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Maximizing harvests, minimizing risks: unveiling the economic impact of weather-based agromet advisories

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Abstract
A comprehensive study was conducted to evaluate the economic impact of Agromet Advisories issued by the Agro-Meteorological Field Unit (AMFU), Sabour, in the 16 blocks of Bhagalpur district, focusing on paddy and maize crops during the period from 2019 to 2022. The study aimed to assess the effectiveness of these advisories in optimizing agricultural practices and improving the livelihoods of farmers. A feedback format was designed to record farmers' responses, involving 440 rice and 440 maize farmers randomly selected from both users and non-users of agromet advisory services. In the case of paddy farmers, those who followed the agromet advisories reported reductions in input costs ranging from 4.34% to 7.81% during the kharif seasons of 2019 to 2022. Additionally, these farmers experienced increases in net profits ranging from 11.84% to 23.08% compared to non-users of Agromet Advisory Services (AAS) who did not utilize weather-based advisory information. Similarly, for rabi maize, farmers who diligently followed the agromet advisories witnessed significant reductions in input costs across the seasons from 2019 to 2022, ranging from 4.7% to 5.3%. Concurrently, these farmers experienced notable increase in net profit ranging from 12.82% to 19.96% compared to non-AAS farmers. Overall, the study findings indicate that weather-based advisories provided by AMFU Sabour have been instrumental in helping farmers, reduce input costs and increase net profits, thereby contributing to sustainable crop production and improving livelihoods. These findings underscore the importance of leveraging agromet advisory services to enhance agricultural productivity and promote the well-being of farming communities.

Keywords: Agromet advisory services, agro-meteorological field unit, economic impact, weather forecast

Introduction
Climate change significantly contributes to the reduction of crop yields and nutritional value due to weather-related factors such as droughts, floods, heat waves, pests, and diseases. (Bal and Minhas 2017) [1]. Weather can affect crops disparately based on their developmental stage and the distribution of weather patterns throughout the crop season (Rathore *et al*., 2001) [7]. Weather forecasts are imperative for planning, especially in agriculture, which is vulnerable to uncertainties. Weather and climate data are essential for effective agricultural management and production. The India Meteorological Department (IMD) initiated the Farmers Weather Bulletin in 1945 to cater to the needs of the farming community (Chattopadhyay and Chandras 2018) [2]. With technological advancements, weather forecasting has significantly improved, leading to the development of a customized agromet advisory weather information system. In 2008, IMD, in collaboration with ICAR and State Agriculture Universities, introduced a district-level agrometeorological advisory service (AAS) called Gramin Krishi Mausam Seva (GKMS). This system focuses on gathering and organizing weather, soil, and crop information, which is then integrated with weather forecasts to assist farmers in making informed management decisions. Currently, the GKMS scheme operates through 130 Agro-Meteorological Field Units (AMFUs) in each Agro-climatic Zone, with each unit preparing District-level Agromet Advisory Bulletins (AAB) for all districts under their jurisdiction (Manjappa and Yeledalli 2013) [4].
AMFU Sabour plays a crucial role in preparing and disseminating Agromet advisory bulletins to farmers across 17 districts in South Bihar, including Bhagalpur, Patna, Gaya, Aurangabad, Jehanabad, Nawada, Arwal, Bhojpur, Rohtas, Kaimur, Buxar, Nalanda, Sheikhpura, Munger, Lakhisarai, Jamui, and Banka.

These advisories are based on value-added weather forecasts received twice a week and are designed to assist farmers in optimizing their crop yield and reducing losses caused by adverse weather conditions. The advisories generated by AMFU Sabour are distributed through various mass media channels, including social media, radio, television, newspapers, and other platforms. These advisories provide a weather forecast and recommend appropriate farm operations, enabling farmers to efficiently utilize resources, save time, and minimize financial losses during unfavorable weather conditions. Economic assessment of the AMFU Sabour agromet advisories can provide valuable insights into their impact on farmers' income and overall agricultural productivity in the district. Several factors can be considered for this assessment:

Increase in Crop Yield

Agromet advisories offer guidance on optimal planting times, irrigation practices, and fertilizer usage based on weather conditions (Hasen *et al*., 2002) [3]. By following these recommendations, farmers can potentially increase their crop yield, leading to higher income(Singh *et al*., 2020) [10].

