

UNDERSTANDING FARMING DECISIONS AND POTENTIAL APPLICATIONS OF CLIMATE FORECASTS IN SOUTH GEORGIA

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INTRODUCTION

The El Niño-Southern Oscillation (ENSO) phenomenon is one of the most important determinants of year-to-year climatic variability and extreme climatic events around the globe (Cane, 2000). In the southeastern United States, El Niño typically brings more rainfall and cooler temperatures to in the fall and winter months, whereas La Niña brings warmer and drier conditions during fall, winter, and spring. After the El Niño events of 1982-83 and 1997-98, detailed studies of ENSO impacts in the region showed the effects on rainfall patterns to be strongest in south Florida. However, ENSO impacts on winter and spring temperatures are greater in north Florida counties and across the Panhandle. Additionally, these effects are significantly greater during the winter-spring than in summer (Hansen, 2002; Neelin et al., 1998). During El Niño years, hurricanes also typically make fewer landfalls in the southeast US.

Climate forecasts have shown promise in supporting agricultural decisions about planting dates, cropping systems, variety selection, irrigation needs, and input application (Hammer et al., 2001; Hansen, 2002; Jones et al., 2000). Market conditions, timing and severity of pests and diseases, and the need for crop insurance can also be better estimated using seasonal forecast (Cabrera et al., 2006; Fraisse et al., 2004). Despite the potential value of climate forecasts, decision makers are not always able to translate raw forecasts into appropriate responses (Ingram et al., 2002; Letson et al., 2001; Phillips et al., 2001). Decision support tools can help decision makers to explore different scenarios and available options and to anticipate the potential risks and gains associated with them (Hammer et al., 2001; Meinke et al., 2002; Tsuji et al., 1998). Intermediary institutions, such as agricultural extension, can also add value to climate forecasts by packaging them with management recommendations and by facilitating their dissemination to farmers (Hansen et al., 2004; Jones et al., 2000).

The Southeast Climate Consortium (SECC) is addressing this challenge. Originally established as the Florida Climate Consortium in 1997, the SECC expanded to include Georgia and Alabama in 2003. The SECC is a multidisciplinary research and extension partnership now involving six universities in the southeast US: Auburn University, Florida State University, University of Alabama-Huntsville, University of Florida, University of Georgia, and University of Miami. The SECC vision is to fully realize the potential of climate forecast application to management of agriculture and natural resources. This mission is being pursued in terms of two main goals: a) to predict climate variability in the southeast US; and b) to develop products and services that effectively communicate climate information to decision makers.

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The principal outreach mechanism of the SECC is an interactive website, *AgClimate*, which provides climate-based decision support tools that enable decision makers to explore climate information as well as effects of climate on agricultural crops and forests [www.agclimate.org]. From the onset, the SECC has been committed to a demand-driven process of tool development, which builds on stakeholder input and feedback. For agricultural stakeholders, this process has demanded a strong partnership with extension services, which are the primary client group for SECC products. Because of their technical background and intermediary roles, extension agents are best placed to channel climate information and management advice generated by *AgClimate* to the farmers in their counties. While outreach efforts aimed toward extension agents are continuing and receiving positive responses, greater emphasis is now being placed on directly reaching out to farmers and other decision makers and on ensuring that *AgClimate* is consistent with their information needs and with skill levels. This paper reports on an exploratory study which seeks to assist this broadening of the SECC target clientele by learning about farmers in South Georgia.

Background information for this investigation is provided by Barlett (1993), who studied the ethnography of family farms in Dodge County, in the Coastal Plain of central Georgia. Bartlett (1993) provided an excellent description of the social, economic, and technological transformations that shaped rural communities in southern Georgia during the 20th century based on field research conducted over several years in the 1980s. The period of Bartlett's study followed several disastrous droughts and was characterized by a prolonged crisis caused by increased production costs and decreased farm prices that forced as many as one-third of full-time farm operations out of business. The crisis led to new attitudes toward farming methods, livelihood goals, and risk management, which still shape agricultural decision making today. It also ushered forward several key risk mitigation mechanisms, including irrigation, crop insurance, government payments, and off-farm working spouses, all of which help southern Georgia farmers cope with the effects of climate variability.

METHODS

The objective of this preliminary research was to gain insight into farming systems, decision making processes, perceptions of weather and climate, and potential application of climate forecasts among farmers of South Georgia. Given that the goal was to understand how farmers make decisions and how they use knowledge of weather and climate, the study used a small-scale purposive sample rather than a large scale survey of randomly selected farmers. County agents helped contact farmers whom they knew and, therefore these farmers were willing to devote time to an extensive interview.

This sampling approach is commonly used in ethnographic research, but it does have the drawback of introducing certain biases. For instance, the sample in this study is somewhat skewed toward younger, more educated farmers, who have better relations with extension or are more active in the community (serving on boards, committees, etc.). All respondents were large farmers, with farms between 2000 and 4000 acres, several times the median or average size of farms in their counties (Appendix 1, Table 1). To correct this bias, a second stage of the study is being planned, specifically targeting small-scale, marginal or 'minority' farmers (Breuer et al., 2006).

A total of eight farmers in Mitchell and Dooly counties were interviewed during January and February 2006 (Figure 1). Additionally, two ‘intermediaries’ (an extension agent and an NGO professional) were interviewed in Dooly and Sumter counties. Respondents were interviewed at their farms or at research-extension facilities. Interviews lasted about 40-60 minutes and followed an open-ended format, loosely structured according to an interview guide. This format allowed farmers to elaborate at length and in their own way on the topics in questions.

Carla Roncoli, an environmental anthropologist, and Joel Paz, an extension agrometeorologist, conducted the interviews. The extension agents who contacted the farmers also participated in the interviews and provided additional contextual information. Extensive notes were taken during the interviews and transcribed shortly thereafter, with the two interviewers cross-checking their recollection and understanding of the responses.

All respondents were provided with informational material on *AgClimate* and the Georgia Automated Environmental Monitoring Network (AEMN). One farmer was given a hands-on demo of *AgClimate*.

RESULTS

Sample population

All respondents were male. Four farmers were relatively young men (from mid-20s to early 40s), the other four were mid-to-late 50s. At least five had a college education in agronomy or agricultural economics from two-year or four-year state colleges. One young man had a M.Sc. in agronomy.

The NGO agent was a young man in his 30s, and worked for AgAmerica (<http://www.ag-america.org>), a non-profit organization that provides services to farms and agribusinesses and is supported by the Southwest Georgia United Empowerment Zone (Dooly and Crisp Counties). The extension coordinator was an African American man in his mid-50s, with a degree in animal science from Fort Valley State University. He had grown up on a farm in a nearby county and had served as an extension professional in the area for over 30 years.

All respondents were married, except a young farmer in his early 20s. All those married had children, ranging from babies to adults.

