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Micro-level Evaluation of Agromet Advisory Services (AAS) Interventions to Address Climate Variability Induced in Dairy Sector

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ABSTRACT

Agriculture is adversely affected by climatic risks like erratic rainfall, hot and cold waves, monsoon and further, it will be severely affected due to expected climate change in the future. The present study was conducted during 2019-20, 2020-2021, and 2021-2022 through a structured questionnaire technique to access the farmer's feedback on technology interventions for stable production systems in dairy sector through Agromet Advisories Services (AAS). Krishi Vigyan Kendra, ICAR-NDRI, Karnal issuing weather-based advisories bulletin every Tuesday and Friday for the benefit of farming community. These bulletins include livestock-based weather advisories, which are very useful for dairy farmers to enhance their productivity, profitability, and animal welfare. The selected interventions were introduced to address the identified climatic stress itself at the micro-level for enhancing climatic resilience in the dairy sector through AAS. The data collected from the identified dairy farmers were analyzed to know the perception of farmers towards climate change and how to mitigate the negative impacts of weather through AAS at the block level. The impact of AAS services was evaluated through different methods *i.e.* interviews, Google form, and mobile phones on the growth performance, fodder production, reproductive performances, etc. of bovines. The study indicated the beneficial effect of AAS on farmers for increasing the productivity of their animals and fodder quantity. Therefore, based on the results of the study it can be concluded that AAS could alleviate the negative impacts of weather extremes at the field level for enhancing the resilience towards extreme weather events for maintaining the overall production and welfare of animals.

Keywords: Agromet Advisories Services (AAS), weather extreme events, dairy sector, feedback analysis

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INTRODUCTION

The impacts of climate change and weather extreme events are found to be real and affecting livestock directly and indirectly. Climatic change in future will further increase extreme weather events such as heat wave, cold wave, droughts and storms (Maini and Rathore, 2011). Since dairy production is climate-sensitive, there are substantial long-term problems. Mostly resource deficit, farmers are expected to be affected more severely by climate change and climatic variability. A drastic decline in agricultural output due to climate change will pose a challenge to the livelihood, food and nutritional security of the already disadvantaged households. Additionally, rise in extreme weather events has detrimental socioeconomic repercussions, particularly on society's most vulnerable groups (Huvisa, 2012).

Agriculture is crucial for subsistence and significantly influences the economy. Weather changes cause huge losses in milk production, growth rate and reproductive efficiency since dairy operations are closely related. According to reports, weather-related agricultural losses and damages increased by 25% in developing nations between 2003 and 2013 (FAO, 2016). The danger to agricultural products is increased by climate change-related extreme weather events as drought, flood, heat wave, and hail (Bal and Minhas, 2017; Chandran *et al*. 2017). If farmers have access to timely weather information and reliable weather predictions, they can reduce weather-related losses and increase agricultural productivity (Weiher *et al*. 2007). Weather predictions are useful for planning agricultural activities and assisting farmers in making critical farm management decisions throughout all temporal ranges (Godgil *et al*. 2002; Maini and Rathore, 2011).

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Since the structure of the information and how effectively it is incorporated into the micro-level decision-making process determine the relevance of the information (Daron *et al*. 2015; Hansen, 2002), providing timely and accurate weather forecasts embedded with advisories on weather forecast-based field operations to be carried out by farmers assumes great importance.

Major disease incidence, lower reproductive performance, and heat stress in animals are long-term consequences of climate change on dairy farming that may have an impact on feed consumption and milk production (Chakraborty *et al*. 2012). Because they lack the coping strategies needed to deal with shock and stress, the poorest people are typically the most sensitive to climate change. As a result, they are more likely to engage in counterproductive behaviour (Daze, 2011). While farmers in their particular agriculture system would greatly benefit from help to create solid and location-specific adaptation methods, rural communities have always worked to adjust to climate change as it progressively transpired over millennia (Chakravarty *et al*. 2021).

