NORTH FLORIDA DAIRY FARMER PERCEPTIONS TOWARD THE USE OF SEASONAL CLIMATE FORECAST TECHNOLOGY

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Abstract. Evidence of increasing nitrogen levels in the Suwannee River Basin in North Florida demands a collaborative effort to find creative ways to reduce N pollution. This study explores the perspectives, perceptions, and attitudes of dairy farmers regarding adoption of climate forecasts as a potential way to mitigate the problem. These farmers are heavily scrutinized because of their nitrogen emissions. By contrasting scientists' pre-conceived attitudes about the usefulness of ENSO-based forecasts with dairy farmers' perceptions, gathered in a participatory and consensual manner, valuable lessons were learned. A deeper understanding of the day to day realities of dairy farming systems help researchers pinpoint management adaptations that are not only useful, but feasible, in light of improved seasonal climate forecasts. Furthermore, dairy farmers' perceptions regarding the use of seasonal climate information to mitigate the nitrate problem are critical for designing future dairy systems.

1. Introduction

Several federal and state agencies including the National Oceanic and Atmospheric Administration (NOAA) predict long term seasonal climate variability fairly accurately (O'Brien et al., 1999). These predictions are based upon the El Niño Southern Oscillation (ENSO) phenomenon that determines El Niño, La Niña, or Neutral years, each of which is associated with characteristic rainfall and temperature patterns in the study area. The Southeast Climate Consortium (SECC) of six universities from Florida, Alabama and Georgia, (http://secc.coaps.fsu.edu/) sees evidence that seasonal, ENSO-based climate forecasts can be used to help reduce the problem of increasing nitrogen levels in the Suwannee River Basin in north Florida (Cabrera, 2004).

The Suwannee River Partnership (SRP), an association of more than 50 organizations including federal, state and local agencies, dairy farmers and the Cooperative Extension Service of the University of Florida dealing with the issue of water nitrate contamination in north Florida, was approached by SECC researchers to ascertain their interest in potential applications of seasonal climate forecasts to the problem of N leaching. The SECC and the Partnership found common ground to use

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research to potentially ameliorate increasing nitrogen levels in the basin by using ENSO-based forecasts.

This study explores the perspectives, perceptions, and attitudes of dairy farmers regarding the potential adoption of seasonal climate forecast technology as a potential way of mitigating the problem. Information gathered from farmers in a participatory and consensual manner is contrasted with scientists' notions of the value and applicability of ENSO-based forecasts in the dairy area. One perception common to climate researchers is that documenting the impacts of ENSO thoroughly or reporting climate forecasts is enough for societal benefits to ensue. However, other elements, such as the existence of adaptive actions in response to climate information, the understanding of the probabilistic nature of seasonal climate forecasts, the knowledge of the expected impacts of using forecast information in terms of specific, yet diverse production systems and the potentially negative impacts if forecasts are wrong, should be understood and overcome for society to benefit (Glantz, 1979, 1986; Katz, 1997; Pielke, 1997). These elements can best be uncovered through continuous interaction with potential end-users, in this case, those involved with different aspects of dairy production.

Previous research has shown that crop yields are impacted by ENSO phases in this area (Mavromatis et al., 2003; Hansen et al., 1998) and yields depend on nitrogen uptake of plants. Consequently, N leaching, the difference between N in the soil and N uptake, is also impacted by ENSO climatic changes. More specifically, N losses from forage crop rotations on a dairy farm in the study area have been shown to be influenced by inter-annual climatic variability (Woodard et al., 2002). Woodward's study lasted four years (1996–1999), and even though it included one El Niño phase (1997–1998), one La Niña phase (1999–2000) and two Neutral years, it does not provide enough information to generalize results according to ENSO phases.

