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RESEARCH ARTICLE

The impact of Weather-Based Agricultural Advisories on Rice Production and Income of Farmers in Nellore District, Andhra Pradesh, India, Under a Changing Climate Scenario

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ABSTRACT

Weather has a considerable impact on agricultural output since it influences crop growth, development, and yields, as well as many agronomic operations such as irrigation and fertilizer scheduling and pest and disease incidence. Weather anomalies have the potential to inflict physical damage to crops as well as soil erosion. Weather conditions have a detrimental effect on the quality of produce during transit, as well as seeds and planting material viability and vigour during storage. From Rabi 2018-19 to 2020-21, A study on the use of agromet advisory bulletins and its impact on yield and economics of rice crop was conducted in Nellore district. To determine the impact of agromet advisory services, users of agromet advisory services (AAS) and non-users of agromet advisory services (non AAS) from various villages in the Nellore district were selected. Those that followed agromet advisories were able to reduce input costs and increase net profit margins when compared to farmers who did not follow the AAS. This benefit was realized as a result of the farmers' crop management practices in accordance with agromet advising bulletins. Thus, the adoption of agromet advisory bulletins that are based on current and anticipated meteorological conditions is an effective instrument for increasing productivity and profitability.

Keywords: *climate change, agronomic operations, Agromet Advisory services, Net profits.*

INTRODUCTION

The majority of Indians eat paddy as a staple food. Asia produces over 90% of the world's rice. Rice accounts for 60% of the region's output. If not addressed properly, climate change will negatively affect rice production [1]. Rice is widely grown in Southeast Asia, and climate change is expected to exacerbate abiotic challenges. Climate, edaphic, hydrological, physiological, and agronomic factors likely influence rice production. Pests and diseases, water, and nutrition are the main factors affecting crop growth and development (yield reducing). The cultivar, its physiology, and crop management all interact with the weather and soils to affect yield level. While productivity is mostly affected by radiation and temperature in irrigated and well-managed crops, it is also determined by precipitation and soil moisture storage in rain-fed locations [2].

The Intergovernmental Panel on Climate Change (IPCC 2001) attributes most of the recent global warming is mainly due to human activity. Climate change has resulted in a 0.6Â°C increase in global average surface temperatures over the last century, the largest increase in 1,000 years [3]. Temperatures have risen in South Asia and globally, especially in winter and spring. Despite increasing seasonal differences, the average precipitation trend has remained stable [4]. The result is that while precipitation has remained stable, the frequency of light rain has decreased while heavy rain has increased [5]. Almost daily, torrential rain fell, wreaking havoc on human life and property. Climate change impacts rice pest and disease infestations. Rice blast, brown spot, sheath blight, and stem blight may spread in Southeast Asia. Wind patterns that are constantly changing may affect the transfer of pests, bacteria, and fungi that cause crop disease. Climate change may alter crop-pest interactions by altering the developmental phases of both hosts and pests. Insects are ectothermic and precipitation-sensitive, so climate change may affect them. This impact may be direct, such as climatic factors affecting insect physiology and behavior [6] or indirect, such as host plants, competitors, or natural enemies. Heat, CO_2, precipitation, natural enemies and host plant are the main variables that can affect insect pest physiology, abundance, phenology and distribution.

Predictive weather forecasts and timely crop management can prevent crop losses. It is possible to select crops based on weather forecasts. Sowing, weeding, pesticide application, irrigation, and fertiliser application can all be better planned by informed farmers. Water, labour, and energy efficiency are improved by weather forecasting. Pesticide pollution is reduced by using agricultural pesticides sparingly. However, the economic benefit of agrometeorological services can be quantified (Nicholls, 1996). But only if the methods used to develop weather-based alerts are linked to farmers' traditional wisdom [7].