Agromet Advisory Services provided by India Meteorological Department (IMD), Ministry of Earth Sciences (MoES) under Gramin Krishi Mausam Sewa (GKMS) scheme is a step towards reducing the weather induce losses by providing in time information to farmers. IMD is providing Medium Range Weather Forecast (MRWF) based District level Agrometeorological Advisories Services (DAAS) since 2008 under the GKMS scheme (Maini and Rathore, 2011). Farmers of around 690 districts are getting biweekly, multilingual bulletins every Tuesday and Friday via SMS portal, WhatsApp, websites, national and regional apps like Meghdoot, Damini, Mausam, Umang, E-Mausam HAU app, Kisan Mitra, etc. The state agriculture extension system, e-choupal, Doordarshan, and All India Radio broadcast advisories as well. Now IMD is able to meet the farmers' demand for micro-level advice by offering block-level Agromet recommendations. Farmers in many places have benefited from using the AAS to reduce crop losses caused by harsh and unfavorable weather conditions. (Rathore and Maini, 2008: NCAER report, 2010; 2015; 2020). The present study was carried out to evaluate the micro-level efficacy of the dairy-focused AAS provided to the farmers and followed by them for managing the feeds and fodders and enhancing the animal welfare and productive performances by protecting them from extreme weather events.

MATERIALS AND METHODS

The major factors affecting livestock production in the Karnal includes seasonal and unseasonal rainfall, lengthy dry spells, shortage of fodder, depletion of the ground water, heat wave, cold wave etc. For the study purpose, a total of 550 farmers were selected from 80 villages of Karnal district (Fig. 1). Feedbacks were gathered from these dairy farmers through primary data, personal interviews, Google form created during the epidemic and Whatsapp on a regular basis. Based on the gathered data, a structured questionnaire which included the socioeconomic profile, landholding size, education status, fodder and silage production and their use during off-seasons, health management during extremes of heat and cold was developed. To know better about the farming conditions and management of dairy animals during the climate-related stress, randomly few dairy farmers were routinely questioned in person during field visits and face-to-face interviews.

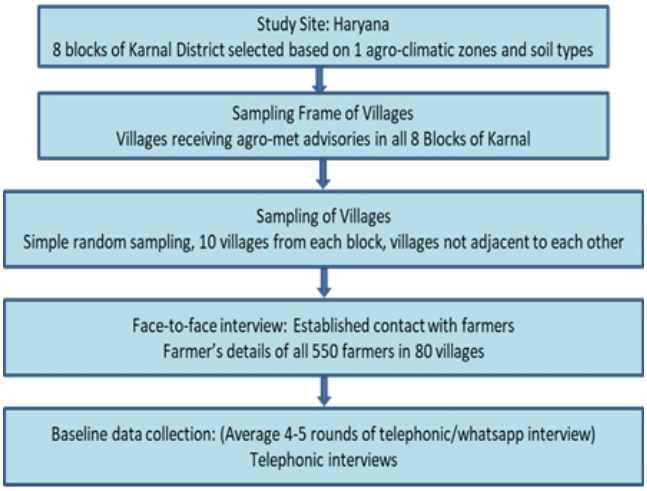

Fig. 1: Flow Chart depicting the steps of the experimental plan

Location of the study

The present study was conducted in the Karnal district. The Karnal is situated above the mean sea level of 250 m at a longitude of 29^0 43' N and latitude of 77^0 20' E. The average ambient temperature varied from approximately 2 ^{0}C in the winter to 46 ^{0}C during the summer season. The average rainfall of the Karnal is about 540 mm. Karnal district is mainly an agricultural-based district with the majority of its population living in rural areas.

Impact Analysis Assessment Framework

To collect secondary and tertiary data from the selected farmers, a questionnaire was developed. The purpose of this questionnaire was primarily to gather the required data from the farmers for the use of AAS provided to them. For the data collection, a multi-stage cluster sampling approach was used. Face-to-face interviews of 550 farmers spread over 80 villages of eight blocks of the Karnal district were conducted during 2019-20, 2020-21 and 2021-22 (Fig. 1).