By using baseline information from Woodard et al. (2002), biophysical crop models of the Decision Support System for Agrotechnology Transfer (DSSAT v4.0; Jones et al., 2003), and a whole dairy farm model, Cabrera (2004) was able to simulate the most common forage rotations in the study area, categorize N leaching according to ENSO phases, and propose ENSO-based dairy management strategies to reduce N leaching. Overall results from Cabrera (2004) indicate that dairy farmers could decrease N leaching mostly by selecting adequate forage rotations in the sprayfields and pastures. The best pasture to prevent N leaching was Bermudagrass, which can also be used in sprayfields strip planted with corn. Also, decreasing crude protein levels in cow diets and increasing the time milking cows spend on pastures would help to reduce N flows towards water resources. During El Niño events, when much higher N leaching risks exist, in addition to these longer term adjustments, farmers could consider a heavier voluntary culling rate to reduce the number of cows, export manure, rent additional pasture land, or modify the waste management system. During La Niña events, when lower N leaching risks existed, farmers could consider maintaining business as usual.

This paper discusses perceptions of dairy farmers regarding the usefulness of climate forecasts for mitigating nitrogen pollution in the Suwannee River Basin from dairy operations and compares these with the benefits perceived by Consortium researchers.

2. Materials and Methods

2.1. STUDY AREA

The Suwannee River Basin encompasses all of nine and parts of another six north-Florida counties, an area of 19,788 km^2. The area has 13 river basins and includes a human population of 285,000. Within this area, the principal focus for this study was on the middle Suwannee Basin that includes Lafayette and Suwannee counties. These two counties are where the nitrogen issue is acute. In the middle Suwannee River there are hundreds of residential and commercial septic systems in rural areas and some 300 row crop and vegetable farms. Finally, 44 dairies with more than 25,000 animals and 150 poultry operations with more than 38 million birds are in the area (Suwannee River Partnership 2003). Interviews and focus groups were undertaken in Lafayette, Suwannee, Gilchrist, Levy, and Alachua counties, where the number of dairy farms totals 64 (Figure 1).

2.2. THE SONDEO

A Sondeo was conducted between the months of January and February 2003 by a multidisciplinary team of eight graduate students from the University of Florida (Alvira et al., 2003). The Sondeo (Hildebrand, 1981) –sounding out– is a team survey method developed to rapidly and economically provide information about agricultural and rural problems. Sondeo team members represented a number of disciplines including agronomy, animal science, agricultural extension, natural resource management, forestry, and community development. Two to three-person sub-teams conducted initial transects and stakeholder interviews. The transects were "windshield" surveys of the area where the dairy farms are located to have an understanding of the general situation. The interviews were conducted as informal, open-ended conversations. After a sub-team introduced itself and explained the subject of the research, the stakeholder and the sub-team members conversed about any aspects of the topic that were relevant. This open-ended approach enabled topics to emerge and be pursued that might have been missed if the researchers had been constrained by a pre-formulated questionnaire. Despite the open-endedness, a set of core themes was discussed in almost all interviews. Notes were not taken by sub-team members during the interview. Following each interview, the sub-team members wrote individual notes, compared them, and then wrote a joint sub-team report for the interview. Finally, the joint sub-team reports were shared and