Reduction in Crop Losses

The advisories provide early warnings and advice on weather events like heavy rain, frost, and hailstorms, helping farmers take preventive measures to protect their crops. This can result in reduced crop losses and improved income for farmers.

Cost Savings

Farmers can save on input costs such as fertilizers, pesticides, and water by following the recommendations provided in the advisories. This can lead to reduced waste and increased cost-effectiveness in farming practices (Prasad *et al*., 2020) [5].

Enhanced Resilience

Timely and accurate information provided in the advisories can help farmers better manage weather-related risks, thus improving their resilience to adverse weather events and ultimately safeguarding their income (Ramachandrappa *et al*., 2013) [6].

Access to Markets

Improved agricultural productivity resulting from the advisories can potentially open up new markets for farmers and improve their bargaining power (Ramachandrappa *et al*., 2018) [8]. This can lead to higher prices for their produce, further enhancing their income and livelihoods. Therefore a study is designed to assess the economic impact of agromet advisory services issued by the AMFU, Sabour for the paddy and maize crop during the year 2019 t 2022.

Materials and Methods

The Agro-meteorological Field Unit (AMFU) at Bihar Agricultural University, Sabour, operates as a crucial hub for weather-related agricultural information dissemination. AMFU receives value-added weather forecasts from the Regional Meteorological Center in Patna twice a week, detailing essential meteorological parameters for the subsequent five days. A multidisciplinary agromet advisory board, comprising experts from agronomy, plant pathology, soil science, Agrometeorology, horticulture, forestry, and animal husbandry, meticulously analyze these forecasts. Based on their insights, weather-based agro advisory bulletins are crafted to provide actionable guidance to farmers (Hansen *et al*, 2002). These bulletins, disseminated through diverse mass media channels including social media platforms like WhatsApp and Facebook, radio, television, newspapers, and agriculture-oriented magazines, not only furnish weather predictions but also offer tailored recommendations for farm operations. This enables farmers to proactively address potential risks associated with adverse weather conditions or capitalize on favorable weather patterns, thereby optimizing resource utilization and enhancing agricultural productivity. A comprehensive study conducted across 16 blocks involving 440 rice and 440 maize farmers, with both users and non-users of agromet advisory services randomly selected, aimed to assess the economic benefits of such services. Regular feedback collection from farmers further ensures the usability and accuracy of agromet advisories, reflecting a commitment to continuous improvement and farmer-centric service delivery.

Results and Discussion

The information was gathered through personal interviews conducted at home and on the farmers' field for the paddy and wheat crop. To make the findings meaningful, the collected data was classified, tabulated, and analyzed. In case of paddy farmers who followed the agromet advisories were able to reduce input costs by up to 7.12%, 7.81%, 4.34% and 7.64% in the kharif season of 2019, 2020, 2021 and 2022, respectively. Increases net profit by 11.84%, 14.70%, 20.53% and 23.08% in 2019, 2020, 2021 and 2022 (Table 1) when compared to non-AAS farmers who did not follow weather-based agro advisory information. AAS farmers were able to reduce input costs by up to Rs. 3073/ha, 3628/ha, 3773/ha and 3874/ha in the year 2019, 2020, 2021 and 2022 respectively. When compared to non-AAS farmers, net profit increased by Rs. 6062/ha, 8083/ha, 11867/ha and 13865/ha in the year 2019, 2020, 2021 and 2022 respectively. AAS farmers received a higher net return due to lower input costs, the use of agromet advisories, and the timely management of inspect, pest, and diseases. AAS farmers followed the practices listed in the agromet advisory bulletins and managed their crops accordingly, such as timely land preparation, sowing, using recommended seed rates and varieties, weeding, harvesting, irrigation, and pesticide applications.