Weather and climate forecasts may influence key farm management decisions [8]. As a result, it is critical to understand farmer expectations and deliver predictions within a reasonable spatial and temporal range [9]. This increases the forecast's reliability and thus the adoption of weather-based advisory systems [10]. These farmers discussed the advantages of using agromet advisory bulletins and weather forecasts to make farm-level decisions.

MATERIALS AND METHODS

Climate of study area and Sample Size

Andhra Pradesh is divided into nine agro-climatic zones based on its climate and geography. The present study was carried out at Krishi Vigyan Kendra Nellore, 14.40' N latitude, 79.86' E longitude, and 58 metres altitude. Nellore is located in Andhra Pradesh's southern Agro-climatic zone, which has hot, humid summers and mild winters. Regarding climate, The hottest months are April and May, with temperatures rising into June. The coolest months are December-February. The sea breeze from the Bay of Bengal keeps the city's climate moderate in both winter and summer. Because Nellore is near the sea, the humidity is high. Cyclones cause flooding and havoc in the city during this time. In the winter, temperatures drop to 23 to 25 °C (73 to 77 °F).

India receives most of its rain during the southwest monsoon. Between October and December, the northeast monsoon brings heavy rains to India's eastern and southern regions. Due to its location in southern India, Nellore receives more rain from the north-east monsoon than the south-west monsoon. The North-East monsoon season typically starts in early October and lasts until mid-December. Around 60% of the city's annual rainfall falls now. The South West and North East Monsoons bring 700-1000 mm of rain (28 to 39 in). As previously stated, Nellore's typical climate, temperatures, and soil conditions are ideal for paddy cultivation.

From 2018-19 to 2020-21, 90 rice farmers from Rajuvolupadu, Veerampalli, and Allur villages in Nellore District were randomly chosen to participate in the study (AAS). A random sample of the same number of non-beneficiary farmers, i.e. non-users of agromet advisory services (non AAS), was taken from each village. The study's sample size was 180, with 90 numbers drawn from each category.

Data Collection and Analysis

To assess the impact of FLD intervention, yield and economical data was collected immediately after harvesting of the crop from both the groups i.e. users of agromet advisory services (AAS) and non-users of agromet advisory services (non AAS). The impact of AAS based recommendations in reducing pest and diseases severities and also economics of plant protection measures were compared with non- AAS based management of pest and diseases. Pre tested Semi structured interviews were scheduled to extract the information and Operation wise expenditure was calculated. All of the selected farmers were interviewed in their homes and on their farms. The collected data was classified, tabulated, and analysed to determine the extension gap, technology gap, technology index, and benefit cost ratio [11] as given below:

Technology gap = Potential yield - Demonstration yield

Extension gap= Demonstration yield - Farmers yield

Yield gap (%) = (extension gap/yield under existing farmer practice) X 100

Technology index (%) =

$$\frac{\text{Potential yield-Demonstration yield}}{\text{Potential yield}} \times 100$$

Paired t test was applied to know if there exists a significant difference in the economics of demonstration and check.

Preparation of weather-based agro-advisories

District AgroMet Units (DAMU) located in the Krishi Vigyan Kendra Nellore, has been serving the farming community in Nellore districts. This project's main goal is to provide timely and accurate crop management advice based on weather forecasts. Weather forecasts are issued every Tuesday and Friday by the Indian Meteorological Department in New Delhi, and include rainfall, maximum and minimum temperatures, wind speed and direction, cloud cover, and maximum and minimum humidity. After receiving the forecast, experts from various disciplines are consulted. Agro advisories are prepared in Telugu and English on Tuesdays and Fridays based on the advice. These advisories are transmitted to IMD for inclusion in national bulletins and are also available in Telugu and English on the IMD website. Bulletins are distributed to farmers on a regular basis in real time via telephone, e-mail, and SMS. Agro-meteorological advisory bulletins are also distributed via E-mail to local Telugu newspapers for publishing and are uploaded on both Telugu and English-language websites. These bulletins are also distributed via E-mail to State Agriculture offices, Agriculture extension officers, ATMA Block level offices, and local newspapers. The weather forecast-based agro-advisory bulletin summarises the weather from the previous week, its deviation from the normal value, rainfall variation, weather forecast information for the next five days, crop management, and specific plant protection measures as recommendations based solely on weather forecasting and changing weather patterns. Thus, farmers can adopt crop management options such as nutrient application, irrigation scheduling and pest and disease management.