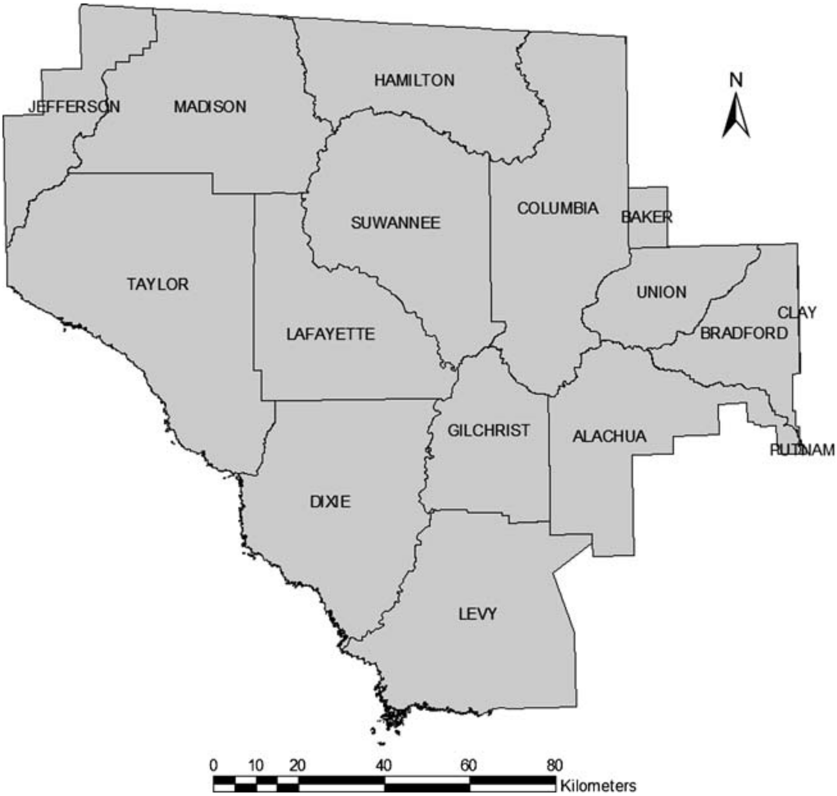

Figure 1. The Suwannee River Water Management District, the study area.

thoroughly discussed among all Sondeo team members. Each sub-team presented its findings, which could be clarified, challenged or contrasted with the results of the other sub-teams. This process of reporting and discussion served as the opportunity to begin noting trends, gaps in information, sources of initial inferences, and identifying new questions to pursue.

During the Sondeo, 13 stakeholders were interviewed. These stakeholders included federal, state, and local government personnel; university research staff, and farm representatives. This Sondeo was undertaken to get a better understanding of the broad issue of nitrogen pollution in water and collect the perception of stakeholders regarding this issue in the study area.

2.3. RECORDED INTERVIEWS

Personal interviews (Bernard, 1995) were undertaken with dairy farmers and/or dairy farm managers during the fall/winter seasons of 2003/2004. Open-ended interviews were targeted to a purposeful sample of 21 farmers (30% of the population).

The number of interviewees was chosen in order to attempt to capture the broad variability of dairy farms represented in the area in a collaborative manner with the Suwannee River Partnership and University of Florida Extension Service agents. A voice tape-recorder was used in every interview after requesting permission from the interviewee. Interviews included a series of topics, but emphasized farmers' perceptions regarding the potential use of climate forecasts to address the problem of N emissions by dairy farms.

2.4. FOCUS GROUPS

Eight focus groups (Bernard, 1995; Stewart and Shamdasani, 1990) took place with various stakeholders including Suwannee River Partnership members, Florida Cooperative Extension Service personnel, USDA technicians, and dairy farmers. The focus groups were held between November 2002 and February 2004. Focus groups were open discussions among five to 15 persons. Topics focused on perceptions regarding seasonal climate forecast innovation technologies as an aid to mitigate the problem of nitrate pollution.

Focus group participants ranged from specialists from official agencies such as the Suwannee River Partnership (SRP), the Suwannee River Water Management District (SRWMD), the Florida Department of Environmental Protection (FLDEP), the Natural Resources and Conservation Service (NRCS) from the United States Department of Agriculture (USDA), the University of Florida IFAS Cooperative Extension Service (CES), to private sector companies, technicians, and farmers. These participants were typically called to meetings by the Suwannee River Partnership and/or by extension agents from different counties in the research area in coordination with the main researcher.

2.5. ANALYSIS

This paper summarizes the results of all the above interactions in a descriptive manner. Names of the participants are not revealed to protect the anonymity of informants. Emphasis has been placed on a qualitative rather than quantitative description and comparisons of dairy farmers and other stakeholders' perceptions with researcher attitudes and findings.