Table 1: Economics (Rs ha^{-1}) of Paddy as influenced by AAS during Kharif season 2019 to 2022

		Cost (Rs/ha)					Cost (Rs/ha)			
S.N.	**Non AAS Farmer**	**2019**	**2020**	**2021**	**2022**	**AAS Farmer**	**2019**	**2020**	**2021**	**2022**
1	Nursery bed raising	600	645	697	738	Nursery bed raising	600	645	677	704
2	Hybrid Seed 15kg	4875	5241	5503	5723	Hybrid seed 12.5 kg	4062	4367	4585	4768
3	Land preparation	3300	3548	3725	3874	Green manuring and Land preparation	4500	4838	5079	5283
4	Irrigation for puddling	1200	1290	1355	1409	Irrigation for puddling	0.0 (waited for good rain as per advisory)			
5	Transplanting	8750	9406	9877	10272	Transplanting	8750	9406	9877	10272
6	Weeding cost	3550	3816	4007	4167	Weeding cost	5800	6090	6395	6714
7	Fertilizer N:P: K(100:40:30	5500	5913	6208	6456	Fertilizer cost N:P:K(70:40:30 kg /ha)	5050	5429	5700	5928
9	Irrigation	3000	3225	3386	3522	6 irrigations were saved	No input cost applied			
10	Plant protection	3310	3558	3736	3886	Plant protection	3550	3816	4007	4167
11	Harvesting and transport to Threshing floor cost.	6300	6773	7111	7396	Harvesting and transport to Threshing floor cost	5000	5250	5513	5733
12	Threshing	2800	3010	3161	3287	Threshing	2800	3010	3161	3287
13	Total cost cultivation	43185	46425	48766	50730	Total cost cultivation	40112	42851	44994	46856
14	Grain yield	77000	82775	86914	90390	Grain yield	78800	85985	92232	96677
15	Straw yield	17400	18705	19640	20426	Straw yield	18589	19950	22416	24130
16	Gross income	94400	101480	106554	110816	Gross income	97389	105935	114648	120807
17	Net income	51215	55001	57788	60086	Net income	57277	63084	69655	73951
18	B:C ratio	2.19	2.18	2.19	2.18	B:C ratio	2.43	2.47	2.55	2.58

