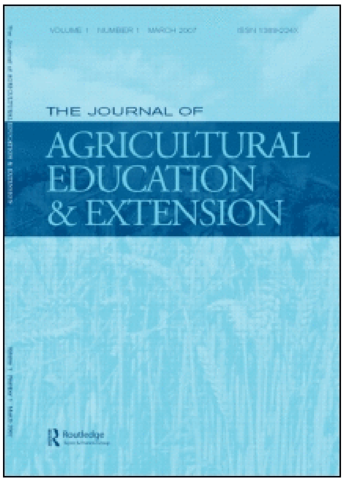

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Constraints and Suggestions in Adopting Seasonal Climate Forecasts by Farmers in South India

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Constraints and Suggestions in Adopting Seasonal Climate Forecasts by Farmers in South India

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ABSTRACT *The main objective of this study was to determine constraints and suggestions of farmers towards adopting seasonal climate forecasts. It addresses the question: Which forms of providing forecasts will be helpful to farmers in agricultural decision making? For the study, farmers were selected from Andhra Pradesh state of South India. One hundred and eighty farmers were interviewed to obtain information on problems and suggestions in adopting climate forecasts. Statistical data analyses (frequencies, percentages) were made to draw results. Absence of location specific climate forecasts followed by poor reliability and failure of the majority of climate forecasts, with poor extension service in climate prediction, forecasts in the media not answering operational needs and low conviction of climate prediction were the major problems reported through farmers. Provide location specific climate forecasts by improving infrastructure at village level, improve credibility of forecasts with proper accountability, improve accuracy of climate forecasts by frequent updating, making climate forecasts in the media relevant to operational needs and improve extension service in climate prediction with frequent visits by extension personnel along with use of different teaching materials and methods, were the different suggestions offered by farmers. This paper determines constraints faced by farmers in adopting climate forecasts, along with suggestions to overcome them. It is clear that participatory engagement to understand farmers' needs and adoption constraints is crucial to realizing the value of climate prediction. To achieve adoption of forecasts, forecasts need to be more accurate, reliable, relevant to agricultural decisions and better communicated. With agricultural systems becoming more susceptible to climate variability, this study helps and guides policymakers in considering the spatial reliability of climate prediction in relation to the spatial scale at which the information may be used.*

KEY WORDS: Constraints, Suggestions, Climate variability, Climate prediction, Adoption

Introduction

Agriculture has been defined as the most weather-dependent of human activities, and most production decisions directly or indirectly involve a consideration of this factor (Oram, 1989). It is clear that climate variability has played a significant role in

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shaping global agricultural production and will continue to do so. One of the challenges facing farmers is to make appropriate management decisions in the face of this climate variability (Ash et al., 2007). Farming communities must cope with issues of climate variability and climate change (Motha, 2007). Although a great deal of importance is placed on avoiding losses in a drought year, it is even more important to make the most of good years. The strongest driver of inter-annual variability in agricultural output in many environments is climate variability. El Nino Southern Oscillation (ENSO) alone can explain 15–35% of global yield variation in wheat, oilseeds, and coarse grains experienced in the last 40 years (Ferris, 1999). In India, a failure in the monsoon season results in a 10–20% decline in total food grain production (Krishna Kumar et al., 2004). In regions strongly affected by ENSO such as southern Africa, India, eastern Australia, and parts of South America, forecasts tend to be dominated by statistical approaches that use ENSO phases (Stone et al., 1996; Meinke and Hochman, 2000; Meza and Wilks, 2003). It should also be realized that other useful agrometeorological services than climate forecasting do exist or may be established and these may often be more helpful to farmers (e.g. Murthy, 2008; Murthy and Stigter, 2006; Stigter, 2004; 2007; 2010).

For climate forecasts to be of value to agriculture they must meet several criteria (Hansen, 2002; Meinke and Stone, 2005), which include:

(a) being reasonably accurate and relevant to the scale of application;
(b) forecasting the most appropriate variable for different types of decisions in particular agricultural sectors, and having lead times appropriate to the decision type;
(c) having economic benefit when applied in the context of the whole agricultural system and its complexity, and where possible, enhancing sustainability;
(d) being unambiguously communicated and targeted to farmers who have the capacity and willingness to change behaviour, i.e. farmers must be willing to update their climate beliefs and overcome cognitive biases.

