Role of end-user behaviour on the adoption decision of an innovation: the case of preventive solutions to control bovine mastitis disease in dairy enterprise

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Adopting innovation is a crucial decision to increase output, productivity and reduce loss. Previous studies have suggested that technology attributes and socio-demographic factors influence the adoption of any innovation. This necessitates understanding the user behaviour in the adoption decisions. The present study focusses on behavioural intentions of the users (dairy farmers) regarding preventive solutions to control bovine mastitis in their dairying enterprise in Kallakurchi district of Tamil Nadu, India. The technology acceptance model (TAM) was employed in this study. Data were collected through a pre-tested interview schedule among 60 farmers during 2022 and analysed using descriptive and multilinear regression methods. The results revealed that farmers' behavioural factors, like subjective norms played a significant role in adoption decisions for preventive solutions. The results imply that policy decisions on any technology generation and transfer programmes need to address the behavioural pattern of users.

Keywords: Adoption decision, behavioural factors, dairy farmers, innovation, mastitis, preventive solutions.

BOVINE mastitis is an important disease that profoundly impacts the quality, economics and overall health of dairy animals. At the national level, this disease causes an economic loss of INR 71,655 million per annum[1]. Systematic analysis of the literature revealed that around 45% of dairy animals are affected with sub-clinical mastitis[2]. Adoption of preventative measures is necessary to reduce the occurrence of mastitis and related loss. Implementing proven milking procedures, periodical screening of the udder, improving sanitation and housing measures can potentially minimize the incidence of mastitis[3]. Awareness and knowledge on early detection and control of sub-clinical mastitis are low, and socio-economic factors also influences the adoption of practices/innovations associated with control of mastitis[4]. These variables explain to some extent the variance in adoption of preventive measures for the control of mastitis. However, the role of behavioural factors in the adoption of animal health/preventive technologies has not been explored in India, similar to the role of socio-demographic factors[5]. This study makes an effort to understand the user's belief in preventive measures to control bovine mastitis and the association between behavioural factors and adoption of such preventive measures.

A cross-sectional study was conducted during January and February of 2022 among the dairy farmers of Nainarpalayam and Krishnapuram villages of Kallakurichi district, Tamil Nadu, India, to assess the relationship between the adoption of preventive measures to control bovine mastitis and its predictors using the technology acceptance model (TAM)[6] which has now found wider applications, including farming technology adoption[7]. Sixty farmers who had been trained on package of preventive solutions to control mastitis during 2020–21 through Farm Field Schools (FFS) and on-campus training formed the study population. As part of the programme, the Farm Science Centre (Krishi Vigyan Kendra), Kallakurichi, demonstrated the early detection of sub-clinical mastitis using surf field test (SFT), California mastitis test (CMT), TANUCHECK and pH paper strip test, use of post-milking teat dip solution(s) such as potassium permanganate ($KMNO_4$) and TANUVAS teat protect methods, use of anti-septic for cleaning the hands before milking, post-milking feeding strategy and periodical application of disinfectants (bleaching powder/lime) in the animal sheds and other associated practices. The farmers were also trained regarding preventive solutions that need to be adopted.

Similar to TAM, six elements (latent variables), namely subjective norm, perceived costs, perceived utility, perceived output, result demonstrability and attitude, were modelled in this study (Figure 1 and Table 1). The subjective norm was elicited using four items (maximum obtainable score = 12), while the others were elicited using two items using three-point continuum scales (maximum obtainable score = 6). The higher score for the subjective norm suggests significant peer group and extension employees pressure to adopt technologies. The reliability of the scales used in measuring latent variables was evaluated using split half method before administration.

Data were collected through a pre-tested interview schedule prepared by the research team with inputs from experts and the literature before and after intervention. Data on socio-demographic profile, farm characters, knowledge, incidence of mastitis, TAM behaviour variables and extent of adoption of preventive practices were collected. The adoption of promoted preventive technologies/practices was measured in a three-point continuum (0, 1 and 2), viz. not adopting, partially adopting and completely adopting. The promoted practices 1 and 5 listed in Table 2 need to be carried out at specified intervals, while 2–4 need to be followed daily. The farmers who adopted practices as specified without missing the periodicity were categorized under completely adopted; those who adopted the practice but missed the recommended periodicity were categorized under

