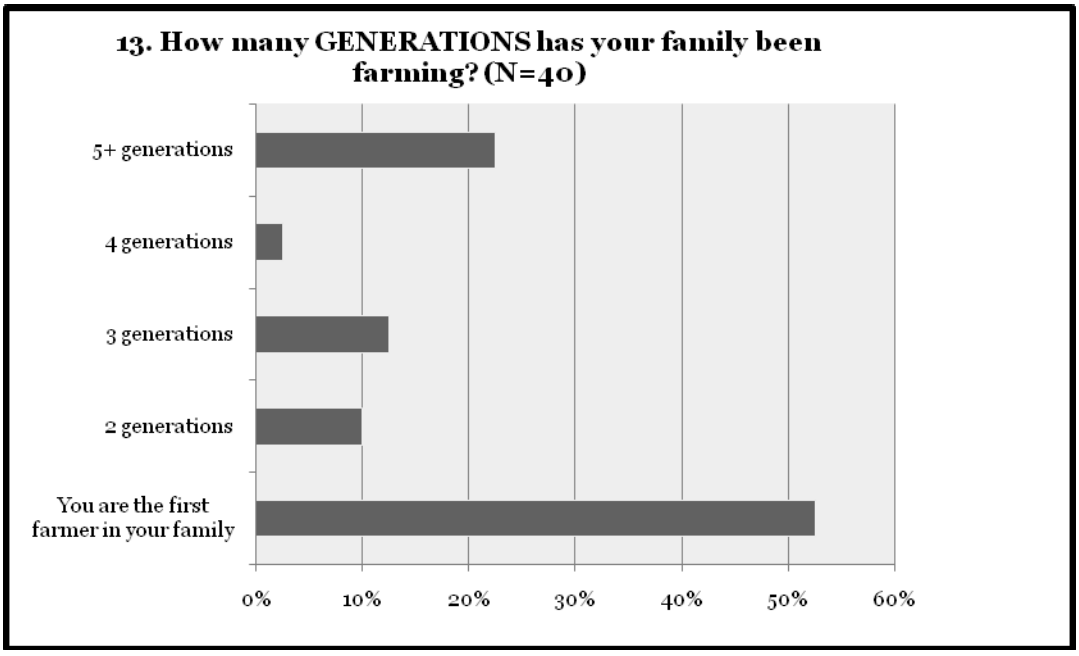


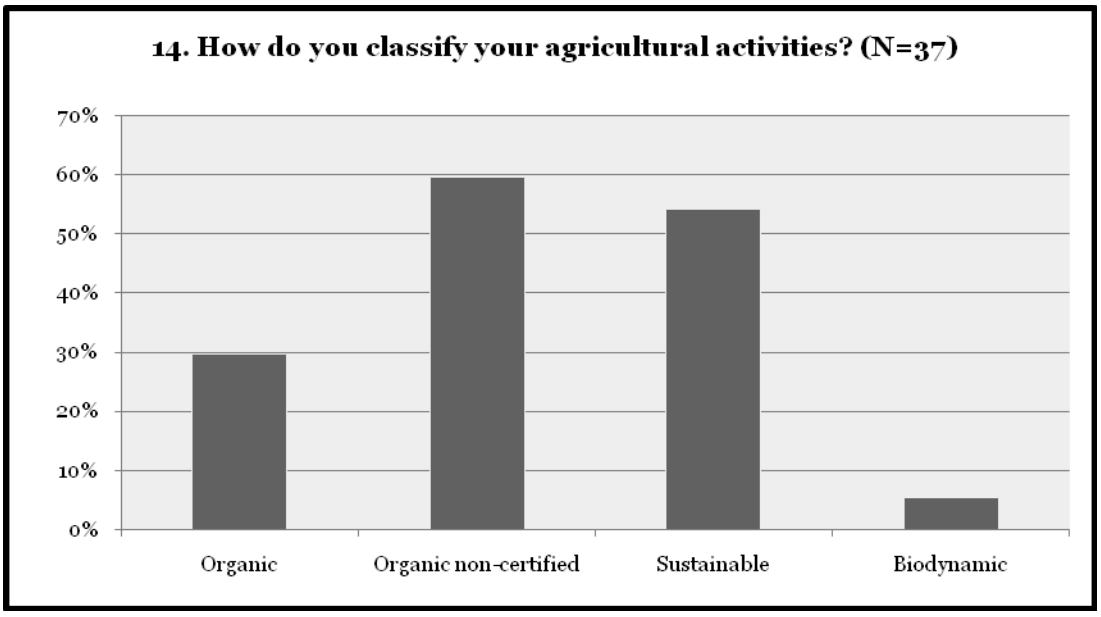
9. Do you derive all or part of your income from agriculture?		
Answer Options	**Response Percent**	**Response Count**
Yes	87.2%	41
No	12.8%	6
	answered question	**47**
	skipped question	**9**