3. Results and Discussion

3.1. PERCEPTIONS OF THE USE OF SEASONAL CLIMATE FORECAST TECHNOLOGY

Opinions about potential use of climate information by dairy farmers were divided. Of the 21 farmers interviewed, 14 (67%) mentioned that they would use improved

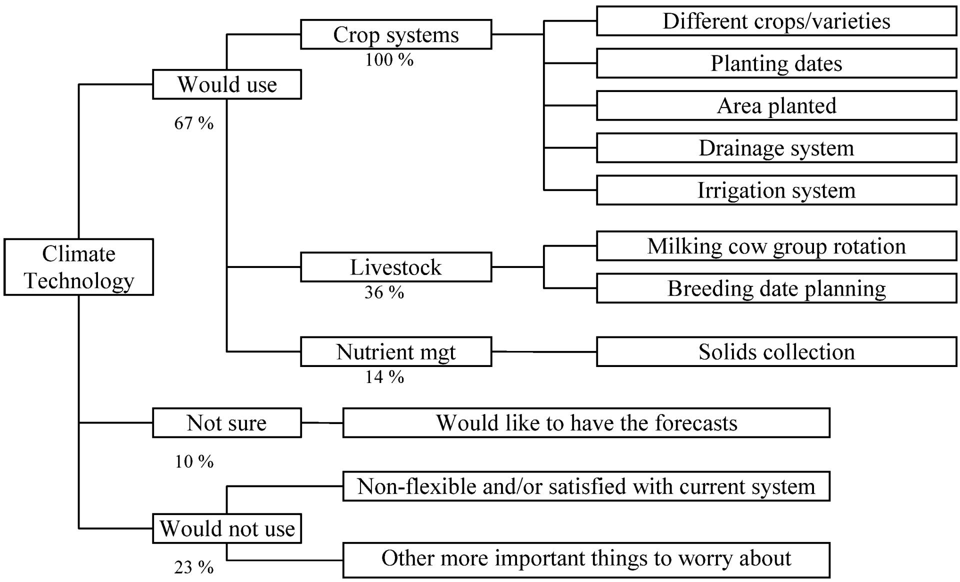

Figure 2. Farmers' perceptions of climate technology adoption.

forecast information, 5 (23%) would not use this technology, and 2 (10%) were not sure (Figure 2). Results from the Sondeo explain in part these disparate attitudes because while all farmers recognized nitrate leaching as a problem partially caused by agriculture, most thought that other sources, especially human waste, was a greater culprit than farming. It follows that if farming is not the primary polluter in their minds, climate information for adjusting management to reduce N leaching is irrelevant.

3.1.1. *Farmers Who Would Use Long-Term Climatic Forecast*

All 14 farmers who believe they would use improved long-term climate variation forecasts say that their main use of the information would be in planning crop systems. One producer mentioned he already uses ENSO phase information to plan the farm's crops:

> I make decisions every year based on my beliefs of if the seasons will be dryer/wetter, cooler/hotter. For example, for winter, if I expect an El Niño, I will plant oats because they do well in moist conditions. If it will be a La Niña, I will choose rye because it handles drier conditions much better. Of course, I will always plant ryegrass and clover, no matter what the climate prediction.

This farmer thinks that forecasts would also be useful for adjusting planting dates in order to obtain better yields and more N uptake. He has yet to implement this latter management strategy. Another farmer also uses long-term forecasts but not based on ENSO phases. He relies instead on the experiential knowledge of an old, experienced person who predicts the upcoming seasons in terms of wetter/dryer and colder/warmer. This in turn determines the crops to be planted. This farmer was very interested in the ENSO forecast information and tools and inquired as to its availability.

In the same manner as the farmer who already uses ENSO forecasts, all 67% of the farmers believe that the use of the forecast would be in crops. Mainly, the producers would use information for selecting crops for specific seasons and to change planting dates. For the winter season, oats and rye were mentioned several times as interchangeable crops. Ten farmers agreed that drier years (La Niña) are better for rye, and wetter years (El Niño) better for oats and/or ryegrass. However, two other producers mentioned that temperature is the most important variable for crop production in the winter, and that hotter winters with less chance of freezes (La Niña) would be better suited for oats. For the case of freezes, four farmers agree that if the prediction could address those events, they would be very useful because that would let them know how much crop production to expect in winter. Based on this they would adjust crop plans. For example, if there were going to be more than the typical 20–25 freeze days, winter forages would be affected. Therefore, they might plant more area in order to produce the required amounts of feed.

Climate forecasts for the spring and summer seasons would be more beneficial for planning the planting date for corn. Those who plant corn (12 farmers) say that the earlier it is planted, the better the results. If farmers know there will be little risk of late freezes, they could plant as early as possible, for example in the first week of March.