A key impediment to forecast uptake in agriculture is the perceived lack of skill: 76% of respondents in a survey of over 2500 farmers in Australia identified forecast reliability as the rationale for not using seasonal climate forecasts (Agriculture Fisheries and Forestry Australia, 2003). It could be concluded that forecasts need to be at least 65–70% accurate to achieve long-term trust and adoption. This is consistent with other studies (e.g. Jochec et al., 2001; Leith, 2006) that have shown an accuracy of 70–80% is required and that the forecasts would have to be proven for a 4–5 year period before they would be adopted. Adoption will still be problematic if there are not suitable options to adjust behaviour to the predicted conditions (Podesta et al., 2002). For example, in Zimbabwe, limited capacity to obtain alternative seed or fertilizer to take advantage of forecasts limits adoption (Phillips et al., 2002). It is possible that improved seasonal predictability can be achieved as our knowledge of oceans and of atmospheric mechanisms improves. It is likely that this improved understanding will best be represented in dynamic coupled ocean–atmosphere models which, although still low in skill in seasonal prediction, offer the best path towards improved forecasts in the longer term (Goddard et al., 2003).

The objective of the present study is to unearth the constraints and suggestions elicited by farmers in adopting climate forecasts in South India.

Methods

Among South Indian states, Andhra Pradesh was chosen as the locale of this study since (a) the farmers in this region are exposed to a great degree of climate variability resulting in high vulnerability, (b) at least some of the existing climate variability is predictable using existing climate knowledge, and (c) researchers' familiarity with local language and culture. Ananthapur, Rangareddy and Visakhapatnam districts representing three different regions of the state were selected randomly. Ananthapur and Rangareddy have a semi-arid climate with average annual rainfall being 560 mm and 770 mm respectively, whereas Visakhapatnam has a coastal climate with annual rainfall of 968 mm. The predominant crops are groundnut in Ananthapur; sorghum and pigeon pea in Rangareddy; and paddy, sugarcane in Visakhapatnam district, so the semi-arid districts of Ananthapur and Rangareddy grow dryland crops, whereas the coastal district of Visakhapatnam grows water logged crops like paddy and sugarcane. Three mandals (a mandal is a unit of administration above village and below district level in a state and comprises several villages) each from the selected districts, with two villages under each mandal, were chosen randomly.

A sample of 180 farmers, 60 from three districts with 10 per village, forms the respondents for the study. The majority farms small-scale (possessing small and fragmented land up to five acres), is above 44 years of age, with little formal education, having 21–30 years of farming experience, and with medium (scores between 4 and 6 on a scale of 1 to 10) knowledge and adoption of seasonal climate forecasts. Average annual income of a farmer ranges Rs.1400–6000 per acre. The major sources of information on climate forecasts to the farmers were neighbouring farmers, followed by television, newspaper and radio respectively. The selected mandals, with villages in parenthesis, for the above three districts are given in Table 1.

An open-ended structured interview was carried out to obtain information from the farmers, and the interviewer probed farmers by giving clues about the possible responses. Based on the number of farmers indicating a particular item (frequency), the responses were ranked as problems in adoption of climate forecasts as well as suggestion to improve their adoption, in, percent values, for data analysis and conclusions (Tables 2 and 3).

Table 1. Selected study mandals with villages in parenthesis, for Ananthapur, Rangareddy and Visakhapatnam districts.

District	Mandals (villages in parenthesis)
1. Ananthapur	Bukkarayasamudram (*Regadikothur and Rekulakunta*)
	Ananthapur Rural (*Chiyyedu and Somuladoddi*)
	Atmakur (*Talupur and Y. Kothapalli*)
2. Rangareddy	Yacharam (*Nasdiksingaram and Nandivanaparti*)
	Kandukur (*Muccharla and Saireddyguda*)
	Shabad (*Manmarri and Antaram*)
3. Visakhapatnam	Anakapalli (*Pisinikada and Venkupalem*)
	Atchutapuram (*Andalapalli and Thimmarajupeta*)
	Munagapaka (*Munagapaka and Chuchukonda*)

Table 2. Problems in adopting climate forecasts expressed by farmers.

S. No.	Problem	Frequency	%	Rank
	Technical			
1.	Absence of location specific climate forecasts.	129	71.67	I
2.	Poor reliability of climate forecasts.	120	66.67	II
3.	Majority of climate forecasts are failing.	118	65.56	III
4.	Climate forecasts given in radio, TV, newspapers not as per operational needs.	115	63.89	V
5.	Traditional climate forecast methods failing.	52	28.89	IX
	Personal			
6.	Poor awareness of weather events.	81	45.00	VII
7.	Ability to change production decisions limited, even with correct forecasts.	72	40.00	VIII
8.	Low conviction of climate prediction.	99	55.00	VI
	Administrative			
9.	No proper extension service in climate prediction.	117	65.00	IV

Results and Discussion

1. Problems in Adopting Climate Forecasts by the Farmers

The possible reasons given by the farmers for the problems are, with their ranking (Table 2):

Table 3. Suggestions to adopt climate forecasts expressed by farmers.