Household organization

All respondents and intermediaries came from farming backgrounds, some from families that have farmed for several generations. Growing up on a farm enabled them to acquire start up land and equipment, along with experience and intuitive knowledge. In the words of one farmer, it “built up in one’s head what is going to work, according to the kind of land and soil one has.”

Most farmers interviewed were part of family operations, including father and sons, uncle and nephew, brothers, father and son-in-law, or mother and son. In some cases income from the farm is divided equally, in other cases each has their own land and farm, but equipment and labor are shared. Multi-family arrangements are not only more economical and efficient, but also more resilient to risk, as they allow different individuals to develop specific areas of expertise, such as

crop management, equipment maintenance, laborers supervision, government programs, commodity markets, budget and finance, or computer technology.

While most farmers interviewed identified themselves as full-time farmers, extra income and benefits from off farm work, particularly by the wives, are necessary for the viability of the family farm. All the wives held clerical or professional positions or ran small businesses from the home. Some respondents also have or had additional income from other sources, often related to agriculture, for example equipment sales, rental, or maintenance, insurance brokerage, cotton ginnery, or warehouses. One farmer had run quail hunting operations on his land.

Among married farmers, some wished for their sons to help on the farm, while others preferred their children to have more lucrative off-farm careers. Acquiring land and starting a farm is becoming more difficult, particularly if one does not have family land. The high cost of equipment and rising cost of fuel are even bigger obstacles than access to land. Young people are also deterred from farming by the large time demands and rigid schedule of farm life, and by the fact that farming is becoming less profitable. Therefore very few young men can establish themselves as full time farmers: consequently the farming population is aging.



Figure 1: Target counties

Production systems

The counties (Mitchell, Dooly, Sumter) visited were selected as representatives of production systems (cotton-peanut, vegetables) that may potentially benefit from *AgClimate* tools and products because they are situated where the ENSO signal is relatively strong. Their economy is entirely agricultural. Counties on the northern edge of the coastal plain tend to have

heavier clay soils rather than light sand as to the south. Mitchell County surrounds the banks of the Flint River, benefiting from greater water availability and good soils for row crop production.

Row crops, and especially cotton and peanut, dominate in all three counties. Typically cotton rotates with peanut, every three years, but also with corn and pasture. Average yields for cotton are 740 lb/acre for dryland and 1000-1200/lb per acre for irrigated land. In exceptional years and with high yielding varieties, cotton can yield 1700 lb/acre, but the cotton is of lesser quality. Smaller acreages are planted with corn, sorghum, and wheat. Soybean and sunflowers are also grown but acreages have shrunk in recent years. Vegetable production is also important in some areas. Some land is left for pasture, under pine, or for wildlife habitat.

Mitchell County

Mitchell County farmers started growing cotton about 20 years ago. Before then it used to be a prime peanut and corn growing area, its light sandy soils being suitable to its cultivation. But recent peanut yields have been declining because of greater climate variability and incidence of fungal disease, against which there is no insurance or effective control. One farmer reported average yields of 5000 lb/acre but in 2005 they suffered 30-40% loss due to fungal disease and excessive rainfall. Profits have been reduced by the elimination of government subsidies and by competition from other counties in Georgia, which have either begun or increased peanut production after the quota system was lifted. Land new to peanut tends to yield more because they have lower disease and pest pressures.

Since the early 1990s, sweet corn has emerged as a high value crop. Government restrictions on farming in the Everglades, FL have opened markets for South Georgia farmers. Farm operations for sweet corn compete with cotton, which needs to be tended at the same time. Two of the farmers interviewed produce sweet corn and neither grows cotton. Sweet corn can be highly profitable but it is costly and risky because of high quality standards and volatile markets.

One farmer interviewed in Mitchell County started to grow grain sorghum a few years ago, which is bought by owners of the hunting estates as feed for quail. As feed, sorghum has the advantage of not rotting as quickly as maize and still benefits from government payments. But, like cotton, it competes with sweet corn for farm operations, so farmers who specialize in sweet corn do not grow sorghum.

Mitchell County is the core of pecan production for Georgia: one farmer interviewed had 650 acres of pecan. But trees are aging and yields are declining and pecan production was adversely affected by the series of storms in the summer and fall 2005.

Dooly County

Dooly County has been a leading producer of cotton and peanut in the state of Georgia for years. Smaller acreages of soybean, wheat, and corn are also produced. Peanut were grown as a rotation crop, but they are less common due to damage from wild hogs and geese and less advantageous government payments.

Production of vegetable, cantaloupe, and watermelon was important, but has suffered from competition from cheap produce imported by large supermarket chains (Walmart, Publix) from Central America, where labor is much cheaper.

Sumter County

Sumter County has moved from a more diversified system, which included hogs and cattle, to a more row crop oriented production system, including cotton, corn, peanut, and

soybean. This shift was explained by increases in government subsidies for row crops as well as declining production of livestock feed because of drought. Until recently, soybean acreages had been gradually increasing but expansion has come to a halt because of the threat of leaf rust.

In the last 5 years, the county has emerged as the leading producer of green bean among counties in Georgia. Production is intensive, involving an estimated 5000 acres, with yields ranging between 200-300 bushels/acre in two growing seasons (spring and fall). There are six processing facilities in the counties, three of which are owned by farmers. Because investments for green bean production can be recouped in 2 to 3 years, farmers are now willing to invest and to aim at quality as well as quantity.

Perceptions and Impacts of Climate Variability and Climate Change

Most respondents expressed a belief that climate is undergoing considerable change. Among causes for climate change, they mentioned global warming, pollution from cars and tractors, destruction of the rainforest, removal of wooded vegetation from the local environment. Perceived changes include the following:

Greater climate variability

Several respondents mentioned that the climate has become more unpredictable, referring to both inter-annual and intra-annual variability. Drought years are perceived as becoming more frequent (one farmer mentioned El Niño as the cause). In farmers' view, years of overall abundant rainfall have become less frequent, but destructive flooding occurs more often. A Dooly County farmer summed it up in terms of "few good years, some bad years, and many minuscule years," the latter characterizing years when they barely break even. Another farmer estimated that, in Mitchell County, for every good year, there are three bad ones. But a sweet corn farmer pointed out that 'good weather' can also be a problem if it leads to market saturation and falling prices.

Because of local variability, farmers may disagree in recalling particular years as being favorable or unfavorable. Respondents in Dooly County particularly stressed spatial variability, reporting widely different rainfall outcomes for different parts of the county. A part of Sumter County is known as 'the devil's triangle' because it tends to suffer drought even when it rains elsewhere.

One farmer pointed out that rain and wind may be bigger problems than drought, because the latter can be remedied by irrigation whereas there no protection against excessive rain and wind. When rains are heavy, soils become muddy and equipment gets bogged down. In deep sandy soils such as those of Mitchell County farmers need at least two days without rain to get equipment into the fields.