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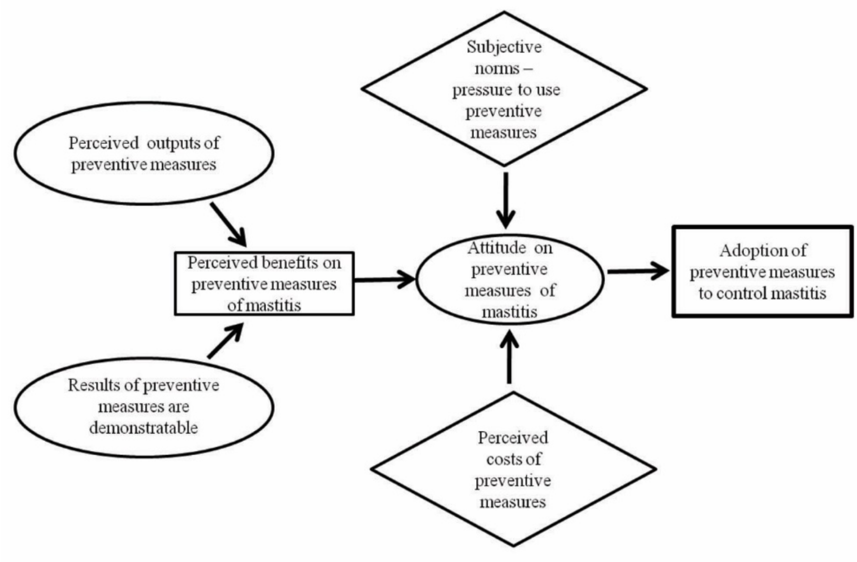

Figure 1. Behavioural model conceived for identifying the elements influencing adoption.

Table 1. Operationalization of variables

Variables	Definition
Subjective norm	Expectations about being approved or supported by family members and potential pressure from the staff of the extension system to adopt preventive measures to control the incidence of mastitis.
Perceived cost	Conceptualized as the effort (time, cost) that dairy farmers perceive to be allocated for the execution of preventive measures to control mastitis.
Perceived usefulness	Reduction of treatment expenditure for mastitis and also loss of milk production.
Perceived outputs	Improvement in animal health and increased income.
Result demonstrability	Results of preventive measures are demonstrable, and cost and benefit can be well defined.
Attitude	Positive/negative feelings associated with preventive measures of mastitis.

Table 2. Extent of adoption of promoted preventive solutions for mastitis among dairy farmers (n = 60)

Serial no.	Preventive solutions	Pre-intervention completely adopted	Post-intervention		
			Completely adopted	Partially adopted	Not adopted
1	Periodical screening of sub-clinical mastitis	0 (0.00)	24 (40.00)	23 (38.33)	13 (21.67)
2	Post-milking – using $KMNO_4$ wash/TANUVAS teat protect	0 (0.00)	9 (15.00)	34 (56.67)	17 (28.33)
3	Using antiseptic to clean the hands before milking	10 (16.67)	52 (86.67)	3 (5.00)	5 (8.33)
4	Post-milking – immediate feeding arrangement	24 (40.00)	58 (96.67)	2 (3.33)	0 (0.00)
5	Periodical application of disinfectant in the animal shed	14 (23.33)	21 (35.00)	27 (45.00)	12 (20.00)

Table 3. Socio-demographic characteristics of dairy farmers (n = 60)

Variable	Mean	Standard deviation
Age (yrs)	40.23	10.31
Land size (acres)	2.49	1.61
Milch animals (nos)	2.70	1.27
Experience in farming (yrs)	14.30	10.53
Gender involved (male: 0; female: 1)	0.87	0.34
Education (yrs)	8.82	5.67
Milk production/day (l)	11.22	6.43
Incidence of mastitis ((No: 0; Yes: 1)	0.62	0.49
Knowledge on mastitis (out of 20 marks)	12.22	3.11

partially adopted, and farmer who did not adopt any practice as non-adopters. The maximum adoption score was 10.

The collected data were entered into an Excel spreadsheet and transferred to Statistical Package for Social Science (SPSS 16) for analysis. Descriptive analysis was carried out for socio-demographic variables. Multiple linear regression was employed to test the strength of behaviour variables by adopting preventive measures to control mastitis. For the regression analysis, the assumptions like linearity, independence of predictor variables, homoscedasticity and normality were tested. The data fulfiled the above-mentioned assumptions of the multilinear regression model. R^2 was used to explain the variance in adoption, and regression

Table 4. Descriptive statistics of Technology acceptance model (behavioural) variables among dairy farmers ($n = 60$)