From October 2019 to March 2020, the farmers community was visited in person to establish the first contact. They were informed of the study's goals and allowed to provide their consent before standing the actual work. A thorough and organized questionnaire was used for the data collection method, and it was trialed in the field before being used to gather actual data. Frequent engagement with the farmers is necessary due to the nature of the data to be collected, and performing face-to-face interviews was not economically viable for the project. As a result, following the first in-person meeting with the farmers, information was gathered through telephonic interviews, where each farmer reached a minimum of four to five times during 2020-21 and 2021-22. Each

telephonic interview lasted on an average of 20 to 25 minutes, during which each farmer was questioned about the benefits of the AAS given to them for dairy animal management and other practices related to dairy production system and fodder production.

Evaluation of the implemented socio-technical interventions' level of satisfaction

Farmers in the study area were also interviewed to assess their level of satisfaction with each socio-technical intervention on a scale of 0 to 3 (no satisfaction, low satisfaction, moderate satisfaction, and high satisfaction) as suggested by Chakravarty *et al*. (2021).

RESULTS AND DISCUSSION

Five hundred fifty-five feedbacks were collected from a heterogeneous group of farmers getting AAS from a different block of Karnal district through which various forms of information gathered like landholding size, education level, herd size, improved fodder crop varieties grow, and their use during the off period, animal health management during different seasons, vaccination schedule, etc.

Socio-economic features of farmers

For comparison of the socio-economic features of farmers for tested interventions through AAS was conducted based on the questionnaire.

Age group of farmers

The data relating to the age group of farmers in different blocks of Karnal district is shown in the Fig. 2. About 17 % of farmers are in the age group of <25 years, 20 % are in the age group range of 25-35 years, 34 % are in the age group of 35-50 years and 20 % are above the age of 50 years. In India, most of the farmers belong to the middle-level age group. This implies that the younger generation may not be interested in taking up farming as a profession. Singh (2013) also reported that the agriculture workforce is getting older with the average age of farm workers increasing to about 40 years in 2018-19 from 36.6 years in 2004-05. They further reported that younger generations are not showing an interest in agriculture. A similar trend was also observed during the present study as shown in Fig. 2.