Temperature and rainfall variation interferes with application of chemical inputs. Chemicals work best under specific environmental conditions; they may evaporate when temperatures are high or may be washed off by heavy rain. One Dooly County farmer calculated losing \$4000 if it rained within 4 hours after he applied the chemicals, as it takes several days for chemicals to be effective in cotton. A Mitchell County farmer suffered a loss in cotton yields in 2005 because the soil was so saturated with rain that plants did not absorb the fertilizer.

Genetically-modified varieties such as Round-up-ready cotton and Bt corn have improved characteristics may mitigate some of the problems associated with climate variability. However, farmers think that these varieties are more vulnerable to other problems, such as

temperature fluctuations and drought, or they may have higher yields but at the expense of quality and, therefore, price. They may also be more vulnerable environmental stresses during particular periods of their growth cycle. There are no varieties that withstand excessive rainfall and no insurance against it.

Cooler and wetter springs

Most farmers mentioned that springs are getting cooler and wetter. This shift has resulted in a one month delay in the planting window. Several farmers recalled that, in their youth, they finished planting before April. In fact, their elders believed planting should be finished by Easter, so that by Thanksgiving they would have finished harvesting.

Table 1. Years recalled by respondents as among the worst and best.

Year	Evaluation	N.	Cause	Crop Impact	Notes
1954	very bad	2	Drought, heat	Corn failed, but decent peanut yields (D, M)	Rained last week of April, then only 1-2 inches between June and August, high heat compounded effect of drought.
1977	bad	2	Drought	Peanut failed (D, M)	One farmer said 2005 was as bad as 1977.
1978	not better	1		(D)	
1979	average	1		(D)	
1980	bad	2	Drought	(D, M)	In 92 days of the growing season they only shut down irrigation to refuel
1986	bad	1	Drought	(M)	
1987	bad	1	Drought	(D)	
1988	bad	1	Drought	(D)	
1990	bad	3	Drought	(D, M)	'Super-dry'
1991	bad	3	Drought	(D, M)	Some parts of Dooly did ok.
1994	bad/good	1/ 1	Flooding		Some farmers started buying insurance for peanut.
1996	good	1		Good cotton yields (D)	
1997	bad/good	1	Drought	(D, M)	Soil was so dry that irrigation had to be used to dig peanut pods for harvest.
1998	bad	1	Drought, heat	(D, M)	Intense rain, flooding in March, followed by 4-yr drought.
1999	bad	1	Drought, heat	(D, M)	Irrigation helped, nothing yielded on dryland, but heat injured crops.
2000	bad	1	Drought, heat	(D, M)	
2001	good	1		Good cotton yields (D)	
2004	bad	1	Drought, winds	Damage to cotton (M)	Drought in Sept (D), 70-90 mph hurricane winds (Ivan)
2005	bad	8	Cold spring, dry fall, storms, disease	Cotton, peanut, pecans damaged (D, M)	July very wet, Sept-Oct very dry.

D=Dooly, M=Mitchell

In recent years, it has often been too cold to plant in March, that is, soil temperatures did not reach 65°F as is needed before planting. Generally farmers aim to finish planting peanut by April 20 and cotton by April 30, but if the spring is cold and wet, as was the case in 2005, they may not start planting until early May. This means that crops are still in the field during the storm season (October) or are not fully mature before the onset of winter, as happened in 2005.

Spring of 2005 was unusually cold and rainy. For most of the spring it was too cold for planting cotton and too wet for planting corn. Although normally corn is planted before cotton, by the time the conditions were right for planting, some farmers had to skip corn and rush into planting cotton. By the time they finished planting cotton it was too late to plant corn. Farmers started planting cotton around May 10th but some had to wait till end of May or even mid June. One farmer referred to planting on May 43rd (he did not want to say 'June' because insurance regulations require all planting to be done by May 30). Insurance regulations also contribute to reducing the planting window to a period of only a few weeks.

According to the AgAmerica agent, shrinking window for planting makes some farmers reluctant to adopt conservation practices, because cover crops keep the soil cool and delaying planting even further. Cool springs are also a problem for sweet corn, most of which is grown at that time. Cold weather slows crop development, making it more difficult to meet the very strict market deadlines for that crop. Farmers try to cope with this problem by staggering planting.

Hotter and drier summers

Summers are perceived to be getting hotter and drier. Drought can be partially mitigated by irrigation (although fuel costs go up). Irrigated crop, on the other hand, can be damaged by heat. One farmer in his mid-30s recalled that, in his youth, it could rain almost every day in the summer, but that rarely happens now.

In 2005, rains in June and July were adequate for some and excessive for others. But from August onward there was very little rain in most areas. Both conditions adversely affected the peanut crop. One Mitchell County farmer suffered a reduction of 600 lb/acre in peanut yield from disease and excessive rain: from 60 days after planting onward, a peanut crop does not need more than one inch of rain per week, but they received 15 inches in the month of July. Another farmer reported that lack of rain during maturation prevented peanut from producing seed. The soil was so hard that the farmer had to use a subsoiler to rip plants from the ground. He would have not planted peanut had he expected drought in September.

Greater frequency of storms

Some farmers reported that tropical storms and hurricanes have become more frequent and intense; bringing excess rainfall and heavy winds in October. This problem is compounded by delayed planting. In the past, farmers used to finish planting by April 1st and they began harvesting peanut in early August and harvest cotton in late August and September. But in recent years farmers may start planting in late April or early May and may not be done harvesting until mid-December.

Heavy rains late in the season delay harvesting, because cotton cannot be defoliated when it rains and harvesters cannot get into the fields. Any delay of harvest magnifies exposure of unharvested crops to hurricane damage, as was the case in 2004 when one Dooly County farmer lost 70% of his crop to 70-90 mph winds of hurricane Ivan.

For an ideal harvest period, farmers wish to have good moisture in the soil but no rain, coupled with a light breeze from the northwest. Winds from the northeast are believed to be

unfavorable, because they bring excessive moisture, thereby increasing risk of leaf spot and white mold disease in peanut.

Milder winters

Some farmers commented that winters are not as cold as they used to be. Warm winters increase the incidence of weeds, insects, and disease, especially thrips.

One farmer in his 50s recalled that when he was growing up, winter began in October and temperatures stayed cold until March. Another farmer in his late 20s recalled that when he was in school they wore a jacket for most of the school year and classes could be canceled because of freeze or snow 4 or 5 times each year. Now snow and ice storms are very rare.

Agricultural Decision Making

Timing

Most planting decisions are made in December and January but farmers may decide as early as August which crops they will plant the following year. But, in 2006 some farmers were holding back from finalizing their decisions by the uncertainties surrounding the new Farm Bill.