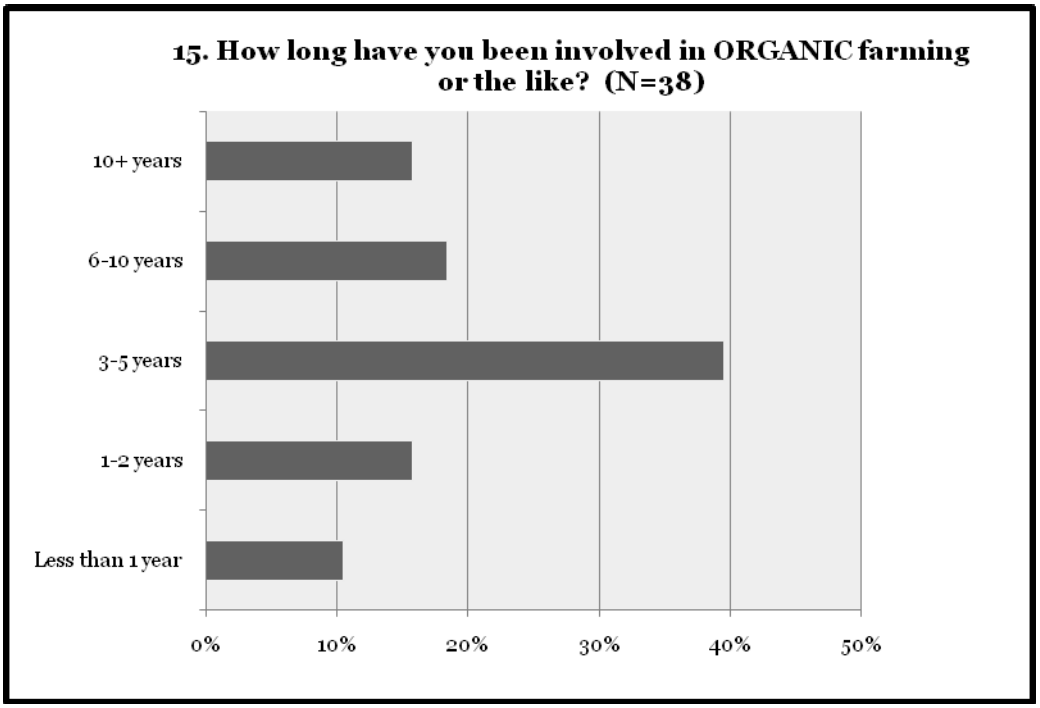
10. Is farming your only occupation?		
Answer Options	**Response Percent**	**Response Count**
Yes	46.3%	19
No	53.7%	22
If no, what else do you do?		22
	answered question	**41**
	skipped question	**15**


11. What percentage of your income came from agriculture during 2008?
81-100%
61-80%
41-60%
21-40%
1-20%
0%
10%
20%
30%
40%
50%


12. How many YEARS have you been farming? (N=37)
10+ years
6-10 years
3-5 years
1-2 years
Less than 1 year
0%
10%
20%
30%
40%