RESULT AND DISCUSSION

Pest & disease incidence and their control

In Nellore, the area under rice cultivation is subjected to many pests and diseases apart from nutrient deficiencies especially Zinc. Temperature, precipitation, and relative humidity all play a significant role in the proliferation of pests and diseases. Nellore being located on shore of Bay of Bengal heavily depends on cyclonic rains for cultivation. Cyclonic rains equally affect the pest and disease severities in paddy growing areas. Unexpected weather changes and usual weather patterns that bring pest and disease appearance along with specific management recommendations is described under Table 1.

The economic benefit derived out of AAS based recommendations in contrast post pest or disease remedial measures (Non AAS based management) for a sample size of 180 respondents for three years was calculated and presented in Table 2. It shows the timely adoption of recommendations has significantly reduced the outbreak of pest and diseases and there by reduced application of no. of sprays. The derived benefit cost ratio calculated only for plant protection management aspects was observed to be superior in case of respondents followed Agro advisory services. Thus, the AAS system not only help farmers to take up early and timely plant protection measures but also improve the agriculture in terms of net returns.

Weather-based agromet advisories impact on yield, economics, and extension parameters

Yield of rice in the demonstration plot fluctuated sequentially over the course of several years. The highest yield (71.5 q/ha) was in 2020-21, while the

Table 1: Effect of weather parameters on prevalence of major pests and diseases in paddy during rabi season in Nellore district

Weather factors congenial for insect /disease development	Crop stage	Pest & Diseases	Control
Initial showers under irrigated conditions (November- December)	Nursery to Tillering stage	Stem borer and gall midge	Carbofuron 3G granules @ 170 gm (or) Phorate 10 G granules @ 50 gm/cent nursery before one week of transplanting
		Leaf folder	Monocrotophos @ 1.6 ml/litre of water
Dew formation in morning hours in (December-January)	Tillering stage to panicle initiation Stage	Blast	Tricyclazole 75% @ 0.6 g /L of water
		Sheath Blight	Hexaconazole 2 ml or Propiconazole 1 ml/ lit of water
Cyclonic rains owing to Bengal depression (November to January)	Nursery to Panicle initiation Stage	Blast	Tricyclazole 75% @ 0.6 g /L of water
		sheath blight	Hexaconazole 2 ml or Propiconazole 1 ml/ lit of water.
		Stem rot	Hexaconazole 2 ml or Propiconazole 1 ml/ lit of water
		False smut	Propiconazole @ 1 ml (or) Carbendazim @ 1 g/litre
Raise in day temperatures above 30°C (February)	Panicle initiation to Grain Hardening stage	Gall midge	Carbofuron 3G granules @ 10 kg per acre
		BPH	Imidachloprid + Ethiprole 80 WG @0.25 g or Monocrotophos 2.2 ml or Pymetrozine 0.6 g/ litre of water
Raise in day temperatures above 35°C (March- April)	Milky to Grain Hardeing stage	Stem rot	Hexaconazole 2 ml or Propiconazole 1 ml/ lit of waterStem rot Hexaconazole 2 ml or Propiconazole 1 ml/ lit of water
		Panicle mite	Profeenophos 2.0 ml/lt of water
		BPH	Imidachloprid + Ethiprole 80 WG @0.25 g or Monocrotophos 2.2 ml or Pymetrozine 0.6 g/ litre of water