For the summer and fall seasons another important decision would be between planting a second crop of corn or sorghum. Three farmers mentioned they would plant a sorghum crop if they know that drier than normal conditions are expected, as it is a more drought-tolerant crop. Potential changes in choice of crops refer not only to different species, but also to cultivars within species.

Another group of informants mentioned an additional possible use of seasonal climate forecasts with respect to crops and potential N leaching. One farmer mentioned they could use forecast information to alter the area of planted crops. In wetter conditions area would increase. In drier (i.e., La Niña) seasons, less area would be sown. Another farmer mentioned that climate data would be useful for planning drainage systems, especially before a wetter season (i.e., El Niño). A further potential use mentioned by another farmer was in planning irrigation systems management. Although these systems are mostly fixed, farmers could make some adjustments in order to not increase environmental concerns, if they know what the seasonal climate would be like, especially regarding rainfall. Focus groups were especially valuable for bringing interesting discussion on potential adaptations to the table. As one or two farmers stated what adjustments they might make if a good seasonal forecast were available, others opened up and added additional activities that might be changed or just “tweaked” in light of forecasts.

Besides the use of forecasts for crops, another potential use of seasonal climate forecasts would be for livestock management. Three out of the 14 interviewees who would use the forecast elaborated on this issue. One farmer mentioned that she could plan her cow rotations differently. Holstein cows are very sensitive to "heat stress" calculated by an index that takes temperature and humidity into account. When the index is high, in hot and humid months, milk production is affected negatively and this impacts manure N excretion and consequently potential N emissions. If seasonal variability toward hot, humid conditions is known ahead of time she would be able to better plan the development of cow groups. This farm, like others, has comfort facilities where milking cows are protected from heat stress, that is, climate effect is diminished. However, on almost all farms, these milking cows spend part of their time outside. The farmer found it logical to think of planning ahead of time to provide the most protection time to the most productive group of cows.

Another decision that could be managed in light of climate forecasts is breeding time. This would be done by changing the number of cows entering the milking group in a certain season according to the forecast. For example, if a mild summer were expected, then the farmer would breed the cows in time to have more milking cows than normal in production for that summer when less risk of N leaching exists. Climate knowledge would allow higher than normal amounts of milk to be produced in summer and less N leaching risk in winter, especially El Niño winters. Similarly, decisions regarding purchases of replacement heifers could be improved based on expected climatic conditions. Typically, farmers buy replacements in the fall. If spring or summer were going to be colder, they could take advantage to buy less expensive replacements before those seasons.

An additional possible use of forecasts mentioned for livestock was for the winter season. Specifically seasonal climate forecasts would be used to anticipate colder than normal winter seasons, which are also detrimental for the cows. In those situations, farmers could plan ahead of time to have more forage (either planted or purchased) available. Extra amounts of fiber would help cows stay warmer.

Another two farmers mentioned the potential use of the forecasts for planning feedstocks. The inventory of feed is a major management task on dairy farms. Therefore, knowing climatic conditions ahead of time would be important for preparing feedstocks (either produced or purchased). For example, one farmer mentioned that if he knew ahead of time that the next season was going to be dryer (as in a La Niña phase), he would plan to have more forage for his heifers and dry cows. The farmer mentioned additionally that not only would it be good to plan for feed shortages, but also to plan for excess feed produced. Too much feed on hand is also a problem. If the predicted conditions for next seasons are good for forage production, then producers could plan not to buy feed. They could also sell feed in advance, or decrease acreage planted. This would be typical in El Niño years.

In addition to the use of forecast for crops and/or livestock, three farmers mentioned that the information could be used for improving the N and P waste management system of the farm. Waste management systems are mostly fixed, so major changes to this system are often not an option. Farmers usually change daily management based more on daily weather than long-term climate, however there are some things that could be planned as is the case for example of collecting solids or not from the waste management system. These farmers mentioned that if they know there will be wetter conditions, they would prefer to prepare the whole system to not collect solids because the pile of solids resulting from the collection would be difficult to handle under wetter conditions and would have a higher environmental risk. This change would mean that the effluent would have more solids in solution. Therefore, the irrigation must have higher pressure and the crops must be prepared to receive a slightly higher percent of N in the effluent. If they know that the conditions would be dryer than usual they would collect all possible solids from the waste management system and would decide how to apply them to farm fields.