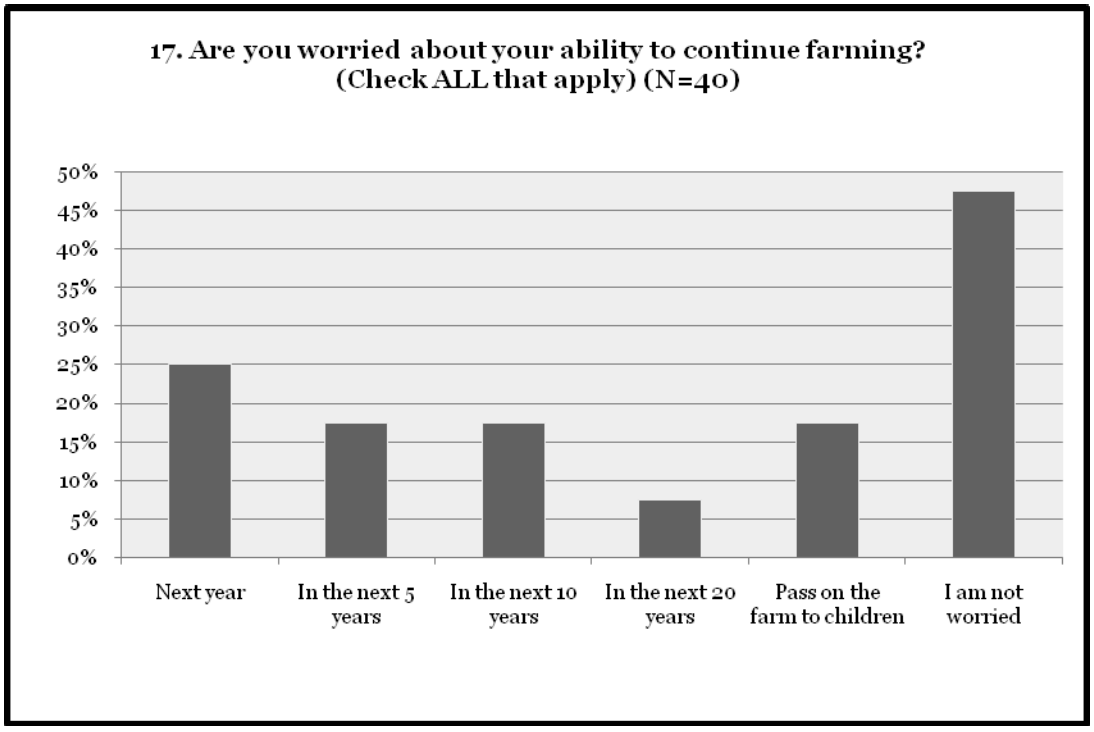

13. How many GENERATIONS has your family been farming? (N=40)
5+ generations
4 generations
3 generations
2 generations
You are the first farmer in your family
0%
10%
20%
30%
40%
50%
60%


14. How do you classify your agricultural activities? (N=37)
70%
60%
50%
40%
30%
20%
10%
0%
Organic
Organic non-certified
Sustainable
Biodynamic



AGRICULTURAL CONCERNS

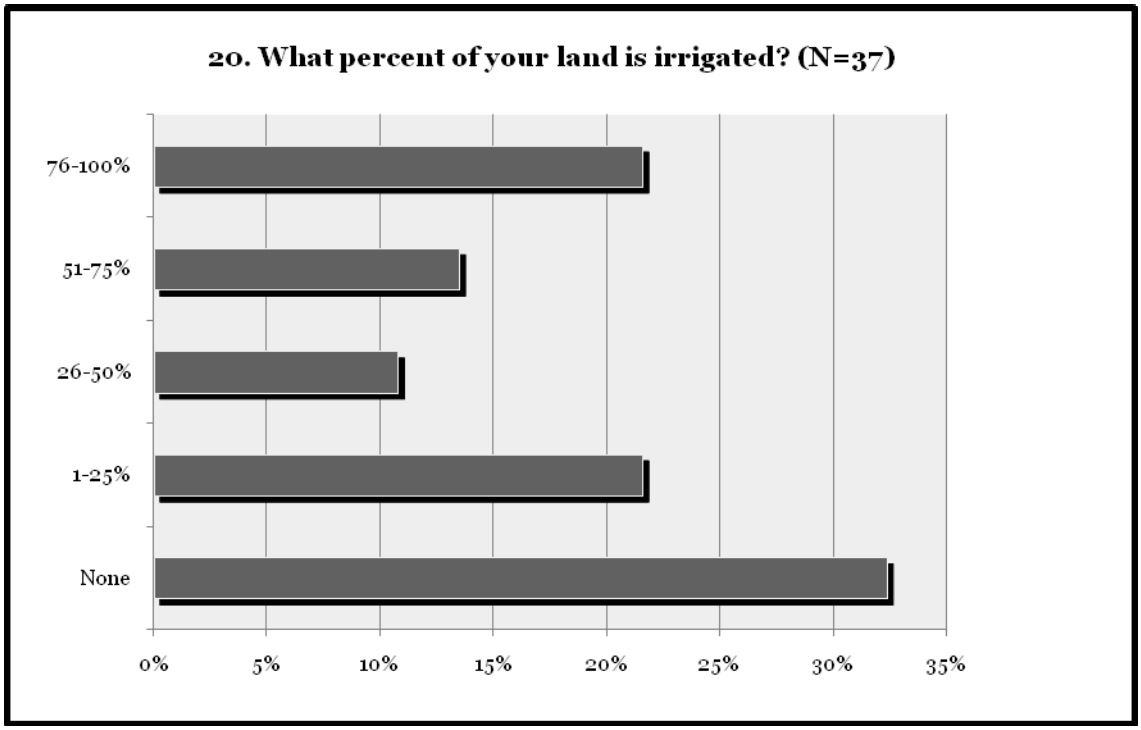
16. To what degree have the following factors influenced your decision to adopt organic or sustainable practices?					
Answer Options	**Strongly influenced**	**Somewhat influenced**	**Did not influence**	**Rating Average**	**Response Count**
Health concerns	32	7	0	1.18	39
Environmental concerns	29	10	1	1.30	40
Market demand/price	18	13	9	1.78	40
Spiritual/moral values	25	13	2	1.43	40
Tradition/family heritage	6	13	19	2.34	38
Other (please specify)					5
				answered question	**40**
				skipped question	**16**