Table 2: The economic impact of weather forecasts on plant protection

Year (rabi season)	**Major Pests and diseases observed**	**No. of agro advisories on Plant protection**	**% of respondents in relation to Plant Protection operations**		**Avg. Benefit –Cost ratio calculated for Plant Protection aspects only**	
			AAS Followers	**AAS Non- Followers**	**AAS Followers**	**Non AAS followers**
2018-19	Sheath blight, Stem borer, BPH, Blast, Stem rot	18	45 (81)	55 (99)	2.6	2.0
2019-20	False smut, Stem borer, Leaf folder, BPH, Blast, Mite	22	60 (108)	40 (72)	2.3	1.8
2020-21	False smut, Stem borer, Leaf Folder BPH, Blast, Mite, Stem rot	21	65 (117)	35 (63)	2.4	2.1

Table 3: Evaluation of AAS vs Non-AAS farmers' productivity, technology, extension, and technology index

Year	Seed yield (q/ha)			% increase over control	Techno. gap (q/ha)	Ext. Gap (q/ha)	Techno. index	B:C ratio	
	Potential	Demo	Control					Demo	Control
2018-19	75	68.3	61.7	10.71	6.8	6.6	9.0	1.63	1.20
2019-20	75	69.0	63.5	8.66	6.0	5.5	8.0	1.67	1.22
2020-21	75	71.5	68.6	4.23	3.5	2.9	4.7	1.72	1.37

Table 4: Economic impact of agro advisory on crop productivity of AAS farmers v/s non AAS farmers

Year	AAS farmer		Non-AAS farmer		Additional income to AAS farmers (Rs./ha)	% gain in income over non AAS farmers
	Yield (Kg/ha)	Returns (Rs/ha)	Yield (Kg/ha)	Returns (Rs/ha)		
2018-19	6825	95550	6165	86310	9240	10.71
2019-20	6900	96600	6350	88900	7700	8.66
2020-21	7150	100100	6860	96040	4060	4.23

Table 5. Extent of variation in rice yields among respondents (n=180)

Category of farmer	Mean	Standard Error	Standard Deviation	CV %	t value	P value
AAS Farmer	6958.38	132.39	837.42	11.88	2.73	0.007804
Non AAS farmers	6458.40	126.45	799.75	12.23		

lowest (68.3 q/ha) was in 2018-19 (Table 3). The average yield over three years was recorded at 69.6 q/ha over Non AAS (64.6 q/ha) for the year 2020-21. It was discovered that the increase in yield percentage ranged between 4.22 and 10.71% during the course of three years of research. The yield increased by 7.9 % on an average, according to the statistics. The findings corroborate those of [12-15]. The findings clearly demonstrate the beneficial effects of FLDs over non-AAS farmers' practice in terms of increasing rice output in the southern zone of A.P., moreover to the advantageous effects on yield attribute qualities. Throughout the study's duration, it was discovered that the benefit-cost ratio was larger among AAS farmers than among non-AAS farmers.

In recent years, the extension gap has been narrowing. It is estimated that the extension gap ranges between 6.66 and 2.9 q/ha. During the study period, the importance of educating farmers through various means for the use of AAS services to minimize the impact of climate change on agricultural productivity was highlighted, as was the need to further reduce the trend of the extension gap.

In the following years, the farmers' collaboration in carrying out such demonstrations has resulted in optimistic outcomes, as indicated by the technology gap is widening (it currently stands at between 3.5 and 6.8 q/ha). The observed technology gap may be due to the disparity in soil fertility level and meteorological circumstances between the two locations studied. [15] discovered similar results, and they published their findings.

The technology index demonstrated the viability of the newly developed technology in the farmer's field, according to the data. The lower the technology index value, the more likely a technology will be viable. Accordingly, variations in technology index (ranging between 4.7 and 9.0) in different regions during the study period may be related to differences in soil fertility state, lack of irrigation, meteorological conditions and insect and pest incidence during the period under consideration.

