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RESEARCH ARTICLE

Exploring Predictive Factors of Adoption of Maize-Based Cropping System in Flood Affected Areas - A Study in Assam

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ABSTRACT

The study was carried out in flood-affected areas of Marigaon districts of Assam to explore predictive factors of the adoption of a maize-based cropping system. The findings reveal that out of four maize-based cropping systems, "Maize-Maize/Mustard-Vegetable" was the most prominent cropping system followed by the majority of respondents (48.33%) in flood-affected areas followed by "Rice/Maize-Maize/Mustard-Vegetable" (22.50%). The major share of the area for four different cropping systems was occupied by maize crops ranging from 68.75 to 75.38 per cent. The adoption level of recommended cultivation practices of maize-based cropping system was found moderate level for majority of farmers (63%) followed by low level of adoption (20%). The socio-economic factors of respondents such as Operational land holding, maize covered area, cropping intensity, resource status, economic motivation, degree of innovativeness, risk orientation, perceived effectiveness and income had significant and positive relationships but age, farming experience and flood proneness had significant and negative relationship with their adoption of maize-based cropping system in flood affected areas. These factors will influence in explaining of 85 per cent of the variation of adoption (Adjusted R^2 = .858). The extension agencies should keep these in consideration of these factors for planning and implementation agencies should target young farmers with less experience in farming for the maize cultivation programme.

Key words : *Maize-based cropping system; Adoption; Flood-affected areas.*

Being a prominent sector, agriculture contributes around 21 percentages in the gross state domestic product and provides engagement to more than 70 per cent of the population in agriculture and its allied sectors. Though rice is the staple food and growing extensively throughout the state other cereal crops like maize, wheat millets etc. along with other field crops are also grown in the state. The climate of the state is sub-tropical with warm humid summers and cool dry winters. The state is situated in a high rainfall zone with an annual average rainfall of 2297.4 mm. Because of the uneven distribution of rainfall across the seasons, Assam is prone to floods and drought-like situations. The state though has natural potential to drive the agriculture sector; erratic and unpredictable weather conditions and floods have been creating adverse impacts and making the farmers vulnerable to the situations more specifically districts like Nagaon, Morigaon, Darrang, Barpeta, Lakhimpur, Dhemaji, West Karbi Anglong, Majuli, Sibsagar, Dibrugarh and Tinsukia. During 2020, around 2200 villages were under water and 87000 ha of crop area were damaged due to flood water (Brahmaputra flood report, http://enmwikipedia.org). As a flood-prone state every year Assam experiences two to three types of floods. However early and late flood also occur in the month of May and September. Because of recurring flood damage to agriculture some farmers shifted their occupation from farming to non farming sector and some of them had been trying to adapt themselves with the situation by changing their cropping pattern to cope up with the flood situation. It is seen that in the last few years, farmers started to cultivate maize crops commercially in the flood-affected areas of

Morigaon, Nagaon, Barpeta, Darrang etc. From the last few decades there is significant growth has been observed in terms of area and production of maize crop in Assam and during 2021-22 the state produced 170000 MT maize from 43000ha. (*Annon, 2021-22*; *Singh, et. al., 2018*). The Farmers from the state have adopted different maize-based cropping systems like summer rice- maize-mustard, maize-maize, maize-maize- legumes, sesame-rice+ maize etc. Different maize-based cropping system like *kharif* maize-mustard- *rabi* maize is predominantly followed by the farmers of Assam and changing scenario maize is replacing the rice-rice cropping system in recent days (*Kalita, B. and Bora, S. 2019*). Maize is one of the most important cereal crops and has higher production and wider adaptability and multifarious uses (*Panwar et al., 2021*) and because of wide spaced crop can accommodate short duration crops including vegetables to increase production and productivity per unit area. But adoption behavior of farmers for crops other than maize is quite different (*Rathore et al., 2003*; *Gupta and Chauhan, 2004*). The objective of this paper was to explore predictive factors of the adoption of maize-based cropping systems in flood-affected areas of Assam.