18. Has the present economic downturn changed any of your agricultural practices (for example: crops you grow, when you irrigate, etc.)?							
Answer Options	**Definitely changed**	**Somewhat changed**	**Nothing changed**	**I don't know**	**No response**	**Rating Average**	**Response Count**
Check one	6	12	18	3	0	2.46	39
Please explain							20
						answered question	**39**
						skipped question	**17**

Agricultural Systems and Production Decisions

19. How many acres do you farm in all?	
Answer Options	**Response Count**
	38
answered question	**38**
skipped question	**18**



21. What crops did you grow in 2008? (List in order of acreage, most to least)	
Answer Options	**Response Count**
	36
answered question	**36**
skipped question	**20**

22. How important were these factors in your agricultural decisions during 2008?							
Answer Options	**Extremely important**	**Often important**	**Neither important nor unimportant**	**Unimportant**	**Extremely unimportant**	**Rating Average**	**Response Count**
Land and soil quality	24	11	1	0	0	1.36	36
Weather and climate	26	8	3	0	0	1.38	37
Infrastructure and equipment	12	19	5	0	0	1.81	36
Costs and availability of inputs	12	20	5	0	0	1.81	37
Access to labor	13	10	8	6	0	2.19	37
Access to loans	3	6	10	11	6	3.31	36
Insurance	4	2	16	10	5	3.27	37
Government payments	3	1	11	9	13	3.76	37
Family tradition	4	6	13	9	4	3.08	36
Personal preference	21	10	4	1	0	1.58	36
Market demand and price	16	17	3	1	0	1.70	37
Cooperative affiliation	3	6	15	8	4	3.11	36
Other (please specify)							5
						answered question	**37**
						skipped question	**19**

23. Which outlets do you use to sell your products?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Online sales	5	5	1	10	13	3.62	34
Cooperatives	1	3	0	5	23	4.44	32
Community Supported Agriculture	12	3	0	4	13	3.09	32
Farmer's markets	16	11	2	4	3	2.08	36
Local grocery stores	3	2	3	7	16	4.00	31
Supermarket chains	1	1	0	2	27	4.71	31
Schools	0	0	0	4	26	4.87	30
Restaurants	7	7	2	10	8	3.15	34
Other (please specify)							9
						answered question	**38**
						skipped question	**18**

24. Where do you get agricultural and technical information?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**

Agricultural extension services	2	10	2	19	4	3.35	37
Consultants	0	4	1	9	20	4.32	34
Farm associations and cooperatives	2	8	6	7	11	3.50	34
Farmer's markets	2	10	4	9	9	3.38	34
Customers and suppliers	2	9	5	17	3	3.28	36
Web searches	6	17	11	3	0	2.30	37
Conferences and workshops	7	17	5	3	1	2.21	33
Newspapers and magazines	3	7	13	10	3	3.08	36
TV	0	0	0	17	17	4.50	34
Radio	0	0	1	13	20	4.56	34
Other (please specify)							11
						answered question	**38**
						skipped question	**18**