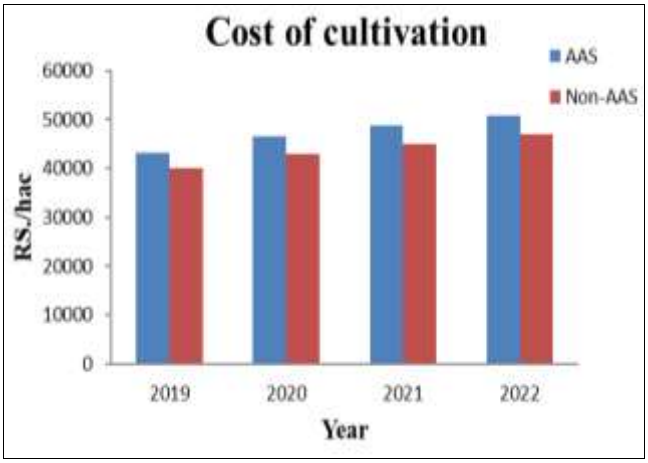

Fig 1: Cost of Cultivation of Paddy during Rabi season 2019 to 2022

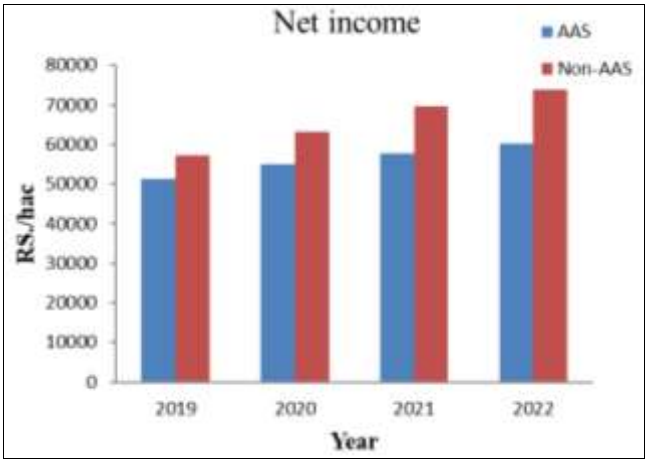

Fig 2: Net income from Paddy during Kharif season 2019 to 2022.

Table 2: Economics (Rs ha^{-1}) Maize as influenced by AAS during Rabi season 2019 to 2022

	Non-AAS Farmers				AAS Farmers			
Particulars	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
Seed	7872	8462	8572	8944	7495	7870	8263	8524
Fertilizers	9882	9936	10418	10842	9498	9872	10366	10842
Micronutrients	1772	1801	1954	2015	1501	1576	1655	1738
Field Prepration(earthing up)	10000	10352	11025	11222	10380	10899	11444	11548
Pesticides	1676	1748	1802	1940	1484	1558	1636	1718
Human Labour	1305	1370	1422	1511	998	1048	1100	1155
Machine Labour	7650	8133	8434	8856	7000	7350	7718	7896
Irrigation	12028	12629	13985	13924	10432	10954	11501	12076
Harvesting (threshing)	7832	8224	8635	9066	8000	8400	8820	9261
Miscellaneous	4000	4200	4410	4630	4000	4200	4410	4631
Total Cost of cultivstion	64017	66855	70656	72951	60788	63727	66913	69389
Grain Yield (q/ha)	129972	136471	143294	150459	139910	145506	151327	157380
Net Profit	65955	69615	72638	77508	79122	81780	84414	87991
B:C ratio	2.03	2.04	2.03	2.06	2.30	2.28	2.26	2.27