Additionally, economic impact studies suggested that farmers who followed AAS given by KVK Nellore reaped significant benefits. The percentage increase in revenue for AAS farmers ranged from 4.23 to 10.71 percent when compared to non-AAS farmers (Table 4). The actual yield gain associated with the adoption of advisory ranged from 290 to 660 kg/ha. As a result, it can be argued that the Agromet Advisory Service Unit's weather forecasts and associated advisories helped the farming community. [15] discovered that farmers who followed agromet advisories in

Karnataka's eastern dry zone obtained an average of 31.4, 24.7, 16.2 and 20.6 percent more benefit from finger millet, redgram, field bean, and tomato, respectively. According to Chaudhari et al. (2010), the increase in yield in Maharastra's high rainfall zone was 13-15 q/ha in rice and 10 q/ha in mango and cashewnut as a result of the adoption of agomet advisory bulletins based on NCMRWF's medium-range weather forecasts. [16] reported that over four rabi seasons from 2004 to 2008, AAS farmers in Uttarkhand's Tarai and Bhabar agroclimatic zones harvested 3.5 to 6.1 percent more wheat and 5.5 to 9.8 percent more rice than non-AAS farmers.

It can be deduced from the above Table 5, that the yield in the case of AAS Farmers was much higher than the yield in the case of non-AAS Farmers, which may be attributed to the adoption of recommended methods provided by experts in many aspects in accordance with the forecast. The co-efficient of variance in the case of non-AAS farmers was 12.23 percent, which was higher than the co-efficient of variation in the case of AAS farmers.

CONCLUSION

The study's critical evaluation revealed that yield and net benefit per unit area were higher for AAS farmers as a result of the AAS unit's advisories on crop production strategies such as ploughing, sowing, pest and disease management, harvesting, threshing, and post harvest processes to maximise the benefit of benevolent weather and mitigate the impact of malevolent weather in order to increase crop productivity. The short-range forecast prediction provided to AAS farmers aided them in avoiding the negative consequences of meteorological occurrences such as heavy rain, dry spells, and high wind speeds, all of which have an effect on the crop's growth. The majority of AAS farmers have seen an increase in added benefit. [17-20] encountered similar observations.

REFERENCE

[1] Aggarwal, P. K., Hebbar, K. B., Venugopalan, M.V., Rani, S., Bala, A., Biswal, A. And Wani, S. P. (2008). Quantification of Yield Gaps in Rain-fed Paddy, Wheat, Cotton and Mustard in India. Global Theme on Agroecosystems Report 43, P. 36.

[2] Ravindrababu, B. T., Janardhanagowda, N. A., Jagadeesha, N., Rajashekhar, K.R. And Rajegowda, M. B. (2007). Application of weather based agroadvisories in eastern dry zone of Karnataka. Journal of Agrometeorology 9 (2): 259-264. DOI: https://doi.org/10.54386/jam.v9i2

[3] Bale, J. S., Masters G. J., Hodkinson I. D., Awmack C., Bezemer T. M., Brown V. K., Butterfield J., Buse A., Coulson J. C., Farrar J., Good J. E. G., Harrington R., Hartley S., Jones T. H., Lindroth R. L., Press M. C., Symrnioudis I., Watt A. D., Whittaker J. B. (2002). Herbivory in global climate change research: direct effects of rising temperatures on insect herbivores. *Global Change Biology*. 8:1-16. Doi: https://doi.org/10.1046/j.1365-2486.2002.00451.x

[4] Chaudhari J. N., Zagada M. V., Mahadkar U. V. And Talathi M. S. (2010). Assessment of weather based agromet advisories in high rainfall zone of Konkan in Maharastra. In: Proceedings of the Nation. Seminar on "Agrometeorological Services for Farmers" held at Anand Agricultural University, Gujrath p. 172-177.