25. To what extent do you trust these sources for agricultural and technological information?

Answer Options	**Completely trust**	**Trust most of the time**	**Trust half the time**	**Rarely trust**	**Don't trust**	**Rating Average**	**Response Count**
Agricultural extension services	2	12	9	12	2	3.00	37
Consultants	1	3	16	6	7	3.45	33
Farm associations and cooperatives	2	12	12	5	2	2.79	33
Farmer's markets	4	10	11	7	3	2.86	35
Customers and suppliers	0	13	14	7	2	2.94	36
Web searches	3	19	13	3	0	2.42	38
Conferences and workshops	6	24	5	1	0	2.03	36
Newspapers and magazines	1	11	14	9	0	2.89	35
TV	0	0	9	14	9	4.00	32
Radio	0	2	9	13	7	3.81	31
Other (please specify)							4
						answered question	**38**
						skipped question	**18**

26. How often do you talk with agricultural extension agents?

Answer Options	**Weekly**	**Monthly**	**A few times per year**	**Once a year**	**Never**	**Rating Average**	**Response Count**
Choose one	2	5	14	5	11	3.49	37
						answered question	**37**
						skipped question	**19**

27. What cooperatives or agriculture-based groups do you belong to?	
Answer Options	**Response Count**
	29
answered question	**29**
skipped question	**27**

SOURCES OF INFORMATION ON WEATHER AND SEASONAL CLIMATE VARIABILITY

28. How often do you seek out WEATHER forecasts?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Choose one	29	7	0	0	0	1.19	36
answered question							**36**
skipped question							**20**

29. Which source do you use for WEATHER forecasts?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Agricultural extension services	3	1	1	4	22	4.32	31
Data Transmission Network (DTN)	1	2	0	3	26	4.59	32
Online services	21	12	2	1	0	1.53	36
Newspapers and magazines	0	3	2	8	19	4.34	32
TV	7	11	4	2	9	2.85	33
Radio	4	7	5	8	8	3.28	32
Text messages	0	1	0	1	29	4.87	31
Farmers Almanac	1	4	4	7	16	4.03	32
Environmental signs (moon phases, presence of certain insects, etc.)	1	5	5	14	6	3.61	31
Conversations	1	6	11	9	5	3.34	32
Other (please specify)							6
answered question							**36**
skipped question							**20**

30. Do you take WEATHER forecasts into account before you make agricultural decisions (for example: what crops to plant, when to irrigate, when to harvest, etc.)?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Choose one	17	15	2	1	1	1.72	36
answered question							**36**
skipped question							**20**

31. How often do you seek out CLIMATE forecasts?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Choose one	10	11	6	7	2	2.44	36
						answered question	**36**
						skipped question	**20**

32. Which source do you use for CLIMATE forecasts?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Agricultural extension services	2	1	3	5	19	4.27	30
Data Transmission Network (DTN)	1	2	1	3	24	4.52	31
Online services	11	14	4	4	2	2.20	35
Newspapers and magazines	2	4	4	10	12	3.81	32
TV	4	6	6	2	13	3.45	31
Radio	3	3	5	8	12	3.74	31
Text messages	0	1	0	0	28	4.90	29
Farmers Almanac	1	5	1	10	14	4.00	31
Environmental signs (moon phases, presence of certain insects, etc.)	2	4	3	9	12	3.83	30
Conversations	1	6	7	7	9	3.57	30
Other (please specify)							5
						answered question	**35**
						skipped question	**21**

33. Do you take CLIMATE forecasts into account before you make agricultural decisions (for example: what crops to plant, when to irrigate, when to harvest, etc.)?							
Answer Options	**Always**	**Often**	**Half the time**	**Rarely**	**Never**	**Rating Average**	**Response Count**
Choose one	7	11	3	12	3	2.81	36
Please specify							6
						answered question	**36**
						skipped question	**20**