This information gleaned from interviews was reinforced by qualitative data gathered during the Sondeo. In effect, the farmers understood that education on the issues and solutions, including effective transfer of climate forecast knowledge and technology, and other technologies are essential components of the implementation efforts of the technical working groups. During 2001 over 1000 farmers participated in such meetings. Gatherings included two row-crop growers' meetings, a forage field day, five dairy farmers' meetings, two poultry growers' meetings, a cattlemen's meeting (beef), and a large-scale growers' meeting. The Sondeo revealed that these meetings with high producer involvement would be important if climate forecasts would be incorporated into Best Management Practices (BMPs) by Partnership members.

3.1.2. *Farmers Who Would not Use Long-Term Climatic Forecast*

Farmers who mentioned they would not use seasonal climate forecasts as a technology to help in decision making argued that they have relatively "fixed" systems. In their rather tightly–bound systems, no changes in management need be planned. One farmer mentioned: "I am married to my system operation ... it works and I don't want to change anything that could mess things up." These farmers said that their decisions are based more on the short term. If they knew there was no rainfall predicted in the following week, they would cut hay. It is difficult for them to envision how they might change tasks months in advance. One producer noted: "unless something as disastrous as a hurricane is forecast, I would not do anything different." Another farmer argued "we have much larger problems to worry about. When we solve those other problems we might start thinking about incorporating climate forecasts in our planning." Another farmer was very convinced that:

> We are not going to change anything even if we know that a very abnormal season is coming. Even then, we would continue to do as we always have, that is, adapt to the weather conditions, making changes to respond to the weather conditions

Other farmers may share this farmer's skeptical view of the technology. Those who are naturally averse to change or have not been exposed to new technologies will exist. The Sondeo and focus groups revealed that all farmers want the general public to understand that producers are not trying to pollute the environment. Farmers only seek to earn their living and to do their best to protect the environment. These farmers expressed that they are already going above and beyond what is demanded of them by regulatory agencies and the general public. Therefore, climate forecast adaptations were a burden they were not willing to deal with because they felt their good will and ability to implement better practices was already taxed to the limit.

3.1.3. *Farmers Who are not Sure They Would Use Long-Term Climatic Forecast*
The two farmers in this category had never previously thought about climate-related management changes. They mentioned that the entire concept was completely new to them, so they would need time to digest the idea. Initially, however, they were not sure if they could incorporate seasonal climate forecasts into their decision-making process. Both these farmers mentioned that, even though they did not know if they would use the technology, they would like to be aware of the forecast to consider it in regard to their performance in the following seasons. Opinions gathered in Sondeos and focus groups suggested that activist groups go a little too far in raising public concerns about environmental issues. The argument was that farmers should learn about the climate forecasts and decide on their own whether or not to use them, and not let the use of these forecast products be forced upon them by media pressure.

3.1.4. *Comparing Scientists and Dairy Farmers' Perceptions on Climate Forecast Adaptations to Decrease N Leaching*
Many researchers have a long-standing notion that the ability to better predict climate will automatically produce benefits to diverse user groups (Messina et al., 1999). Because of agriculture's dependence on atmospheric phenomena, this sector has been a particularly targeted area for climate applications. Scientists have found crop models an especially amenable tool for using climate data as inputs to obtain measurable outcomes under different climate scenarios (Hansen, 2002; Jones et al., 2000). However, this reliance on crop models, that take into account rainfall, temperature, soil, solar radiation and other variables, has sometimes led to overlooking the realities farmers face in the field, and the system characteristics that make some types of production tightly bound and relatively inflexible.