[5] Everingham Y. L., Muchow R. C., Stone R. C., Inman-Bamber G., Singels A. And Bezuidenhout C. N. (2002). Enhanced risk management and decision-making capability across the sugarcane industry value chain based on seasonal climate forecasts. *Agricultural Systems*., 74(3): 459–477. Doi: http://dx.doi.org/10.1016/S0308-521X(02).

[6] Hansen J. W. (2002). Applying seasonal climate prediction to agricultural production. *Agricultural Systems*., 74(3): 305–307. Doi: https://doi.org/10.1016/S0308-521X(02)00042-2

[7] Houghton J. T., Ding, Y., Griggs, D. J., Noguer, M., Van Der Linden, P. J., Xiaosu, D., Maskell K, Johnson, C. A. (2001) Climate Change 2001: The Scientific Basis. Cambridge University Press,Cambridge. pp. 881.

[8] K. Manjappa and Yeledalli, S. B. 2013. Validation and assessment of economic impact of agro advisories issued based on medium range weather forecast for Uttara Kannada district of Karnataka. *Karnataka J. Agric. Sci.,26 (1) : (36-39) 2013.*

[9] Kushwaha, H. S., Mehra, M., Rai, H. K. And Singh, R. S. 2010. Economic impact analysis of agrometeorological services for farmers of Tarai and Bhabar Agro-climatic zone of Uttarakhand. In:Proc. Nation. Seminar on Agrometeorological Services for Farmers held at Anand Agricultural University, Gujrath during 10-13 November, 2008. pp. 187-194.

[10] Lee, C. S. (2008). The characteristics and tendencies of the climate in the past hundred years inTaiwan. (in Chinese) Commu. *Global Climate Change* 59:23-26.

[11] Liu, C. M., Wu, M. C., Li, S. H., Chen, Y. C., Yang, Y. T., Lin, W. S., Tzeng, Y. H., CD Chen. (2008) The estimation of future climate change in Taiwan. (in Chinese with English abstract) Global Change Center, National Taiwan University. Taipei, Taiwan.

[12] Mitra, B. and Samajdar, T. 2010. Yield gap analysis of rapseed and mustard through frontline demonstrations. *Agril. Ext. Review* 22 (2):16-17.

[13] Nicholls, J. M. (1996). Economic and social benefits of climatological information and services: a review of existing assessments, WMO/TD-No. 780, World Meteorological Organization, Geneva, Switzerland. p 38.

[14] Nicholls, N. (2000). Opportunities to improve the use of seasonal climate forecasts. In Applications of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems: The Australian Experience (eds Hammer, G. L., Nicholls, N. and Mitchell, C.), Kluwer, Dordrecht, The Netherlands. p 309–327.

[15] Patt, A. and Gwata, C. (2002). Effective seasonal climate forecast appli-cations: examining constraints for subsistence farmers in Zimbabwe. *Global Environ. Change*. 12: 185–195.

[16] Rajegowda, M. B., Janardhanagowda, N. A., Jagadeesha, N. and Ravindrababu, B. T. 2008. Influence of agromet advisory services on economic impact of crops. *J. Agrometeorol.,*10: 215-218.

[17] Singh, Surendra, Rao, V.U.M. and Singh, Diwan. (2004). Scientific support in farm decision making through weather based advisory services in Harayana. *J. Agrometeorol.,* 6 (sp.): 265-267.

[18] Subhash Katare, S.K. Pandey and Mohd. Mustafa. (2011). Yield gap analysis of Rapeseed-mustard through front line demonstrations. *Agriculture Update* Vol. 6 (2): 5-7

[19] T. Watanabe, K. Takashi. (2009). A general adaptation strategy for climate change impacts on paddy cultivation: special reference to the Japanese context. *Paddy Water Environ* 7:313–320.

[20] Venkataraman, S. (2004). Climatic characterisation of crop productivity and input needs for agrometeorological advisory services. *J. Agrometeorol.,* 6 (11): 98-105.