WEATHER AND CLIMATE SERVICES

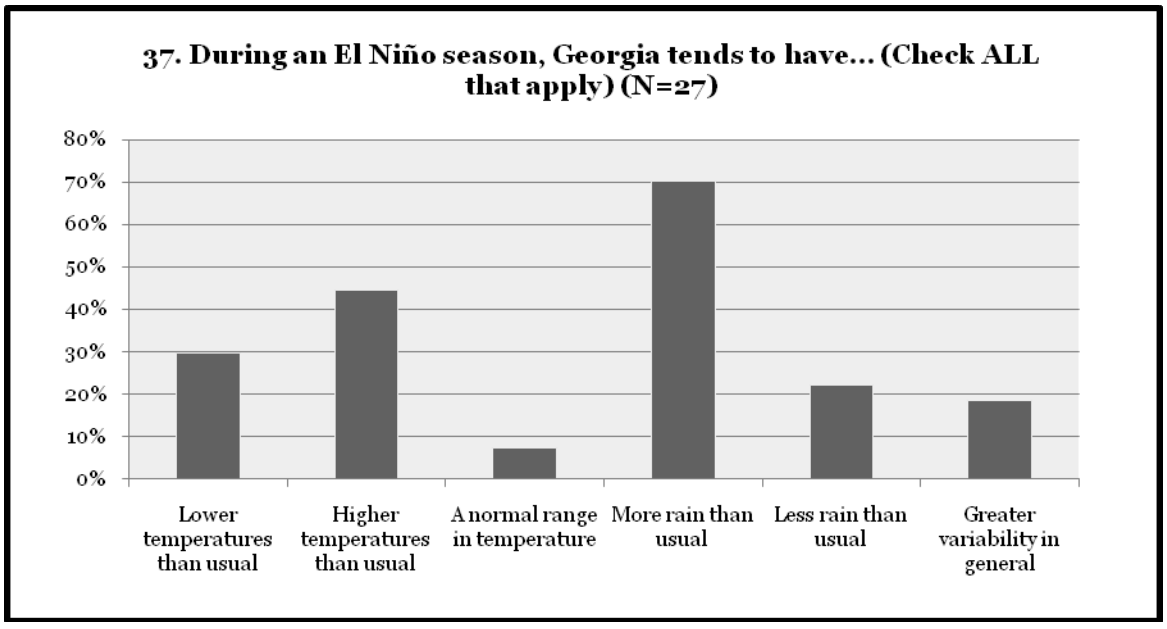
34. Are you familiar with www.agroclimate.org?		
Answer Options	**Response Percent**	**Response Count**
Yes	8.3%	3
No	91.7%	33
If yes, do you find it useful?		3
	answered question	**36**