S. No.	Suggestion	Frequency	%	Rank
	Technical			
1.	Provide location specific climate forecasts by improving infrastructure at village level.	152	84.44	I
2.	Improve credibility/trustworthiness of climate forecasts with proper accountability.	135	75.00	II
3.	Improve accuracy of climate forecasts by frequent updating.	121	67.22	III
4.	Climate forecasts in radio, TV, newspapers should be relevant to the operational needs of farmers.	91	50.56	V
5.	Coordinate the efforts of farmers and officials to discuss the changing weather patterns.	43	23.89	IX
	Personal			
6.	Improve awareness on weather events by trainings, visits by officials of meteorology department.	68	37.78	VII
7.	Information on climate prediction should be accompanied by proper intervention strategies to be adopted by the farmers.	59	32.78	VIII
8.	Improve farmers' conviction of climate prediction.	83	46.11	VI
	Administrative			
9.	Improve extension service in climate prediction like frequent visits by extension personnel along with use of different teaching materials and methods.	115	63.89	IV

(I) Absence of Location Specific Climate Forecasts. This was the major problem because the climate forecasts usually cover a wider area and speculation exists among farmers whether their place receives rain, etc., or not. Also the information becomes vague with absence of location specificity. Most climate forecasts are provided at a regional scale and there is good evidence that forecasts need to be localized and put in the context of local climate conditions (Austen et al., 2002; Jagtap et al., 2002). A good example of this need for locally explicit forecasts has been demonstrated in Argentina through an analysis of adoption of forecasts following the widely communicated La Niña event of 1998–1999, which followed a strong El Niño event in 1997–1998 (Podesta et al., 2002). Fifty-eight per cent of farmers did not change their management in response to the forecast, with a large number not believing that the climate forecasts applied well to their sub region. There is also good evidence that farmers will have more confidence in climate forecasts if they are communicated from a trusted 'expert' (Jagtap et al., 2002; Luseno et al., 2003) rather than from an institution or agency.

(II) Poor Reliability of Climate Forecasts. This was a problem because of the lack of certainty of climate forecast information. Hence farmers lack trust in the forecasts. Similar lack of trust or comprehension of forecast information was already reported (Eakin, 2000; Phillips et al., 2001; Roncoli et al., 2002). Constraints to the adoption and use of climate forecasts were primarily related to a misalignment of the scientific nature of the forecast products and the operational and application specific needs of the user community.

(III) Majority of Climate Forecasts are Failing. A majority (two out of three) fails because of lack of accuracy ($<70\%$ accurate considered a failure), which in turn affects the different timing of farm operations that are based on existing climate. This is confirmed by case studies in Stigter (2010).

(IV) No Proper Extension Service in Climate Prediction. This was a difficulty because extension personnel do not regularly interact with farmers to discuss climate forecasts. Also there were no regular extension activities related to climate forecasts in the villages or awareness of climate variability publicized through mass media. This has also been reported by Murthy (2008) with respect to weather forecasts in Andhra Pradesh. Agricultural extension agents, working with farmers and forecasters could help forecasters to focus on the climate variables and spatial resolutions that matter to farmers and provide feedback from farmers to the forecasters about the performance and utility of the forecasts. They could assist farmers to interpret and apply forecasts for making decisions such as the time of planting, choice of crops and crop varieties, application of fertilizers, herbicides, pesticides and irrigation water. Success will be dependent on the cooperation and coordination across the regional and national meteorological agencies, extension agency, local government units and farmers' associations, which may require changes in responsibilities, accountability and incentives (AIACC Working Paper, 2007). Most of this applies also to other agrometeorological services than climate forecasting (e.g. Stigter, 2008).

(V) Climate Forecasts Given in Radio, TV, Newspapers Not as per Operational Needs. This is a problem because of the poor relevance of the content of forecasts to the

operational needs of the farmers. This is in line with earlier reports from Eakin, (2000), Phillips et al. (2001) and Roncoli et al. (2002).