Most farmers approach banks for loans in January. To do so they have to submit an estimate of which crops they will grow and how many acres of each crop. These estimates cannot be drastically changed regardless of conditions. In January and February farmers also arrange for seed purchases. In the past, farmers could book seed in advance, but at present seed companies are no longer willing to take reservations. To ensure timely access to preferred seed some farmers cultivate a special relationship with the seed company representatives.

Crop insurance decisions must be made by the end of May with no changes being allowed thereafter.

Goals

The interviews highlighted goals that guide farmers' decisions. These goals may not always be maximizing yields and profits. In her study of Dodge County farm families, Barlett (1993) identifies two farm management styles, a more ambitious, entrepreneurial one, and a more cautious, conservative one. During the 1980s farm crisis, the former often led to foreclosure and bankruptcy, while the latter enabled farms to ride out the crisis. A more risk averse style seems to prevail today among most farmers interviewed for this study (except a few cases, such as specialty crop farmers).

Farmers interviewed mentioned the following goals:

- Avoid catastrophic losses and forced disinvestments.

A Dooly County farmer stressed the importance of being conservative, "not to overextend oneself," especially during times of price instability. Being conservative means containing costs, not taking unnecessary risks, and diversifying operations. While recognizing that downturns cannot be entirely avoided, given the many factors that are beyond farmers' control (e.g. markets and climate), farmers must try to avoid losses from which they cannot recover. The emotional and social consequences of such losses, particularly when they force farmers to sell family land or home equity, can be devastating. Such situations may cause shame and guilt, and, in some cases, may lead to depression, divorce, and even suicide. Building or maintaining equity enables a farmer to recover from losses. For example, capital assets of \$75K-

100K or more can be used to carry over loans from one season to the next one. Such a strategy requires skill in convincing the bank that one can recover from a bad year and repay the loan. It also entails the danger of losing equity if one is unable to do so.

- Meet living expenses and repay debt

Most farmers interviewed had attained a middle class lifestyle. They were sending children to state colleges, bought cars for their wives and children, and one mentioned taking the family to Europe for a holiday. A Dooly County farmer expressed his production goals in terms of providing adequately for his family and paying down the money he borrows from the bank each year.

- Attain consistent levels of production (satisfy the market)

A Mitchell County sweet corn farmer reported that his primary goal is attaining the same level of production each year. In other words, he ‘aims at the middle rather than at the top’, because buyers like consistency of supply and appearance. In fact, such brokers often tell farmers how much they expect to buy from them and are unwilling to take any surplus.

In making decisions within the framework of these goals, farmers must consider several factors in addition to climate. These factors include the opportunities and limitations afforded by available resources, additional risks, and potential returns.

Resources, Risks and Returns

- Land

Some farmers manage risk by spatial diversification, establishing fields in different parts of the county or across counties. However, they try not to spread their landholdings too far apart or into fragmented small plots, to avoid wasting time and money running around, particularly given current fuel price increases. Ideally, farmers like to have several fields within 6-10 miles of a hub (but some travel more than 35 miles between fields). In making decisions about how to allocate their time and resources among the different plots, they are keenly attuned to the weather, comparing what happens in their different fields and in their neighbors’ fields.

In land purchase or renting decisions, farmers assess soil types, management practices, and government subsidies attached to the land. Farmers typically know other farmers in the community and the management history of the plots they are considering to buy or rent. Nonetheless, a farmer might decide to rent depleted land and manage it to build up soil quality if they can obtain a long-term lease so that the landowner cannot take back the land once it has become productive. On the other hand, landowners are often unwilling to sign long term leases. Landowners that rent land to farmers may be widows, retirees, or farmers who have more land than they can operate.

Land prices vary according to soil quality and government subsidies attached to the land. Land values have increased since the economy has slowed down, as people take money out of the stock market and invest it in land. The high cost of land means that it is very difficult for farmers to set up a viable operation unless they get land, as well as the use of equipment, from their family. Most farmers interviewed inherited land, which, in one case, had been in the family for longer than 100 years. In the counties visited, farm land can be bought for \$1500-2000 per acre. Seasonal rental fees are \$30-80/acre for dryland and \$100-200 for irrigated land.

Overall farm size has increased considerably since the 1980s. Under current conditions, the minimum for viable farming is 1000 acres for full-time farming or 500 acres for well diversified operations supplemented by non-farm income. Total cultivated acreage among the farmers interviewed ranged from 2000 up to 4400 acres, including owned and rented land (Table 2). This is much higher than the county-wide averages (Appendix 1, Table 1).

Table 2. Distribution of acreage among crops for eight South Georgia farmers

Farmer/ County	Cotton	Peanut	Corn	Wheat	Pecan	Sweet corn	Snap beans	Green pasture	Fallow	TOTAL
1/M	????	????								2000
2/M	????	????								4400
3/M		????				450				3000
4/M		200	1350		650	1000			250	3450
5/D	2400	900								2300
6/D	2100	900								3000
7/D	1700	300	115	300			85	200		2690
8/D	2100		150				80			2330

M=Mitchell County, D=Dooly County; ???? = Farmer grows crop but did not specify acreage.

- Labor

Although most farming operations are highly mechanized, some farmers employ a few (2-4) laborers during the entire year and hire a few more seasonally, such as, for harvesting cotton. But finding laborers can be difficult, which forces farmers to invest in equipment, such as tractors and harvesters which can help speed up operations.

Organizing and allocating labor time and machinery among different fields and crops can be challenging, especially as climate variability shrinks the optimal planting and harvesting windows. The labor requirements for cotton limit the farmer's ability to diversify by growing other crops. For example, cotton farmers do not grow wheat or soybean, because they mature before cotton, therefore delaying the cotton harvest. Sweet corn also competes with cotton operations. Bottlenecks may also occur between peanut, corn, and cotton, especially if a cool spring climate does postpone planting of peanut and corn so they cannot be harvested before cotton is mature.

Availability and cost of labor remains a major constraint for vegetables, green bean, and sweet corn operations, which all require considerable manual labor. Formerly, a vegetable farmer in Dooly County employed as many as 40 to 160 people between April and August, but he quit producing vegetables because the many labor and health regulations were costing him too much time and money. This made it more difficult to compete with foreign vegetable producers who have access to cheap labor. He reported that, after he stopped producing vegetables, his production costs declined by \$20,000 per year: he used those savings to increase his crop insurance coverage.

A Mitchell County sweet corn farmer hires a crew of about 50 Haitian seasonal migrants for harvesting corn. He finds that Haitian laborers are able to work all day during the hot summer

months, whereas American laborers cannot. But, since they are paid by the crate, they may refuse to work when conditions slow them down, such as when plants are knocked to the ground by wind.

The crew works for the farmer's business partner in South Florida: once they finish harvesting in South Florida, they move north to Georgia, and then continue to Missouri, Kentucky, or Michigan. But climate variation affects the availability of such labor. For instance, if it is unseasonably warm in Florida, laborers finish harvesting in Florida and begin arriving in Georgia earlier than usual. Harvesting early enables Georgia farmers to take advantage of better prices, which peak shortly before Memorial Day. But some migrant families wait to leave Florida until early June, when their children are out of school (it may be worth exploring this relationship between school year and labor availability).