METHODOLOGY

The present study was undertaken in the state of Assam. Marigaon district was selected randomly among the flood-affected districts of Assam. Out of a total of seven ADO circles four ADO circles namely- Mayong, Gosorguri, Gerua and Lahorighat were purposively selected for the study as most of the areas of these ADO circles are affected by floods every year. From each of the ADO circles two VLEW elekas were selected and from each of the VLEW eureka one village was selected randomly. A total of eight villages were selected randomly for the present study. Fifteen respondents were selected from each of the villages by simple random sampling method and the total population size for the study was 120. Data were collected through the personal interview method by using a structured schedule. After that, tabulation, as well as frequency, percentage, and mean calculation, was done for the socio-economic and psychological characteristics of respondents. For measuring the extent of adoption score was given for each of the cultivation practices by using the formula and the score ranged from 18 – 52.2. Based on the total score obtained from the cultivation practices the respondents were categorised as low, medium, and high levels of adoption. The extent of adoption was measured by using the following formula-

$$EA_{xi} = \frac{AAxi}{PAxi} \times 100$$

Where,

EA_{xi}= Extent of adoption of x^{th} respondents in i^{th} practices.

AAxi= Actual area covered for x^{th} respondents in i^{th} practices.

PAxi= Potential area covered for x^{th} respondents in i^{th} practices.

In order to determine the factors that influence the adoption behavior of farmers on maize-based cropping system in flood-affected areas, the Pearson product-moment correlation coefficient and multiple linear regression (MLR) model was carried out. The results of correlation analysis were fitted in a regression equation and regression analysis was run in SPSS.

RESULTS AND DISCUSSION

Socio-economic characteristics of maize growing farmers : The profile analysis of the respondents who followed the maize-based cropping system revealed that the majority (44.17%) of the respondents belonged to an age group of 36- 50 years with a medium educational experience level of 5.83 to 13.63 years. Average experience in education was found as 9.73, which indicates that most of the respondents completed their formal education up to IX standard. 64.17 per cent of respondents had a large family where the numbers of family members were 7 and more than 7. A joint family system is still seen in the study areas. Most of the respondents had high experience in farming with an average of 25 years. Small farmers dominated in the study areas with a percentage of 38.33 per cent, who had an operational land holding of 1-2 ha and it is followed by the marginal farmers group. In the case of maize cultivated area, 62.50 per cent of the respondents had a medium percentage share of maize cultivated area from their operational land holding with medium cropping intensity. An average of 159 per cent of their net sown areas were cultivated with more than two crops. In the study areas, floods occurred more than three times with an average of 58 cm in depth and 8 days of inundation period.

The majority of them belong to a medium flood-prone area, necessitating the need for land configuration to accommodate crop other than rice under water-

Table 1. Maize-based cropping system practices in sample areas

Cropping system	Situation I* No. (%)	Situation II** No. (%)	Over all No. (%)
Maize-Maize/Mustard-Vegetable	43(71.67)	15(25.00)	58(48.33)
Rice/Maize-Maize/Mustard-Vegetable	17(28.33)	10(16.67)	27(22.50)
Rice/Maize-Maize/Boro paddy-Jute/ Vegetable	0 (0.00)	24(40.00)	24(20.00)
Rice/Maize-Maize/Boro paddy-Vegetable	0 (0.00)	11(18.33)	11 (9.17)
Total	60(50.00)	60 (50.00)	120(100.00)

*Situation-I: Range of flood water level 30-45 cm and inundation period 4-7 days
**Situation –II: Range of flood water level 46-90 cm and inundation period 8-15 days

stagnated conditions *(Panwar, 2008*) and through the vertical cropping concept (*Panwar et al., 2019)*. The major portion of respondents were under the medium resource status group, which means availability, accessibility, and applicability of different resources like seed, fertilizer, pesticides etc were medium. Likewise, farm information source relevancy was found as medium for majority (74.17%) of the respondents. There were different information sources available in the areas like newspaper, TV, extension agents, peer farmers etc. But among all these, TV was found as the most available, accessible and applicable resource and it was ranked as first followed by friends or relatives and extension agents. *Noopur et al., (2023)* stated that farmers are influenced by TV, friends and relatives for adoption of production technology. In the case of organizational linkage, the farmers' organisation was the most linked institution by the respondents. After that DAO and KVK were ranked as second and third linked institutions respectively. 35 per cent of the respondents visited to market on a daily basis followed by 28.33 per cent who visited once in 2-3 days. For market agents visiting a farm, 40 per cent of market agents visited once in 15 days to a farmer's farm and it is followed by 29.17 per cent of market agent visited to farm once in a month. Maximum (75%) of them belonged to medium training exposure group. Majority of them attended training on maize and other training programmes for 1 to 3 days. Likewise for economic motivation, degree of innovativeness and risk orientation majority proportion of respondents were under medium category group and share a percentage of 65.83 per cent, 77.5 per cent, and 65.83 per cent respectively.