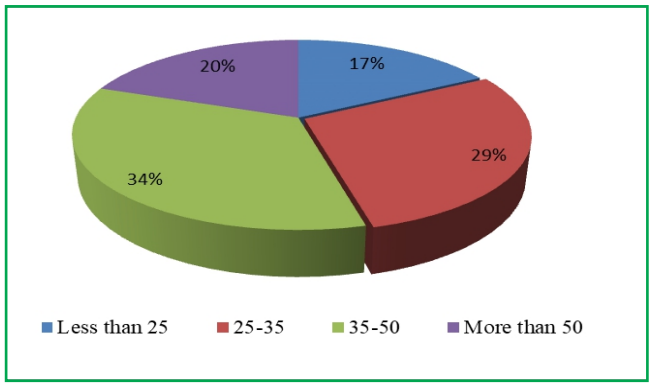

Fig. 2: Percent of farmers of different age groups involved in agriculture

Educational level of farmers

Haryana is one of the most literate states in India with 77% literacy. The literacy rate in Karnal district is 76%, with 84% literacy among males and 68% among females. Among the surveyed households about 98% have someone who obtained some level of education while 2% do not have any members in the household with any formal education, indicating a high level of literacy in these villages (Singh, 2013). 9% of the farmers are graduates, 21% are 12th pass outs, 26% are 10th pass outs, 29 % are 8th pass outs and the number of illiterate farmers is nearly 12% in the study area. The education level of farmers in the Karnal is shown in Fig. 3. Moreover 3% are post graduates involved in agricultural practices. Education improves the farming skills and productive capabilities of the farmers. It helps to follow the instructions recommended to them (Huang and Luh, –2009). However, no consensus has been agreed upon among the experts who studied the impact of farmer education on farm productivity. The results of some authors (Abdulai and Huffman –2014; Asadullah and Rahman –2009) found a significant role of education in the augmentation of agricultural productivity. On the other hand, Coelli et al. (–2002), Deb (1995) and Wadud and White (–2000) did not find any significant impact of education on farm productivity and efficiency. The study of Hasnah and Coelli (–2004) showed even a significant negative impact of education on farm efficiency. Again, studies like Lockheed et al. (–1980), Phillips (–1994), and Tilak (–1993) reported mixed impact.

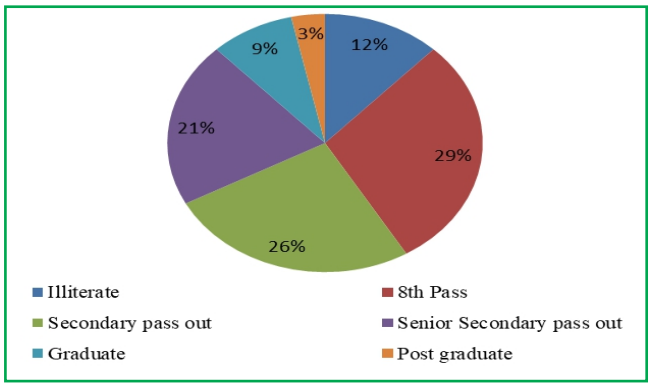

Fig. 3: Percent of farmers having different educational background involved in agriculture

Size of land holding

The size of land holdings of the farmers in Karnal district are shown in the Fig. 4. The majority of the farmers are marginal 67 % viz. small (<2 Acre) are 31% and medium land holders (2-5 Acre) are 36%. With a lack of capital and resources, the small and marginal farmers cultivate their land with family members' help since they cannot afford hired laborers for every work (Singh, 2013). Marginal and small farmers do dairy based operations at their own risk because of lacking capital. The large farmers with more landholdings can save more and spend these savings for further investment in the next entrepreneur's skills (Singh, 2013). The percentage of large land holders (5-10 Acre) is 20% and very large holding

farmers (>10 Acres) are 13%**.** Thus, capital accumulation is a resultant phenomenon for large farmers. Several studies revealed that technology being income biased gives better returns to the already better endowed, making them more prosperous. It also leads to an increase in disparity between large and small farmers (Gautam, 2021).

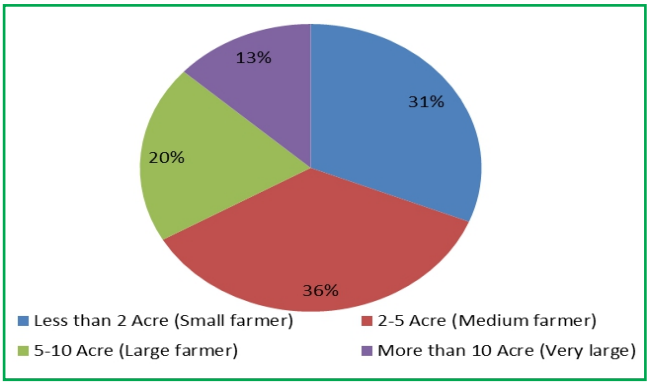

Fig. 4: Various categorized of land holding of farmers in Karnal

Weather information through mass media

The results were concluded that 85% of respondents get climate and weather-related information from various sources including radio, television, government department (agricultural extension), private organizations, newspapers, cell phone, internet and community members. Among them 27% get weather information through Whatsapp group followed by newspaper (16%) and TV+Newspaper (12%) and TV+Radio (12%) (Fig. 5).