- Irrigation

Irrigated crop area has increased dramatically in South Georgia during the past 20 or 30 years. In the counties visited, water for irrigation is widely available. Even during the multi-year drought in 1998-2000 there was enough water for irrigation and nothing grew in fields without irrigation during those years.

Farmers interviewed had 50 to 90% of their land under irrigation. One farmer explained that one needs to have at least 50% of landholdings under irrigation to make a profit or even to secure a loan from the bank. The limiting factors to irrigation are costs of fuel, equipment, and infrastructure. Currently, it costs about \$20,000 to dig an irrigation well. Recent increases in fuel prices from \$0.40 per gallon in 1998 to more than \$2 per gallon in 2005 are severely eroding profit margins. Given the relative abundance of ground water, farmers are more concerned with minimizing fuel costs than they are with optimizing water use efficiency.

Large center-pivot irrigation systems cover 220 acres; smaller ones cover 120 acres. During the growing season, farmers monitor crop conditions and follow weather forecasts closely to make decisions about irrigation. During most of the growing season crops need about 2 inches of water per week, but, if temperatures are very hot farmers may irrigate continuously.

In addition to supplying crop water needs, farmers also use apply fertilizers through their irrigation systems, which distributes fertilizers more evenly through the field than do other application methods. If fertilizers are applied to the soil surface, they are subject to runoff if rains are heavy, which does not occur for fertilizer applied through the irrigation system. Irrigation may be also used during periods of low temperature to prevent frost or freezing damage, or during periods of heavy winds to prevent wind-blown sand from covering and killing young plants, which is called *sanding*. Sanding has become a worse problem over the past 2 decades because many of the tall trees, especially long leaf pines, have been cut from surrounding fields, so that few trees remain to slow winds. Because of its high cost, irrigation is largely used for crop production, but a few farmers are beginning to irrigate pastures as well.

- Equipment and infrastructure

New technologies help farmers speed up planting and harvesting operations, which is particularly advantageous in case of late planting. For example, using a GPS guiding system, an auto-steer tractor can cut planting time in half. At the same time, the heavy financial investments in equipment and infrastructure reduce farmers' flexibility to respond to changing conditions. As an extension professional put it, capital-intensive operations are like 'battle ships' set on a determined course that cannot be turned at short notice. Farmers borrow large amounts of money

to invest in equipment and infrastructure, often with only 5 or 6 years to pay off the loan. Therefore, they must use the equipment in which they invest and may not be able to grow the crops they grow, even if climate or price outlooks indicate that returns may be poor. Equipment investments are particularly constraining for machinery that cannot be used for other crops, such as a cotton harvester that costs about \$350,000.

Similarly, a farmer cannot start growing a new crop without the necessary infrastructure for that crop. Availability of drying, cooling, and storage facilities determines whether and how much of a crop a farmer may grow. The availability of processing facilities, such as vegetable canneries, peanut shellers, cotton gin, also affects whether a farmer can cultivate a new crop.

Though equipment investments carry large inertia with respect to selection of crops to cultivate, a Mitchell County farmer with landholdings of about 2000 acres responded positively when questioned whether he could use climate forecasts in making production decision, commenting: "I am not so big that I cannot change". Future research should be conducted to identify the thresholds and conditions at which farmers lose such flexibility relative to their investments, debt burden, markets, and other factors.

- Disease

The experience or threat of disease affects farmers' decisions. For instance, in the 2005 season many farmers in Mitchell County experienced losses from fungal diseases (early and late leaf spot, limb rot, and white mold), and tomato spotted wilt virus (TSWV). The disease has been around for about 15 years, having come to the region from Louisiana, but has gotten much worse in recent years. Farmers try to prevent it by beginning to spray early and continuing to do so frequently (as one farmer put it 'behave as if expecting the worse case scenario'). This can mean applications every 10-14 days beginning 15 days after planting. This strategy, however, may be hindered by heavy rains, since one may not be able to move around in the field and chemicals may be washed off.

Another option adopted by some farmers is to move up the planting dates. A farmer reported delaying planting peanuts until mid-May (as opposed to mid-April as they used to do). Nonetheless, his peanut crop was hit with TSWV. Couple with the effect of heavy rainfall in June and July, the virus caused a loss of about 30%-40% of the crop, which dropped from an average of 5000 lb/acre to about 3400 lb/acre.

From 2001 to 2004, Sumter County experienced a growth in soybean acreages, which grew from 1600 to 8400 acres. But in 2005 acreage fell to 4600 because of the threat of the Asian soybean leaf rust, which had affected neighboring counties. According to a respondent, extension recommendations emphasized the threat to an extent that farmers were too afraid to plant it.

- Production costs

Most of the farmers interviewed complained that farming is becoming increasingly unprofitable, not only because the negative impacts of climate and disease, but also because production costs keep increasing while commodity prices continue to decrease. Farmers use large quantities of fuel to operate machinery, irrigation pumps, etc., so raising fuel prices seriously reduces their profit margins.

Improved cultivars helps farmers to address some problems, such as weeds, diseases, and storms (e.g. storm resistant cotton), but these technologies also increases production costs. For instance, most cotton farmers grow Bt cotton, which entails paying a 'technology fee' to

Monsanto. The price of Bt cotton seed is set at different levels in various areas, according to what the market will bear. But farmers must sign trading agreements with Monsanto that prevents them from shopping around. When farmers planted earlier varieties, they planted extra seed to assure good stands, but now they calculate and plant the minimum amount of seed and avoid replanting as much as possible.

The considerable expenditures required for sweet corn production deter some farmers from growing it. Sweet corn appearance determines its marketability and price; the highest rating, A-fancy, calls for almost flawless ears. To obtain such quality a farmer must maximize inputs and follow a strict schedule of cultivation, irrigation, fertilizing, and spraying. Given that sweet corn prices fluctuate widely, there is no guarantee that the farmer would be able to recover their costs. One Mitchell County sweet corn farmer calculated that it cost him \$700 per acre to grow sweet corn and \$1100 per acre for harvesting and packaging for a total of about \$2000 per acre. Because of low market prices when the crop was ready for harvest in 2004, he left 40 acres of sweet corn unharvested rather than selling below cost of production. If a climate outlook was not positive for sweet corn, he might have planted peanut instead, which has a smaller potential for profitability but requires less of an investment.

- Commodity prices

Since the 1970's, commodity prices have been declining, shrinking farmers' profits. Several farmers interviewed consider the low prices and volatile markets of commodity crops a greater problem than climate variability, because the latter can be remedied to some extent by irrigation. In fact, a farmer commented that crops do better with irrigation than with rain, because water allocation can be better controlled.