(VI) Low Conviction of Climate Prediction. This low conviction about the sense of climate prediction exists among farmers regarding these forecasts and their accuracy. Verification statistics should be computed and presented to the farmers on probabilistic forecasts, for model-generated and objectively-generated forecasts to make their own evaluation of these forecasts. There is evidence that repeated exposure to forecasts enables farmers to better understand them (Patt and Gwata, 2002).

(VII) Poor Awareness of Weather Events. Although mentioned by only 45% of the respondents, this is a problem because many farmers are unaware of the dynamic interactions of weather elements in the atmosphere. It is also due to the fact that action support systems in agrometeorology do not reach the actual livelihood domain of farmers (Stigter, 2007; 2008).

(VIII) Ability to Change Production Decisions is Limited, Even with Correct Forecasts. This is the case because proper intervention strategies to be followed by farmers rarely accompany a climate forecast (see also Murthy and Stigter, 2006). Sometimes the farmers were limited by lack of resources to change their production decisions. Currently, climate forecasts are provided as probabilities of potential occurrences. Additional consideration must be given to the magnitude of the forecast event, the degree to which it is predicted to differ from previous conditions, the likely impact of the event if correctly forecasted and adverse impacts associated with forecasts that fail to suggest the eventual occurrence (Cabrera et al., 2006).

(IX) Traditional Climate Prediction Methods Failing. This is a problem because many farmers felt that weather patterns in their region had changed and traditional indicators for climate prediction were not as reliable as they were before, very likely caused by climate variability. Many farmers felt that weather patterns in the Andean semi arid region had changed and traditional indicators were not as reliable as they were in the past (Corinne et al., 2000). Climate variability has weakened farmers' confidence in local knowledge. Elders recalled that in the past they were able to predict the rain onset so accurately that they could mobilize family labour and plant on dry soil, knowing that the rains would soon follow, but now their sons refuse to go to field until it actually rains (Roncoli et al., 2001). See also Stigter (2010) for traditional and modern expert systems. However, certain traditional indicators like the positioning of the nest by weaverbirds are a good indicator for seasonal forecast. If these birds make their nest in the lower portion of the tree, it means less rain will occur; and if they make their nest in the upper portion of the tree it indicates high rainfall in that season. This came true in 2005/2006 where the nests were made in the upper portion of the tree, witnessing heavy rains in the season in the state of Andhra Pradesh. Indeed, traditional forecasts often predict variables of greater relevance to farm decisions than do scientific forecasts. In the absence of scientific forecasts,

traditional forecasts together with previous experience remain the only basis for farm-level decisions pertaining to the ensuing season (Ngugi, 2002).

2. Suggestions on Improving the Adoption of Climate Forecasts as Given by the Farmers

The suggestions given by the farmers on improvement of adoption of climate predictions, with their ranking (Table 3):

(I) Providing Location-specific Climate Forecasts by Improving Infrastructure at Village Level. This was the major suggestion expressed by the farmers. Details were on improving infrastructure, like installing rain gauges, observatories and other weather tools at village level because the current forecasts are more regional specific and do not take account of the variability across small areas. More micro met stations are needed to collect data that are locally relevant and that can inform climate models and forecasts at a finer spatial resolution (Brondizio and Moran, 2008). Improving climate information is only half the battle; the other half is ensuring that farmers get the information in ways they can use it in support of their farming decisions. It should be provided on a narrow spatial and time scale covering the local plots (IFPRI Forum, 2006). The attention for what happens at the village level was also shown in the work of Murthy (2008) and the case studies of agrometeorological services collected in Stigter (2010). The need for bringing action support systems in agrometeorology to the livelihood of farmers was abundantly illustrated by Murthy and Stigter (2006).

(II) Improving Credibility/Trustworthiness of Climate Forecasts with Proper Accountability. This was suggested because before adopting the forecasts, they should be worthy of belief and reliance. The accountability of weather forecasters should be looked upon since wrong forecasts may often lower confidence among farmers. The forecasters should be willing to be evaluated for success via an independent body for forecast correctness, or applicability of climate forecasts. This will enable them to increase credibility. Credibility can also be developed by making public a scientific analysis of the forecast over recent periods compared to the actual climate conditions experienced (Marx, 2002). This information needs to be publicized to the general media so that the public can develop some confidence in the forecasts. The forecasters need to provide the media with both success stories and disaster stories that would help to build credibility. For forecasts at all scales, comprehensive post-processing is needed to produce reliable uncertainty information. Teaching users what the information means, and how to interpret its complexity would work to enhance credibility and legitimacy, and can be an important avenue for overcoming the scale constraint (Phillips and Hansen, 2001; Hansen, 2002).