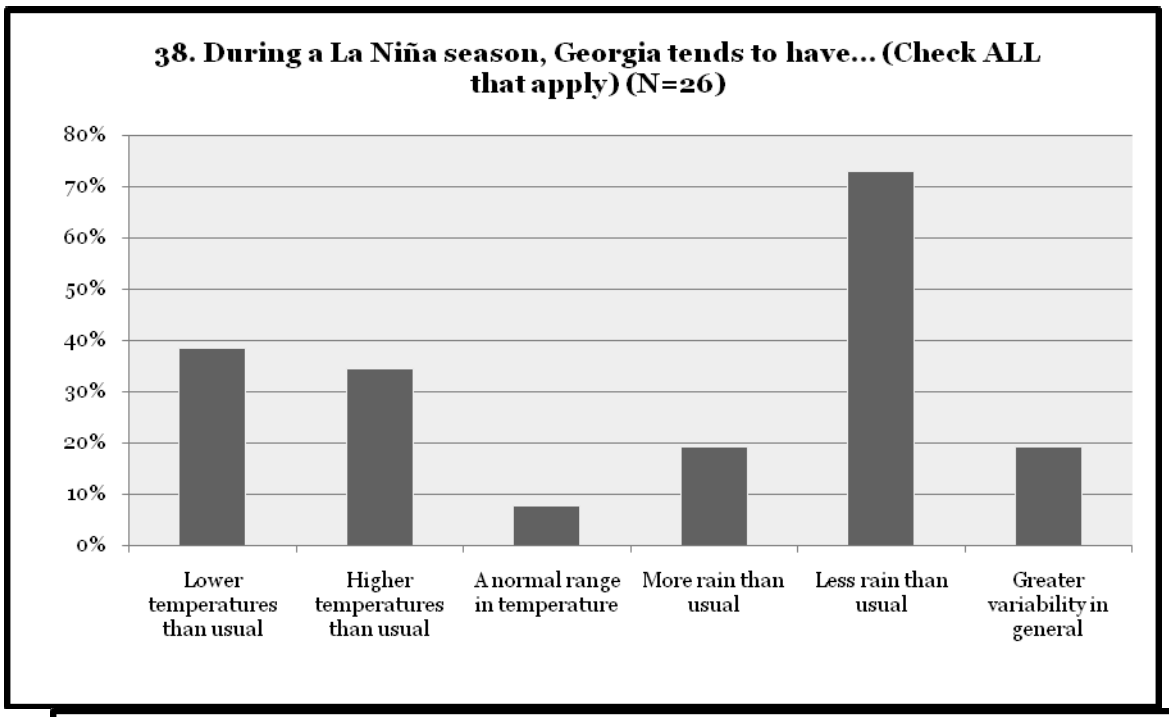
skipped question	**20**

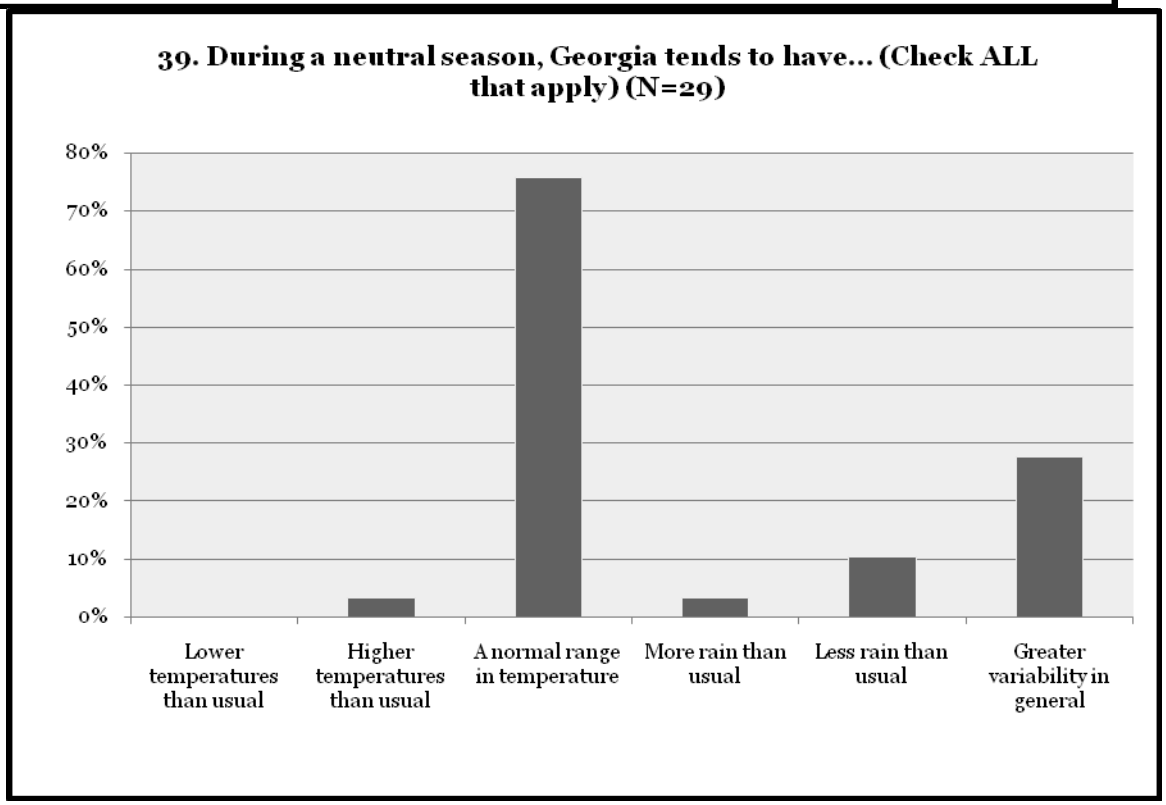
35. Are you familiar with www.georgiaweather.net?		
Answer Options	**Response Percent**	**Response Count**
Yes	16.7%	6
No	83.3%	30
If yes, do you find it useful?		4
answered question		**36**
skipped question		**20**

GENERAL KNOWLEDGE CONCERNING WEATHER AND CLIMATE

36. Are you familiar with El Niño and La Niña (also called ENSO) phases?							
Answer Options	**Very familiar**	**Somewhat familiar**	**I have heard of them**	**Not familiar**	**No response**	**Rating Average**	**Response Count**
Choose one	3	14	11	4	0	2.50	32
answered question							**32**
skipped question							**24**