Although cotton benefits from government payments, the current price of \$0.52 per lb (about \$260 per bale) is too low to adequately compensate farmers for the costs and risks they face. A Dooly County farmer estimated that he would be more inclined to invest or take risks if the cotton price was at least \$0.75 per lb. Cotton prices are also affected by climate and market conditions in other producing states (Texas, Arizona) and countries (India, Thailand, Brazil). International trade agreements and internal policies within China (the largest buyer) also influence cotton prices on the world market. Finally, price fluctuations may occur without apparent reason as a result of speculators in the futures market.

Farmers try to reduce risks by getting information as early as possible from brokers and from farmer-oriented media. A Dooly County farmer and his brothers employ a 'market scout' all year around. When the price reaches his 'target' price he 'locks-in' a certain number of bales. This means entering a contract with a broker, whereby the farmer commits to deliver that number of bales at that price at harvest time (the broker is paid a percentage of the sale price). Because price can continue to fluctuate, the farmer does not contract for all of his expected production all at once, but in installments, hoping to get the maximum average price. Moreover, the farmer does not enter into contracts for his total expected production because, if factors beyond the farmer's control lead to yield losses and his production is less than his total contract obligations, he will have to buy cotton at the going market price to make up the difference.

Among other row crops, none is highly profitable. Among them peanut gives the best returns, though not as good as previously because of declining yields and prices and the reduction in subsidies. The current price for peanut has fallen from \$680 per ton in the 1990s to about \$350. According to one of the farmers interviewed, with corn one can at best break even. Georgia farmers are disadvantaged in competing against Iowa and Illinois, where corn is

produced in larger scale and pests are less of a problem. In Mitchell County, where sandy soils dominate, growing corn requires intensive irrigation and input of N fertilizer. Wheat and soybean give equally poor returns.

The low profitability of alternate row crops leads some farmers to skip rotations and grow cotton or peanut year after year, even though yields decline. One farmer interviewed estimated that he needs to produce at least 900 lb per acre of cotton to break even. But another commented that the threshold depends on the level of investment, debt burden, government payments, and other factors. For peanut, the threshold is said to be 3000 lb per acre.

Vegetable production can be very profitable but prices are more volatile than row crops and are affected by competition from Florida, where they are harvested earlier than Georgia, and Central America, where labor is less expensive. With sweet corn “one can either make or lose a lot of money,” as one farmer put it. For example, a crate (48 ears) used to sell for \$7.35 but at the time of the interview in January 2006 it sold for only \$4.35. Sweet corn has very narrow marketing window, with prices being highest before Memorial Day and the Fourth of July, and lowest around mid-June. Farmers stagger planting to take advantage of different marketing opportunities, but are constrained by the availability of manual labor required for harvesting.

- Credit

Banks credit may be extended for some crops but not others, and will have a significant impact on the crop farmers choose to plant. For instance, one Dooly County farmer reported that he grows peanut as a rotation crop only because he needs to plant a legume in his rotation, but cannot get a loan for a other legume crops. This situation forced him to plant peanut two years on a row, which led to a decline in yields and a financial loss so that he had to sell some equity to repay the debt.

Future research should be conducted to establish both the potential role of climate forecasts in credit decisions, as well as how lending institutions establish their policies regarding crop loans.

- Insurance

Crop insurance availability and options also affect planting decisions and should be further investigated. For instance, while insurance is available against hurricanes, hail, and other risks, there are no insurance products available against generalized wet conditions such as those that led to increase plant disease and depressed yields of peanut in 2005.

In some cases, farmers respond to climate anomalies by increasing their insurance, but this means adding the greater premium costs to the already large burden of production costs.

- Government payments

Farmers talked often about government subsidies in explaining their planting decisions. For example, one Mitchell County farmer began planting sorghum because he could get government payments for that crop. Another decided not to grow peanuts because the government payments were not sufficient for the crop.

One farmer commented, “If it wasn’t for government payments, we would be out of business.”

We need to learn more about how the subsidies work and how they play out in farmers’ decisions against other factors, such as costs, climate, and labor.

Potential Management Responses to Climate Forecasts

The following strategies were mentioned by respondents or derived from their statements.

If there is a high probability that rainfall will be below average, farmers would:

- Reduce expenditures as much as possible.
- Increase insurance coverage.
- Ensure irrigation equipment is in working order and funds are available to purchase fuel.
- Delay planting to minimize the risk of long dry spells after planting.
- Plant crops that benefits from better insurance coverage and subsidies which can make up for yield reduction.
- Plant drought tolerant varieties or crops if available.
- Plant more ‘vigorous’ varieties that establish root systems faster.
- Reduce or eliminate nitrogen applications.
- Stretch out pesticide and fungicide applications because less is needed if it does not rain much and to minimize costs.
- Defoliate and pick cotton incrementally in order to preserve soil moisture by keeping soil covered by foliage.
- Reduce the total amount of crop under contract if they expect a yield shortfall or price hike.

If there is a high probability that rainfall will be above average, farmers would:

- Plant peanut rather than sweet corn in fields that do not drain well.
- Plant less peanut in heavier soils.
- Cut back on spraying chemicals to avoid waste and save money.
- Adjust contracts to lock in a good price if a market glut is expected

If there is a high probability that temperatures will be above average, farmers would:

- Plant less peanut and more cotton because peanut is easily stressed by heat, whereas cotton performs well under high temperatures.
- Buy chemicals ahead of time to control white mold in peanut. These chemicals are expensive so farmers do not buy them unless they really need them, but the chemicals are also less expensive when purchased early rather than during a period of high demand.

If there is a high probability that temperatures will be below average, farmers would:

- Buy a less expensive, more generic fungicide for peanut rather than white mold specific fungicides, which are more expensive.
- Avoid planting a cover crop if a cold spring is expected.

If there is a high probability that storm frequency, including hurricanes, will be greater average, farmers would:

- Plant storm resistant varieties, i.e., those resistant to lodging.
- Wait to defoliate cotton because leaves provide some protection of unharvested cotton from rain damage.

If there is a high probability that winter conditions will be mild, farmers would:

- Prepare to buy and apply more pesticides and herbicides.

Sources of Information

Weather and climate

Farmers are keenly interested in weather information and check it daily, sometimes several times a day, during the growing season. Older farmers consult the Farmers' Almanac, but local TV and radio stations are by far the most common sources of weather information. Respondents also mentioned receiving forecasts through CNN and the Weather Channel. One farmer gets text message updates from Weather.com on his cell phone.

Some farmers use computers for e-mail. Familiarity with the internet is more common among farmers younger than 30-35 years of age, who grew up at a time when personal computers were becoming more common. A few farmers reported consulting the NOAA website. None of those interviewed were aware of *AgClimate*.