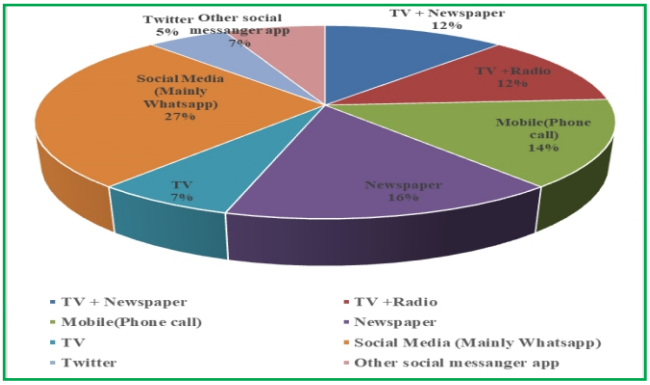

Fig. 5: Percentage of distribution of farmers using various social media tools

The results of the present study are in accordance with Singh, 2013, reported that farmers are getting information related to weather information, extreme events, pests and diseases outbreak, forecast of start of rainfall, predictions of 2-3 months of rainfall, and 2-3 days of rainfall from different sources. This was probably because the majority of the farmers were literate and the emergence of Smartphones, Facebook and WhatsApp had been giving virtual communication experience. Hence, the majority of young farmers were attracted to using social media (Darshan, 2015). A critical analysis of the socio-economic characteristics of farmers who use social media revealed that the majority of farmers belong to young and middle age group and majority of young farmers happened to be small and marginal farmers. Since most of the farmers are young, we can reinforce their entrepreneurial behavior by providing attractive and relevant information through social media. Majority of households had medium family education status, therefore it is possible to use social media as one of the media mix and as a supplement and compliment to conventional transfer of technology programs (Darshan *et al*. 2017). Mass media is playing significant role as a tool in the dissemination of information more precisely. Hence, study implies that mass media tool was found to have positive and significant relationship with the adaption strategies. Mass media helps to upgrade the agricultural activities and allied sector including daily weather conditions according to modern technologies which are good among in farmers (Manjusha *et al*. 2019).

Herd Size

In the Karnal district, livestock farming is an important complementary enterprise to crop production. Of the surveyed households, 95% are engaged in crop-livestock mixed farming and 12% of households keep small ruminants. This is because farm households derive certain products from livestock that can be used in agriculture in turns supplies feed to livestock resources. The results showed that the majority of households have livestock in the locality and only 10 households reported that they do not have any animal. Buffalo is the most important dairy animal in the study area, but the incidence of keeping this particular species of livestock declined from 84% to 76%, while the incidence of dairy cow keeping increased from 12% to 15% during the last 10 years (Singh, 2013). 25% of the farmers have less than 2 animals, 52% of farmers are having animals in the range 2-5, 18% farmers have animals 5-10 and 5% farmers are having more than 10 animals (Fig. 6).

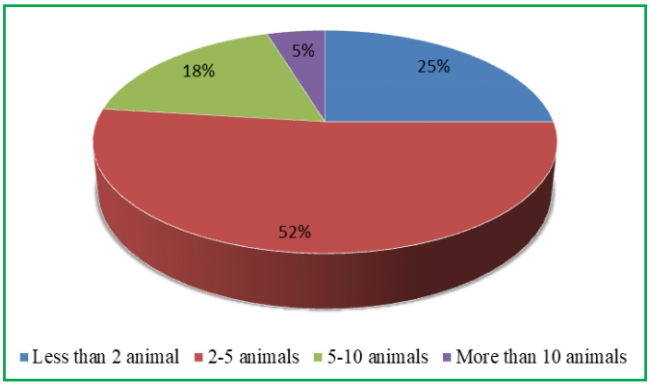

Fig. 6: Percentage of herd size of farmers of Karnal district

Perception and usability of agromet advisory services in dairy sector

The perception and usability of AAS by dairy growers were evaluated at block levels using different questionnaire like Meghdoot app for weather related advisories in Fig. 7. The percentage use of Meghdoot app was maximum in Karnal block (46%) followed by Assandh block (40%) and it was least