Variable	Mean	Standard deviation	Minimum	Maximum
Subjective norm	7.26	1.72	4	10
Perceived costs	4.28	1.32	2	6
Perceived utility	1..62	0.84	1	3
Perceived output	2.10	1.00	1	4
Result demonstrability	4.13	1.08	2	6
Attitude	5.68	0.54	4	6

Table 5. Multiple linear regression of adoption and its predictors among dairy farmers ($n = 60$)

Predictor variables	Unstandardized coefficients B	Unstandardized coefficients SE	Standardized coefficients B	t-value	Level of significance
Constant	2.65	2.55		1.04	0.30
Subjective norm	0.64**	0.13	0.57	4.86	0.00
Perceived costs	–0.18	0.19	–0.12	–0.98	0.33
Perceived utility	–0.08	0.26	–0.03	–0.30	0.76
Perceived output	–0.24	0.25	–0.13	–0.99	0.33
Result demonstrability	–0.20	0.22	–0.11	–0.90	0.37
Attitude	0.31	0.41	0.09	0.76	0.45

**P value < 0.001, $R^2 = 34\%$.

coefficients were used to explain the change in adoption as a response to change in behaviour variables.

The average age of dairy farmers was 40 years, with nine years of formal education, possessing 2.49 acres of cultivable land (Table 3). They possessed 2–3 milch animals that produced 11 litre of milk daily. The farmers had an experience of more than 14 years of dairying. The majority of the dairy farmers were women. Around two-thirds of the farmers had to deal with bovine mastitis in the last three years before the intervention and had accessed the animal health service providers (Department of Animal Husbandry and Dairy Unions). The farmers had knowledge of causative agents, preventive methods and other associated factors. The average knowledge score of farmers on mastitis disease after the intervention was 61% against the pre-intervention score of 39% (an increase of 66%). The mean score of a subjective norm among dairy farmers was 7.26 ± 1.72 against the maximum score of 12; perceived cost, perceived output, perceived utility, result demonstrability, and attitude were 4.28 ± 1.32, 1.62 ± 0.84, 2.10 ± 1.00, 4.13 ± 1.08 and 5.68 ± 0.54 respectively, against a maximum score of 6 (Table 4). Table 4 reveals that the farmers perceived the cost of technology as less and results of technology are observable. Further the farmers had a high amount of pressure from the social system to adopt the technology.

Table 2 shows that before the intervention with extension programmes, the adoption of preventive solutions was similar to other such interventions[8]. After intervention many farmers adopted the usage of antiseptic for cleaning their hands before milking and post-milking feeding strategy, followed by a periodical screening of sub-clinical mastitis. Partial adoption was noticed for the usage of 'teat protect' solutions and disinfectants for sheds. The extent of adoption of preventive solutions was 69% among farmers (score 6.85 ± SD1.93 out of 10). Thus, variance and a gap exist in adopting preventive solutions to control mastitis.

In order to understand the adoption variance, a simple linear regression was performed to determine the association between behaviour variables with the adoption of preventive solutions (at a 95% confidence interval). Except for subjective norm, all other variables showed no significant relationship with the adoption of preventive solutions. The subjective norm explained about 29% of the variance in adoption in a single linear regression model. When all the behavioural variables (six) were added to the multiple regression model, about 34% of the variance in adopting preventive solutions was explained by behavioural predictors (Table 5). This is in line with the observations of other researchers[8–12], who reported the significant influence of behavioural factors in the adoption of technologies. Due to limitations in the data for linear regression, authors have not studied innovations' characteristics and sociodemographic factors, which may account for the remaining variance in adoption[13–15].

Among the behavioural variables, subjective norm had a positive and highly significant association with the adoption of preventive solutions. TAM revealed that subjective norm affects significantly and positively the adoption decision of preventive solutions. Farmers with motivation and support from family members and potential pressure from the extension system were 0.64 times more likely to adopt preventive solutions than those without, keeping other variables constant. This was similar to other findings[16–18].

To sum up, the present study focused on adopting preventive solutions to control bovine mastitis among farmers whose understanding of mastitis, preventive solutions and skills was enhanced through extension educational programmes. This implies that a series of continuous extension programmes with innovative extension models have the potential to influence adoption decisions, which is currently limited in animal health service provider programmes. In this study, variance in adoption among farmers was noticed. The behavioural variables were able to explain the variance in adoption. Specifically, subjective norms had greater potential to influence adoption decisions. For better adoption of technologies, policymakers must include family members in extension programmes that could lead to peer pressure to adopt technologies as well as support to animal handlers from the family. Moreover, external pressure from extension system has to be exerted to persuade farmers through innovative extension programmes.

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