Atmospheric scientists believed dairy farmers might adjust crop patterns in sprayfields, crop patterns in pastures, reduce protein in the diet, and reduce confined time in response to seasonal forecasts and environmental concerns. Scientists from the SECC also thought dairy managers could increase culling rates, export manure off the farm, rent additional land, and engineer adaptations in their waste management systems. Modeling approaches in the literature and in-house work supported these assumptions. The farmers, however, did not always agree with the

TABLE I
Scientists and dairy farmers' perceptions on climate forecast adaptations to decrease N leaching

	Perceptions of Applicability	
Potential adjustments or adaptations	Scientists	Farmers
Crop patterns in sprayfields	Yes	No drastic changes possible
Crop patterns in pastures	Yes	Only a certain percentage of total area
Planting dates	Not identified	Yes
Area planted to different crops	Not identified	Yes
Drainage/irrigation system	Not identified	Minor modifications
Breeding/cow group rotation	Not identified	Yes
Reduce protein in the diet	Yes	Risky
Reduce confined time	Yes	Only minor
Increase culling rates	Yes	Non-economic
Export manure off the farm	Yes	Not mentioned
Rent additional land	Yes	Not mentioned
Waste management system	Yes	Only minor modifications

practicality of management adjustments, especially large deviations from normal practice (Table I).

A social science, anthropological or human-centered approach using rural appraisals, informal conversations, semi-structured interviews, and focus groups allows researchers to ground model outcomes into user-based knowledge. For example, scientists might recommend a different level of protein in the diet to reduce N leaching in El Niño years. Dairy farmers, on the other hand, may find this management change infeasible because they need to maintain certain milk production levels that they think can only be reached with high protein levels. Another example is a researcher's recommendation based on model outcomes, to plant Bermudagrass in lieu of another species (Woodard et al., 2002). A dairy farmer might recognize the change as good for reducing N leaching, but may not be able to make the change because it is economically or financially infeasible.

4. Conclusions and Recommendations

The present study indicates that seasonal climate forecasts are not necessarily a panacea for dairy farmers. Seasonal climate, although of high importance to dairy management operations, has already been largely incorporated into current management schemes. It is unreasonable therefore, to expect major shifts in dairy farming systems in light of improved seasonal climate variability forecasts based on ENSO. Nevertheless, the fact that two-thirds of the stakeholders interviewed believe there is some value in the forecasts for production and environmental reasons confirms that climate forecasts have an important role to play in the overall decision-making and risk avoidance behavior of dairy stakeholders.

Dairy farmers in general would use seasonal climate forecasts primarily for crop management. This potential use of ENSO-based seasonal forecasts expressed by dairy farmers is consistent with previous reports (Cabrera, 2004). Although this is a useful finding and coincidence between producers and researchers, it leaves other management adaptations or system "tweaking" as merely potential technology shifts to be further researched in conjunction with end-users. Adjusting time in confinement, protein in the feed, and increased culling rates may not be possible because of system properties exhibited by the complex interplay of production, environmental regulation, economics, and other local living conditions and livelihoods.

Further research calls for the inclusion of seasonal climate variability forecasts into existing Best Management Practices experiments. Studies that explore the interaction between seasonal climate and nutrient overflow in dairy farm systems must be promoted. Farmers should be involved from the early stages of these research processes.

The main barriers for potential adoption of seasonal climate forecast technology by farmers are the "rigidity" of dairy farms and the lack of management resources. Agencies interested in delivering seasonal climate forecasts as an innovation must identify the narrow niches where they may be used based on the experience of others. The technology should be translated into clear and rapid management adjustments that farmers could apply without involving major system modifications.

The fact that some dairy farmer stakeholders have never before thought of the potential application of seasonal climate forecasts denotes a lack of awareness of available forecast innovations among the stakeholder community. Step one in any diffusion process, i.e., awareness of the existence of a given technology, is missing among some dairy farmers in the study area. Commitment to extension and outreach programs that make this information available to all networks of stakeholders and especially to dairy farmers is essential to the future success of incorporating climate-based management into overall schemes to reduce N loading into the environment.

The participatory process described in this study underscores the critical need to include farmers and other major stakeholders in every stage in order to assess real perceptions that will be used for consensual problem-solving. Its relevance is even higher when complex problems exist as is the case of the interactions of N pollution, its regulation, and the potential use of seasonal climate forecasts as a way to mitigate them.

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