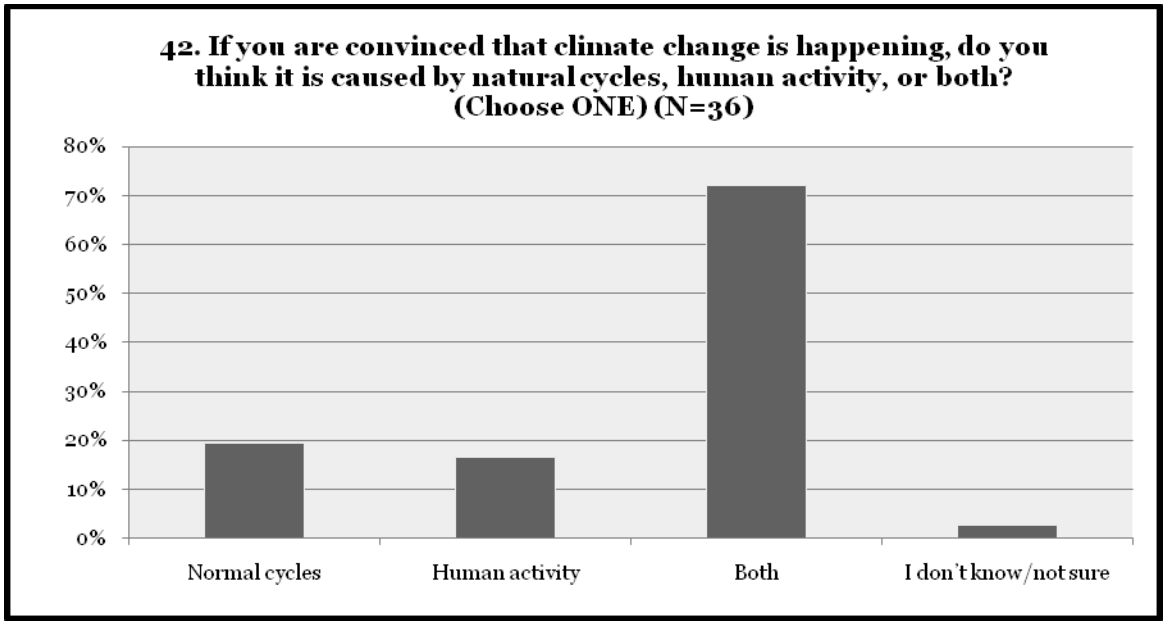


40. Do you agree that El Niño/La Niña phases affect agriculture in Georgia?							
Answer Options	**Strongly agree**	**Somewhat agree**	**Neither agree nor disagree**	**Somewhat disagree**	**Strongly disagree**	**Rating Average**	**Response Count**
Choose one	15	8	13	0	0	1.94	36

answered question	**36**
skipped question	**20**

CLIMATE CHANGE

41. Do you agree that climate change is happening?							
Answer Options	**Strongly agree**	**Somewhat agree**	**Neither agree nor disagree**	**Somewhat disagree**	**Strongly disagree**	**Rating Average**	**Response Count**
Choose one	21	11	2	1	0	1.51	35
						answered question	**35**
						skipped question	**21**



43. In your opinion, which of the following phenomena in the Southeast U.S. are affected by climate change?							
Answer Options	**Always affected**	**Often affected**	**Sometimes affected**	**Rarely affected**	**Not at all**	**Rating Average**	**Response Count**
Wildfires	3	21	7	4	0	2.34	35
Hurricanes	7	19	7	2	0	2.11	35
Flooding	6	20	6	3	0	2.17	35
Drought	10	22	2	1	0	1.83	35
Temperature extremes	7	24	3	1	0	1.94	35
						answered question	**35**
						skipped question	**21**

44. Do climate change considerations affect your decisions in the following areas?

Answer Options	Always	Often	Half the time	Rarely	Never	Rating Average	Response Count
Farming operation	5	14	7	6	3	2.66	35
Marketing	3	5	3	16	7	3.56	34
Lifestyle	7	9	5	9	5	2.89	35
						answered question	**35**
						skipped question	**21**

45. In adapting to climate change, is organic or sustainable farming more or less adaptive than conventional farming?

Answer Options	Much more adaptive	A little more adaptive	About the same	A little less adaptive	Much less adaptive	Rating Average	Response Count
Choose one	22	10	4	0	0	1.50	36
						answered question	**36**
						skipped question	**20**