Maize-based cropping system followed in sample areas : It is observed from Table 1 that the most prominent maize-based cropping system followed in the sample areas was "Maize-Maize/Mustard-Vegetable" with 48.33 per cent adopters followed by "Rice/Maize-Maize/Mustard-Vegetable" (22.50%).

Vegetables grown either for commercial purpose or domestic purposes in kitchen gardens play a significant role in food and nutritional security (*Noopur et al., 2021*).

In flood situation–I (flood water level ranges from 30-45 cm and inundation period 4-7 days) majority of respondents (71.67%) followed Maize-Maize/ Mustard-Vegetable cropping system and the remaining proportion of respondents (28.33%) adopted Rice/ Maize-Maize/Mustard-Vegetable cropping system. While in situation–II (flood water level ranges 46-90 cm and inundation period ranges 8-15 days) 'Rice/ Maize-Maize/Boro paddy-Jute/ Vegetable" cropping system was adopted by the majority of farmers (40%) and 'Maize-Maize/Mustard-Vegetable' cropping system was the second important cropping system adopted by the 25 per cent farmers. It may be inferred that farmers of flood-affected areas cultivated maize crops to escape the damage caused by flood and shifted their cropping system from rice-based to maize-based cropping system. Again, farmers from very high flood intensity and severity areas adopted the maize –boro paddy–vegetable cropping system while in moderate or less flood intensity and severity areas farmers adopted maize – mustard –vegetable cropping system.

Further, It was seen from Table 2 that all respondents followed the practices of "method of sowing" and "irrigation and drainage management" as per the recommendation of a package of practices while around 56.67 per cent of farmers adopted weeding operation as per the recommendation. Around 17.50 per cent of farmers adopted the recommended varieties of maize crop. On the other hand, the recommended 'fertilizer management and plant protection practices were not adopted by any of the respondents. Farmers adopted some varieties and plant protection chemicals which are not recommended by the state department of agriculture. Fertilizers are applied in maize crop with

Table 2. Distribution of respondents according to adopters of recommended cultivation practices of maize crop

Recommended practice	Situation –I* (n=60)	Situation –II** (n=60)	Overall (N=120)
Varieties	15 (25.00)	6(10.00)	21(17.50)
Method of sowing	60(100.00)	60(100.00)	120(100.00)
Weeding operation	38(63.33)	30(50.00)	68(56.67)
Irrigation and drainage management	60(100.00)	60(100.00)	120(100.00)
Fertilizer management	0(0.00)	0(0.00)	0(0.00)
Plant protection practices	0(0.00)	0(0.00)	0(0.00)