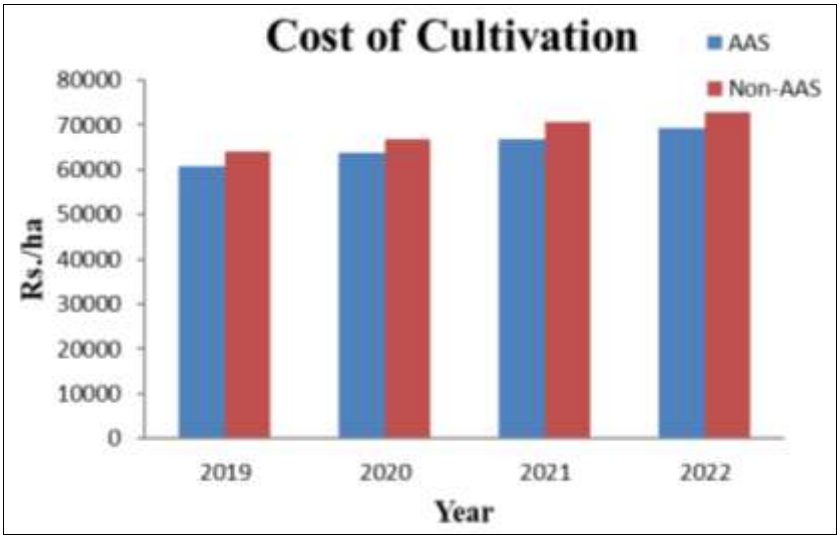

Fig. 3: Cost of Cultivation of Maize during Rabi season 2019 to 2022

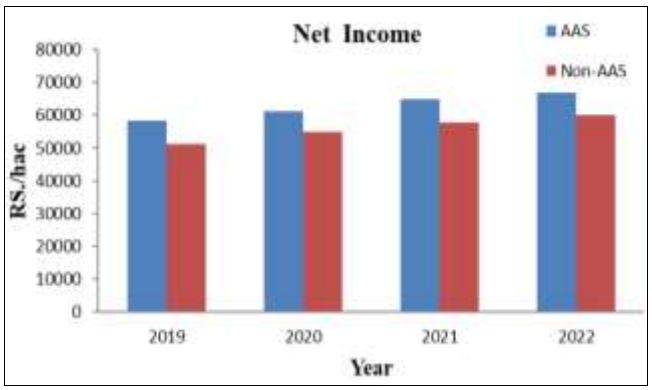

Fig. 3: Net income from Maize during Rabi season 2019 to 2022

The economic assessment of weather-based agromet advisories issued by AMFU-Sabour extends beyond paddy to include rabi maize, revealing further insights into the benefits reaped by farmers. Through comprehensive data collection and analysis, the impact of these advisories on input costs and net profits becomes evident. For rabi maize, farmers who diligently followed the agromet advisories witnessed substantial reductions in input costs across the seasons from 2019 to 2022. The reductions amounted to 5.0%, 4.7%, 5.3%, and 4.9% respectively. Concurrently, these farmers experienced remarkable increases in net profits, with gains ranging from 12.82% to 19.96% compared to non-AAS farmers who did not utilize weather-based advisory information in 2019, 2020, 2021, and 2022. Delving into the monetary impact per hectare, AAS farmers successfully curtailed input costs by up to Rs. 3229/ha, Rs. 3129/ha, Rs. 3744/ha, and Rs. 3562/ha in the years 2019, 2020, 2021, and 2022 respectively. Conversely, net profits soared by Rs. 13167/ha, Rs. 12164/ha, Rs. 11776/ha, and Rs. 10482/ha during the same period, showcasing the significant financial advantages enjoyed by AAS farmers across all years.

The superior net return observed among AAS farmers can be attributed to their meticulous adherence to the practices outlined in the agromet advisories (Prasad *et al*., 2020) [5]. These practices encompassed timely land preparation, sowing, utilization of recommended seed rates and varieties, weeding, harvesting, irrigation, and pesticide applications. By aligning their actions with the guidance provided in the advisories, AAS farmers effectively managed their crops, mitigating risks associated with pests, diseases, and adverse weather conditions. Overall, the data underscores the tangible economic benefits of AMFU-Sabour's weather-based agromet advisories for rabi maize farmers. These advisories not only contribute to cost savings and increased profits but also empower farmers to make informed decisions, fostering resilience and sustainability in agricultural practices. As climate change continues to pose challenges, the adoption of such innovative solutions emerges as a crucial strategy for ensuring the prosperity of farming communities.

Conclusion

In conclusion, the economic assessment of weather-based agromet advisories issued by AMFU-Sabour paints a compelling picture of their transformative impact on farmer livelihoods in both paddy and rabi maize cultivation. The data showcases significant reductions in input costs and substantial increases in net profits for farmers who embraced these advisories. From 2019 to 2022, paddy farmers witnessed consistent savings in input costs and notable boosts in net profits compared to non-AAS farmers. Similarly, rabi maize farmers experienced impressive financial gains across all years, illustrating the effectiveness of the advisories in enhancing agricultural productivity and profitability. These findings underscore the importance of timely and informed decision-making facilitated by weather-based guidance, particularly in the face of climate change-induced challenges. By aligning their practices with the recommendations provided in the advisories, farmers are empowered to mitigate risks, optimize resource allocation, and enhance overall resilience. Ultimately, AMFU-Sabour's agromet advisories emerge as invaluable tools for driving sustainable agricultural practices and securing the prosperity of farming communities amidst evolving environmental conditions.

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