A few large farmers use Data Transmission Network (DTN) technology, which provides regular updates on weather, commodity prices, etc. DTN is a private company based in Omaha, Neb., and is the leading business-to-business provider of real-time information services, including weather info and commodity prices. But the price of the subscription at several hundred dollars per year is a constraint for some farmers.

Farmers interviewed mentioned calling the extension office or nearby agricultural research station for climate information. A few larger farmers also hire consultants to advise them on pest management and other technical issues, and may discuss climate-related issues with them.

Ag-America has funded the establishment of several AEMN weather stations in its areas of operation in Byromville, Unadilla, and Vienna (Dooly County) and in Arabi and Hatley (Crisp County). Farmers are very keen on getting the stations near their farm and several would be willing to pay for them because it helps them document losses for insurance claims. Insurance companies tend to rely on average rainfall for the county, without taking local variability into account. Some years ago, farmers lost cotton to a freeze because it was too cold to defoliate in time for harvesting. They used rainfall and temperature data from the Cordele station to make their case to the insurance companies.

In addition to scientific information, farmers rely on their own experience for clues on weather and climate. Among traditional forecasting indicators used by older farmers, some mentioned expecting perturbations, especially drought, during years that have 13 lunar cycles. One Mitchell County farmer recalled that the area suffered droughts in 1977, 1980, 1986, all of which had 13 moon cycles. Older farmers also observe the weather during the 12 days after Christmas. Each day corresponds to a month of the year and what happens in that day predicts how the weather will be during that month. It is unclear how many farmers rely on such indicators and whether they used them in making decisions, but some respondents said that older farmers still use these traditional methods.

Technological innovations

Extension services are a primary source for information on new technology, particularly new crop varieties, chemicals, scheduling, and management practices. Generally farmers

interviewed commented positively on UGA research and extension, but we should treat these comments with caution because respondents were contact farmers or were identified through extension agents, some of whom were present during the interviews. An extension agent commented that, because farming has become increasingly risky and unprofitable, farmers have become more open to what research has to offer.

One farmer said he never adopts a new variety unless he knows it has been tested in field trials over a number of years. Another cautioned that experimenting in small plots is different from managing a whole farm. Short-term tests may also be deceiving: for instance, the Georgia King cotton variety was tested successfully for two years but it did not do well on the farm.

Some extension agents adjust researchers' recommendations based on their experience on the ground and knowledge of local conditions. For instance, researchers recommend planting peanut by May 10, but an extension professional maintained that when planting on irrigated fields, farmers must be more flexible and plant whenever the soil is moist and the temperature is warm.

Agricultural programs on radio and TV, farmers' magazines, and websites are sources of technical information. A young farmer with a M.Sc. degree regularly searches the web for information on new cultivars, treatments, and management practices.

Technical information is also provided by private seed and input companies, but farmers do not trust them entirely as they understand that companies seek to maximize their own profits. However, farmers carefully read labels of chemical inputs as they realize that mistakes can seriously affect family health and income.

Informal interactions also play a key role. Farmers who participate in trainings or workshops may pass information to others during farmers' meetings, community events, or other venues where farmers gather, such as equipment dealerships, repair shops, and farm stores.

Personal networks also serve as channels of technical information flow. One farmer learned about sweet corn from hunters from California who patronized his hunting estate. While visiting his in-laws in South Florida, he met another farmer who became his business partner and taught him the technical aspects. South Georgia farmers have had long-standing links with South Florida farmers, who buy land in Georgia to take advantage of seasonal differences. Farmers from the Midwest also buy land and bring their crews to Georgia, to grow cold season crops (cabbage, zucchini, arugula, etc.) in time to capture the early market and higher prices.

Farmer cooperatives and organizations, such as sweet corn and green bean farmers associations, may channel technical information to their members. But generally associative life in South Georgia is weak compared with other areas. One farmer explained this in terms of the ethnic origins of white farmers in the area, who are mostly of Scottish, English, and Irish descent, with a strong individualistic orientation, unlike Midwest farmers who derive a strong tradition of cooperation from their Scandinavian origins.

Most of all, farmers trust their peers. They observe what their neighbors are doing and, if it piques their interest they will discuss their neighbor's operation. Farmers like concrete examples and demonstrations rather than abstract concepts. Therefore new information conveyed through the personal experience of other farmers, particularly individuals who are known and respected in the community, may be better received than information presented through lectures by outside experts. Farmers take time to trust someone or something new and prefer a more indirect style of social interaction. Typically, it is best to start talking about the weather and general issues before introducing the reason for a visit. This means that it may take more than one exposure for farmers to become receptive to the new technology.

Commodity prices

Price is one of the key determinants of planting decisions with respect to what crops to plant and how many acres, so farmers follow market trends very closely. As for other kinds of information, they follow agricultural and market programs on radio and TV (e.g. Georgia Farm Monitor) and subscribe to bulletins and magazines.

Commodity brokers also provide information and some farmers employ 'market scouts' to monitor price fluctuations, not only locally but elsewhere as well. Cotton prices in Georgia are affected by what happens in competing states, such as Texas and Arizona, and even in other countries, such as China, India, Brazil, and Thailand.

Information Needs

Farmers are generally more interested in short-term (1 to 5 days) weather forecasts than in long-term seasonal forecasts. One farmer said he has no confidence in long-term predictions. Except for a young farmer with a M.Sc. in agronomy, who directly referred to El Niño, most farmers discussed weather events and weather forecasts, rather than longer-range prediction.

A young farmer was given a short demonstration of *AgClimate* tools and reacted enthusiastically to most tools and information presented. However, in the case of probability-of-exceedance graph, he commented that the minimum amount of rain one needs at any given time largely depends on what happened previously. For instance, if it had rain between January and April, even 2-3 inches of rain spread throughout the month of May would be enough for planting.

Predictions for rain and wind are especially important when farmers apply fertilizer and other inputs. Rain can wash off expensive chemicals; heavy rain and violent winds may cause fertilizer to spread irregularly in the field, causing yield losses and uneven quality, which adversely affects prices. Information about rainfall is particularly useful when cotton is blooming because, at that stage, it requires a lot of water. If drought is predicted, farmers can prepare to irrigate. Precipitation forecasts are also crucial when farmers are getting ready to harvest peanut.

Winds can be more damaging than excessive, untimely, or insufficient rainfall. A crucial piece of information is whether the year is prone to thunderstorms and hurricanes, which can be destructive and disruptive. For instance, when hurricanes hit Florida, South Georgia experiences heavy rain and strong winds. In September 2004, Hurricane Ivan brought winds 70-90 mph to Mitchell County. One farmer interviewed lost 70% of his cotton crop.

Monitoring of soil temperature is important prior to planting peanut. It is recommended to plant after the average 4-inch soil temperature has reached 65°F for three consecutive days or longer.