*Situation-I: Range of flood water level 30-45 cm and inundation period 4-7 days

**Situation –II: Range of flood water level 46-90 cm and inundation period 8-15 days

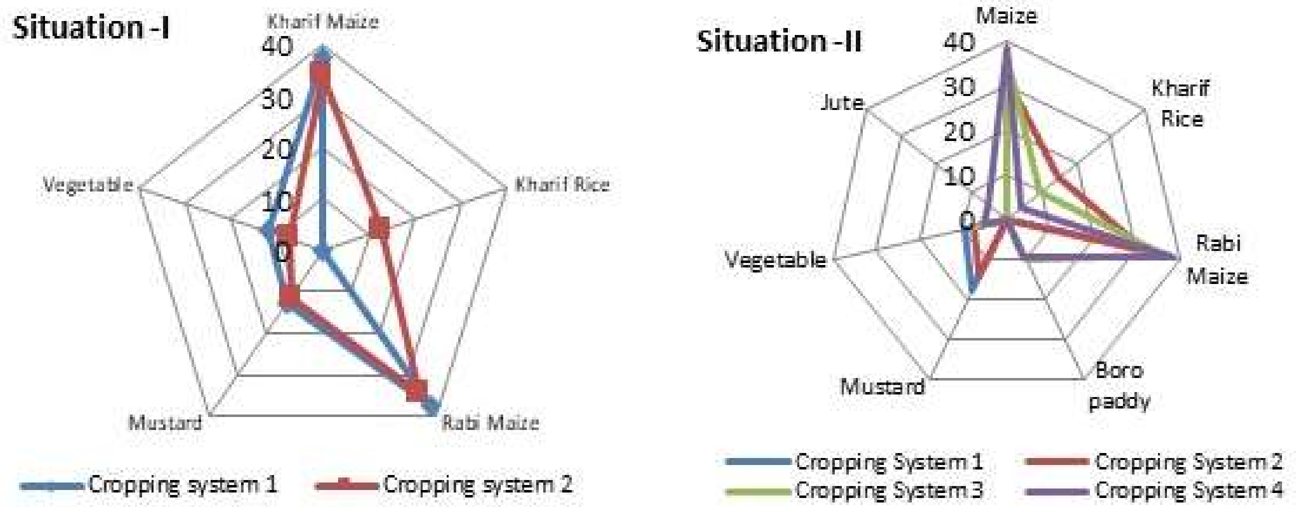

Fig. 1. Percentage share of average area by different maize-based cropping systems in situation-I &II.

over doses. It may be due to either presence of private extension service providers like input dealers, other company personnel who marketing their products or adjust the cultivation practices based on the nature flood intensity and severity.

Again, it was observed that area coverage by each of the crops under the cropping systems varied according to the flood situati**ons (Fig-1).** In flood situation-I, two cropping systems were practiced by the farmers. The highest percentage of the area was occupied by maize (75.38%) in cropping system-1 while in cropping system-2 maize covered around (68.75%). *Kharif* and *rabi* maize are important crops in terms of area coverage in cropping system -1 & 2. In flood situation-II *kharif* and *rabi* maize occupied the majority of areas in all four cropping systems. But out of four cropping systems highest crop area was covered by maize in cropping system-4 (76.54%) followed by cropping system-1 (73.16%). This finding is akin to the findings reported by *Pandey, et al. (2017).* It can be interpreted that in terms of area coverage in flood-affected areas maize become a dominating crop though some areas are occupied by *kharif* rice.

The extent of adoption measures of maize-based cropping system adopted by the farmers in the study area in coping with affected situations and its variability was assessed with the help of a standardized index developed for this study. The observed index range of farmer's overall adoption ranged from 18 to 52.2 with an average of 31.55 and a standard deviation of 7. 48. Data in Table 3 revealed that almost 63.33 percent of the respondents were medium-level adoption followed by low (20%) and high (16.67%) adoption category. This indicated that the majority of the farmers in study area had a moderate level of adoption which need

Table 3. Distribution of respondents according to their level of adoption of maize-based cultivation practices (N=120)

Category	Score range	No. (%)
Low adoption	Below 24.07	24(20.00)
Medium adoption	24.07-39.03	76(63.33)
High adoption	Above 39.03	20(16.67)
Total		120(100)
Mean	31.55	
SD	7.48	
CV	23.72	

to be increased through vocal for local (*Sandhu and Chauhan, 2020*). Similar findings were reported by *Ranawat et al. (2011)*; and *Sarvesh and Mishra (2018).*

Correlation of independent variables with the extent of adoption : From Table 4, it is observed that out of 19 independent variables 12 independent variables have a significant relationship with the extent of adoption. The related independent variables are age(X_1), farming experience (X_4), Operational land holding (X_5), maize-covered area (X_6), flood proneness (X_7), cropping intensity (X_8), resource status (X_9), economic motivation (X_{15}), degree of innovativeness (X_{16}), risk orientation (X_{17}), perceived effectiveness (X_{18}) and income (X_{19}).