in Nissing block (15%) in Fig. 7. The percentage of farmers using fodder crop related advisories was maximum in Karnal block (85%) followed by Indri and Munak block (74%) and it was least in Assandh block (40%). The percentage of farmers using livestock and fisheries and related advisories through KVK from 550 respondents was maximum in Kunjpura block (76%) followed by Gharaunda block (75%) and it was least in Nissing block (56%). The percentage of farmers getting alerts regarding aberrant weather (Nowcast advisories) through what's app was maximum in Karnal block (82%) Indri block (78%) and it was least in Nissing block (42%).

Reproductive problems as perceived by the dairy farmers

Feedback collected from 550 respondents in different blocks and villages indicated that average dairy herd's fertility is declining with increased culling rate due to repeat breeding, major reproductive problem in Karnal district, high incidence of repeat breeding adding significant costs to milk production (Beever 2006). In Karnal district, extreme climates directly affect the reproductive efficiency of cattle and buffalo (Nanda *et al*. 2003). The results of the present study revealed that repeat breeding was the major fertility problem as perceived by 68 % farmers. This high incidence was mainly because of poor conception through artificial insemination, which might be due to several reasons such as poor quality of semen, untrained inseminators and farmers' inability to present the animals at proper time of heat for artificial insemination. Through proper use of AAS bulletin by dairy growers, these problems can be alleviated through balanced feeding mechanism, vaccination slot and better health management. The results of the present study are in accordance with Venkatasubramanian and Rao (1993) and Venkatasubramanian (1994). Anoestrus was found to be the second most serious problem that was due to imbalance feeding of dairy animals that resulted in mineral deficiencies. The animals were being maintained on dry fodder and a little bit of concentrate. Other reasons were silent heat, failure to detect heat and management factors. These problems are easily diagnosed and minimized its negative impacts on Animal health and its production through the AAS bulletin. With the help of AAS, dairy growers easily find the best way to maintain proper nutrition and region-specific mineral mixture (As given in AAS Bulletin) for the animals to reduce the incidence of reproductive problem. The major possible cause of the reproductive problem is the imbalanced concentration of minerals (Ahmet *et al*. 2008). It is well recognized that proper feeding of animals is essential to maintain their reproductive status (Vankatasubramanian 1994 and Singh and Barar 2008). Kilic *et al*. (2007) recommended zinc as a trace element for normal reproductive function. Incidence of retained placenta was reported by 26% of the respondents. They reported the causes of the retained placenta as mineral deficiencies, pre-mature birth, abortion, lack of tonosity in uterus muscles, infection in uterus, etc. this also indicates the poor feeding of the dairy animals. Metritis/endometritis were perceived by 23% respondents as fourth important fertility problem. Farmers reported it after problem identified by veterinarian, because it is problem of uterus and is difficult to detect by them. About one-fifth (17%) farmers ranked dystocia cases as fifth important reproductive problem. The major reason behind this incidence was large size or abnormal foetus, which may lead to dystocia. The other causes were failure of proper parturition and abnormal anatomical condition of the dairy animals. Prolapse of