For cotton, air temperature is crucial estimating the rate of crop development. Cotton plants grow more slowly on cool days than on warm days. Temperature measurements during the cropping season help farmers to estimate when their crop reaches a specific developmental stage. Heat units or degree days are used to estimate the accumulated effects of temperature, based on the averages of daily maximum and minimum temperatures.

In addition to local conditions, farmers are also interested in climate conditions in competing states, especially Florida, Texas, Arizona, and California. One sweet corn farmer pointed out that climate in Florida affects his profits more than the climate in Georgia, because Florida has such a big share of the market. Hot humid conditions in South Florida cause a market

glut. When many hurricanes disrupt production in Florida, such as in 2005, Georgia farmers have a ‘good’ year.

SUMMARY OF IMPLICATIONS FOR AGCLIMATE AND THE SECC

- Climate and yield predictions can help inform farmers’ decisions and improve their ability to minimize risk and increase profits if delivered in a user-friendly format and in timely fashion. But information must be delivered timely (planting decisions are made by Dec-Jan).
- The crop development section in *AgClimate* is a response to in-season forecast needs enunciated by farmers. Because rainfall conditions at the time of cotton flowering affect crop yields, farmers might benefit from the development of a prediction tool for cotton phenology.
- Farmers know that the minimum rainfall required by crops at various stages depends on how much moisture is retained in the soil from previous rainfall. A soil water balance tool could help blend climate and weather into the *AgClimate* crop development tool.
- Farmers are interested in knowing whether the year is prone to thunderstorms and hurricanes, which can destroy crops or disrupt farm work. An explanation of the link between El Niño/La Niña phases and the occurrence of hurricane landfalls would be useful.
- Temperature is very important for sweet corn and vegetables. Information on temperatures (e.g. the likelihood of mild winters, cool springs, or hot summers) can help farmers make decisions about crop and varietal choices, time of planting, chemical input application, and conservation practices.
- Forecasts can play a role in the overall suite of information that a farmer uses to make decisions. But revenue potential, determined by the combination of crop prices, government payments, and insurance coverage, remain the most important factors that farmers consider in deciding which crop and how much of each crop to plant. .
- Climate-based technical recommendations on when to plant must include or be linked to information on commodity prices and an understanding of the market window that farmers want to target through their planting decisions.
- Farmers are interested in climate information in competing states, and even about anomalous conditions and events in countries that may influence world prices of crops they grow. *AgClimate* could include links to sites that give such information.
- Rising fuel and other input costs are one of the greatest challenges for farmers. Any tool or information that helps reduce costs and optimize efficiency in irrigation or input application would potentially be of great financial/economic benefit to their operations.

- Extension continues to be a key source of information for farmers. Technical consultants may also adopt *AgClimate* tools to serve their clients. But there is a considerable variation among agents in their ability to use computers, and therefore *AgClimate* tools.
- In order to directly target farmers, *AgClimate* tools may need to be presented in less technical terms and translated into a simpler language. Case studies, possibly enriched by personal narratives and photographs could help attract attention and built confidence among farmers.
- Online connection and computer use are common among younger farmers. *AgClimate* could be enhanced by links to relevant sites, e.g. for weather forecasts, commodity prices, and technical information. We should ensure that links to *AgClimate* are added to other sites that are likely to be visited by potential users.
- Farmer-to-farmer communication, led by individuals who are well known and respected in their communities, or by young people who are computer literate and have a farming background, is an important avenue for dissemination and capacity building. Practical demonstrations are likely to be more convincing to farmers than lectures by experts.
- Social marketing strategies could enhance the visibility of *AgClimate* in farmers' communities. Outreach efforts could take advantage of existing social networks and organizations. Farmer-oriented TV and radio programs could be used to advertise *AgClimate* and simple inexpensive brochures could be distributed where farmers gather.
- Because farmers feel that their production systems have become increasingly risky and unprofitable, they have become more open to the application of new research findings. But, farmers are aware that results of short-term tests may be deceiving. They are only likely to adopt *AgClimate* products after evidence of good results over several years.

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APPENDIX 1

Table 1. Farm size. Source: USDA-NASS, 2002.

	Median farm size (acres)	Average farm size (acres)
Dooly	228	524
Mitchell	174	373
Sumter	174	437
Georgia (TOTAL)	100	218

Table 2. Cotton production in 2004. Source: USDA-NASS web site
http://www.nass.usda.gov/Statistics_by_State/Georgia/index.asp#.html.

	Harvested area (acres)	Average yield (pounds/acre)	Total production (bales)
Dooly	80,800	574	96,600
Mitchell	45,900	851	81,400
Sumter	32,900	584	40,000
Georgia (TOTAL)	1,280,000	674	1,797,000

Table 3. Peanut production in 2004. Source: USDA-NASS web site
http://www.nass.usda.gov/Statistics_by_State/Georgia/index.asp#.html.

	Harvested area (acres)	Average yield (pounds/acre)	Total production (pounds)
Dooly	11,300	2745	31,000,000
Mitchell	27,700	3485	96,500,000
Sumter	10,200	2845	29,000,000
Georgia (TOTAL)	610,000	3000	1,830,000,000

Table 4. Corn production in 2004. Source: USDA-NASS
http://www.nass.usda.gov/Statistics_by_State/Georgia/index.asp#.html.

	Harvested area (acres)	Average yield (bushels/acre)	Total production (bushels)
Dooly	1,300	144	187,000
Mitchell	13,500	178	2,403,000
Sumter	6,500	150	978,000
Georgia (TOTAL)	280,000	130	36,400,000

APPENDIX 2

Ranking of 2002 market value of agricultural products sold in Georgia

Item	Farms	Sales (\$1,000)	Rank by Sales	Percent of Total Sales
Total sales	49,311	4,911,752	N.A.	100.0
Poultry, eggs	3,883	2,780,214	1	56.6
Vegetables, melons, potatoes, sweet potatoes	1,715	383,556	2	7.8
Cotton and cottonseed	3,206	318,013	3	6.5
Nursery, greenhouse, floriculture, sod	1,199	315,324	4	6.4
Other crop, hay	7,691	246,936	5	5.0
Cattle, calves	18,770	240,070	6	4.9
Milk, other dairy products from cows	517	212,720	7	4.3
Fruits, tree nuts, berries	3,611	122,151	8	2.5
Grains, oilseeds, dry beans, dry peas	3,828	102,464	9	2.1
Tobacco	822	89,058	10	1.8
Hogs, pigs	995	65,384	11	1.3
Horses, ponies, mules, burros, donkeys	2,677	16,573	12	0.3
Other animals, other animal products	433	9,944	13	0.2
Aquaculture	159	5,310	14	0.1
Cut Christmas trees, short-rotation woody crops	188	2,095	15	N.A.
Sheep, goats, their products	1,792	1,940	16	N.A.

Sources:

http://www.nass.usda.gov/census/census02/topcommodities/topcom_GA.htm

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