(III) Improving Accuracy of Climate Forecasts by Frequent Updating. This was proposed because dependability of forecasts decreases with increase in lead time (forecast time). Further improvements in accuracy can be obtained by reducing crop model error through, e.g., modelling additional yield-limiting factors, improved

measurement or calibration of model inputs such as soil properties, and assimilating remotely sensed vegetation indices (Hansen et al., 2006).

(IV) Improving Extension Service in Climate Prediction. Improvement of such and other agrometeorological services can be done by frequent visits by extension personnel along with use of different teaching materials and methods, because rarely do extension personnel interact with farmers regarding climate prediction and other agrometeorological services on a regular basis. Also the use of different teaching materials (like display boards, bulletins) and methods (like personal contacts, informal discussion) on changing weather events were not given the deserved attention. Climate Field Schools are discussed in this context by Stigter (2008; 2010). However, farmer differentiation is highly necessary here (Stigter, 2010).

(V) Climate Forecasts in Radio, TV, Newspapers should be Relevant to their Operational Needs. This should be the case because climate forecasts need to be simple, comprehensive and preferably in the local language that would provide farmers with the ability to make decisions. In fact many farmers suggested that they too be made partners in the development of knowledge on climate prediction. Information on climate prediction should be accompanied by proper intervention strategies to be adopted by the farmers because forecasts alone are insufficient for farmers to make decisions. Strategies related to minimizing risk, like protecting the crop from impact of cyclones, etc., are very essential to farmers. Murthy (2008) has shown that the same applies to daily weather forecasts.

(VI) Improving Farmers' Conviction on Accuracy of the Sense of Climate Prediction. This was suggested because some of the farmers expressed the need for it. The climate prediction agencies should provide facts and publicize their successful efforts to gain confidence and belief among farmers. Improving awareness on weather events by training and visits by officials of meteorology departments was a suggestion. Adoption rates and reported benefits have been fairly high in pilot projects in Zimbabwe, Southern India and Burkina Faso, where extended interaction between smallholder farmers and researchers overcame some of the communication barriers (Huda et al., 2004; Meinke et al., 2006; Patt et al., 2005). Climate forecast information is best packaged within a suite of services that include education, technical guidance and perhaps advocacy through farmer training workshops, which provide training in seasonal probabilistic prediction and the new graphical formats, and a forum for discussing management implications with their peers. This allows us to test farmers' understanding and reactions to the package of tailored information and training in a group setting. Because climate-related fluctuations in production can have large impacts on price and hence accessibility of staple foods, the use of climate-related production forecasts to manage markets and strategic grain reserves to stabilize prices is an appealing food security intervention (Hansen et al., 2007).

Conclusion

The broader adoption of climate forecasts and all other agrometeorological services hinges on effective dissemination and communication of agriculture-specific decision information and its integration into the end-user's decision process (Garbrecht and

Schneider, 2005) and livelihood (Stigter, 2007; 2010). The goal is to integrate the efforts of both traditional and scientific climate prediction methods for improved understanding of uncertainties and limitations towards their application in farm management. The current skill of forecasts in most regions is quite low and the relevance of forecasts to agricultural decisions and the way they are communicated does not encourage widespread confidence and adoption. Participatory engagement to understand user needs and adoption constraints is crucial to realizing the value of climate forecasts and all other agrometeorological services (e.g. Stigter, 2004). To improve success in the use of climate forecasts efforts should be better targeted to (a) regions where forecast skill is currently useful or is likely to improve to useful levels, (b) the farming systems and mix of enterprises that are amenable to incorporation of seasonal forecasts, and (c) specific farming decisions that have the lowest down-side risks in relation to the benefits that can be achieved from forecasts. A first step in this targeting of future efforts in seasonal forecasts is to better understand climate drivers at a regional scale and to better quantify the likely limits to predictability. In parallel we need to understand how forecasts can be better incorporated into farming decisions, not just in a technical sense but also in terms of the adaptive capacity of farmers and farming communities. Central to this approach is ensuring that forecasts are placed in the context of complex farming systems where climate decisions are just one variable in a matrix of many decisions (Ash et al., 2007). It is important that care be exercised in demonstrating and communicating the value of forecasts and all other agrometeorological services, so that there is confidence and trust in both science and in how it is being used to inform decision-making in extension (Stigter, 2008).

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