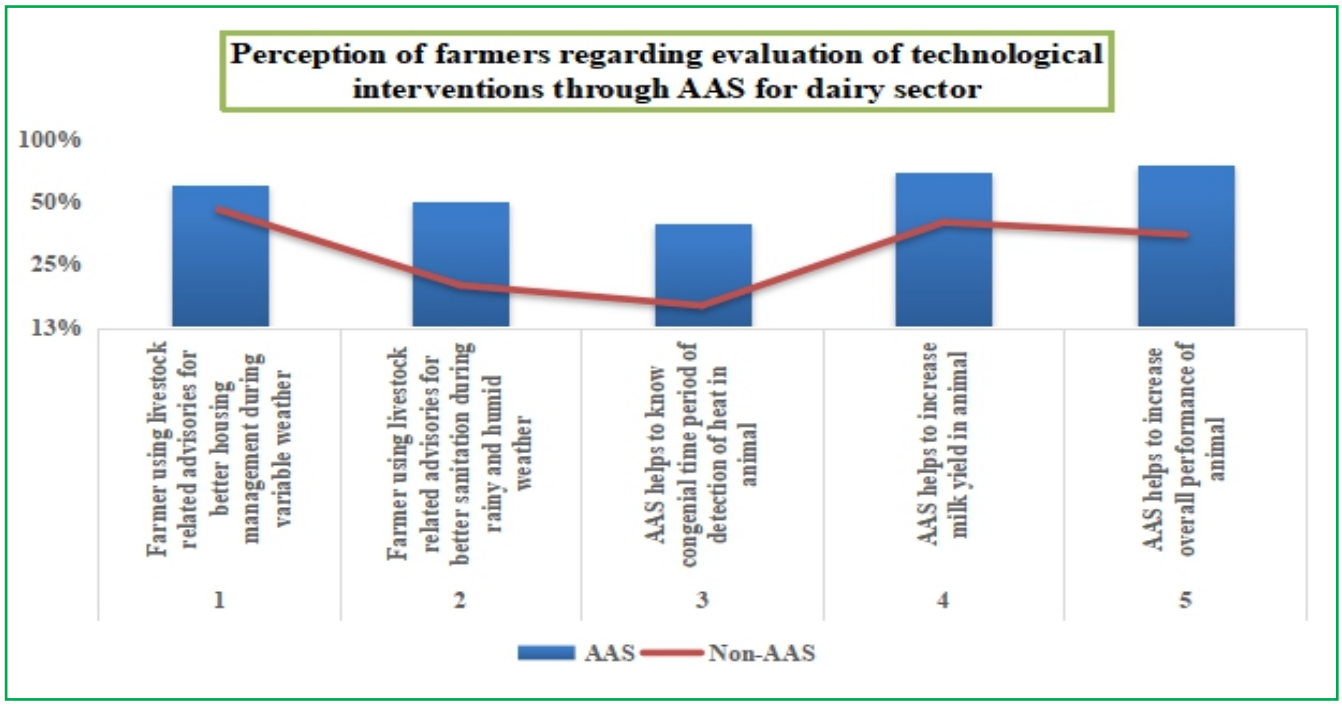

Fig. 7: Perceptions of AAS and Non-AAS farmers regarding evaluation of technological interventions hrough AAS for dairy sector

vagina/uterus was reported by 16% respondents. The major reasons for that were infection in the vagina/uterus and lack of muscular tonicity because of mineral deficiency. Torsion of uterus as fertility problem was reported by 15% respondents and it was mainly due to abnormal physical condition of the dairy animals. Cystic ovaries were reported by about one-tenth of the respondents. Generally, farmers were unable to identify this complex reproductive problem. These types of problems are not included in AAS bulletin but this situation was aggravated due to the lack of veterinary hospitals at the village level. In this situation, farmers were unable to approach veterinary surgeons in the city or other villages and tried to find out a solution by indigenous technical knowledge. Sometimes farmers lead to great economic loss.

Technological interventions through AAS for the dairy sector

The impacts of AAS for the dairy sector in different blocks of Karnal were evaluated using different technological interventions listed in Table 1. Among them, the use of AAS for improved management in fodder crops and their production was maximum in Karnal (66%) followed by Kunjpura (56%) and it was least in Indri (26%). The majority of the dairy grower was near Karnal city for better pricing of milk and their market profitability so the adoption rate of technological interventions was maximum in Karnal followed by Kunjpura and it was least in the Munak block of Karnal.

Table 1: Evaluation of technological interventions through AAS for dairy sector in different blocks of Karnal District (value are in parenthesis were cumulative perceived benefits)

S.No.	Treatment	Assandh	Gharaunda	Indri	Karnal	Kunjpura	Munak	Nilokheri	Nissing
1.	Number of dairy grower using AAS for improved fodder crop varieties and its management.	30	46	26	66	56	36	40	40
2.	Farmer using livestock related advisories during rainy and humid weather for better management of animals	50	70	74	82	80	60	74	60
3.	AAS helps to know congenial time period of vaccination	30	46	38	62	56	50	40	56
4.	AAS helps to know ideal time for feeding of supplement mixture to enhance milk production	50	40	58	70	68	38	42	52
5.	Identified and reduce the negative effect of heat stress using AAS advisories eg. Alteration in housing management	60	56	46	76	70	36	50	40
6.	AAS helps to know ideal time period for silage making and use of silage in dry period	20	26	26	46	40	26	30	40
7.	AAS helps to know ideal time period for feeding of supplement mixture to enhance the milk production.	50	60	54	80	60	40	34	60

The results of evaluation of technological interventions through use of AAS and Non-AAS farmers for dairy sector were concluded that AAS help the dairy growers for better housing management during variable weather and those farmers who are adopted AAS have better sanitation during rainy and humid weather. Similarly Non-AAS farmers face a lot of difficulty during that season he managed these adverse weather conditions using its own Indigenous Traditional Knowledge (Fig. 7). But there is also a major limitation in AAS regarding the congenial period for the detection of heat in animals. In AAS farmers, it might be helpful for better health management and helps to reduce the various risks of reproductive problems in animals. The major benefits were gained by AAS farmers using the technological interventions, the AAS adopter farmers were able to increase milk yield in dairy animals. The overall AAS adopter farmers have profitable dairy farms through better health management. However, the Non-AAS adopter farmers were not able to maintain the growth and milk yield of their animals due to a lack of knowledge of stress management in animals, and manifests several physiological problems in dairy animals.

Farmer's satisfaction level through AAS

The above results were concluded that various socio-technological interventions levels tested by dairy owners through questionnaire were found that majority of dairy farmers were highly satisfied (Table 2) in forecasting of probable weather events in the form of AAS, identified critical period window for better management of heat and cold stress with the use AAS, developed contingency planning for scarcity of fodder and mitigating negative effect of climate change at micro level with the use of AAS. The results were correlated with the method adopted by Chakravarty *et al*. (2021).

Table 2: Farmers satisfaction level through AAS to mitigating climate change at micro-level in Karnal for contingency planning

S.No.	Socio-technological interventions	Famer satisfaction	Reason for response
1.	Use of area specific mineral mixture	1	Although it sustains hig h milk production, it is expensive
2.	Forecasting of probable weather events in the form of AAS	3	Easy access and mostly useful for dairy growers
3.	Identified critical period window for better management of heat and cold stress with the use AAS	3	This interventions was good and it helps to dairy growers to combat heat and cold stress period
4.	Developed contingency planning for scarcity of fodder and mitigating negative effect of climate change at micro level with the use of AAS	3	This interventions was good and it helps to dairy growers to overcome green feed and fodder scarcity

CONCLUSION

The study concluded that use of AAS helped to the dairy owners for better management of dairy animals during stress period. AAS helped the dairy owners for better housing management and sanitation during rainy and humid weather. Whereas, Non-AAS farmers face a lot of difficulty to manage their dairy animals and they are using its own Indigenous Traditional Knowledge. AAS provided, the suitable way to alleviate negative impacts of climate variability at micro-level by using need based operation in dairy sectors for maintaining higher production and profitability in dairy sector. The livestock development strategy in the changing climate scenario should essentially focus on minimization of potential production losses resulting from climate change. AAS helped the farmers to know the latest technologies which are a good sign that speaks about the interest of the farmers. The results of the study clearly indicated that the beneficial effects of AAS for management of dairy animals. Therefore, emphasis should be made further in the other district for education and awaking the dairy farmers for using the AAS for sustainable production and animal welfare during extremes/ unexpected weather conditions.

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