Age (r = -.383) was found to have a negative significant relationship with the extent of adoption. This indicates increasing the age of respondents will decrease the adoption. It may be interpreted that young farmers are more innovative and interested in adopting new technology to earn more income and improve their existing situation. But the old-aged farmers are more orthodox in nature. They did not want to leave their cropping system which is followed for several years. So young farmers are more inclined towards the maize-based cropping system. This finding is corroborated by the findings of *Gideon et al. (2017)* and *Ebojei et.al (2012).*

Table 4. Relationship of independent variables with extent of adoption

Independent variables	r-value	P-value	t-value
Age (X_1)	-.383**	0.000	-4.189
Educational experience (X_2)	0.62	.529	0.632
Family size (X_3)	.032	.747	0.323
Farming experience (X_4)	.537**	0.000	6.430
Operational land holding(X_5)	-.543**	0.000	-7.019
Maize covered area (X_6)	.819**	0.000	15.4
Flood proneness (X_7)	-.330**	0.000	-3.777
Cropping intensity (X_8)	.469**	0.000	5.740
Resource status (X_9)	.413**	0.000	4.575
Information source relevancy (X_{10})	-.028	.777	-.284
Institutional linkage (X_{11})	-.116	.241	-1.180
Farmers visit to the market (X_{12})	.082	.407	.833
Market agents visit to the farmer(X_{13})	-.048	.631	-.481
Training exposure (X_{14})	-.030	.380	-.882
Economic motivation (X_{15})	.068*	0.50	1.966
Degree of innovativeness (X_{16})	.074*	.034	2.154
Risk orientation (X_{17})	.639**	0.000	9.019
Perceived effectiveness (X_{18})	.524**	.000	6.654
Income of farmers (X_{19})	.204*	.026	2.250

*Significant at 0.05 level of probability;
**Significant at 0.01 level of probability;
r = Correlation coefficient

The farmer who has more farming experience had more adoption of the maize-based cropping system so this variable is positively related to the extent of adoption (r = .537). If a farmer has more experience in farming he can better understand and identify the advantages of a new cropping system or crop as compared to the old one based on the situation. Similar findings were reported by *Kudi et al. (2011)*, *Oinam, et al. (2019)* and *Abubakar et al. (2019).*

Operational land holding had a negative relation with the extent of adoption (r = -0.543). It may be due to the reason that the farmers who had less land holding had a higher adoption percentage. Because they are more conscious of income and with less land they want to profit more. If they choose any cropping system which will not suitable for their situation it may cause huge damage and they do have not enough land to cultivate more so operational land holding has a negative relationship. This finding is corroborated by the findings of *Abubakar et al (2019).*

The maize-covered area was found to be positively related to the extent of adoption (r = .819). Farmers who had more maize-cultivated areas had more adoption. This may be interpreted that farmers who have more maize cultivated areas their levels of adoption will be more.

For farmers who belong to a highly flood-prone area where flood water causes huge damage to crop fields and the duration of flood inundation is for long period the extent of adoption becomes less, so flood proneness was negatively significant with this dependent variable (r = -.330).

The independent variable resource status (r = .413) is positively related to the extent of adoption. This indicates farmers having more access to and availability of resources will extend of adoption of maize-based cropping system. It may be interpreted as in the study areas seeds, fertilizer, pesticides etc. are easily available for growing maize, also the resources can easily be accessed by the farmer so the extent of adoption is greater.

Economic motivation (r = .068) was found positive relationship with the extent of adoption of maize-based cropping system which indicates with an increase of farmers' economic motivation the extent of adoption is also increased. It may be interpreted that farmers who take up farming as a business will be more concerned about improving and proven technologies and they adopted the scientific technologies for earning more profit. A similar finding was reported by *Khan and Chauhan, (2005)*

Degree of innovativeness (r = .074) was found positive relationship with the extent of adoption. This indicates with increases in the degree of innovativeness farmers' adoption level is increased. Innovative farmers always try new technologies that are advantageous over the existing technologies and thus their levels of adoption of technologies are more. The finding is supported by the findings of *Tankodara and Gohil (2020).*

Risk orientation (r = .639) was found a positive significant relationship with the extent of adoption. Farmers who want to take more risks to earn profit adopted a more maize-based cropping system. *Takam et al. (2018)* and *Tankodara and Gohil (2020)* also reported similar findings.

The perceived effectiveness of maize-based cropping systems to adapt flood-prone areas (r=0.524) and income were positively related to the extent of adoption. With the increasing effectiveness as perceived by the farmers, the extent of adoption of maize-based cropping system increases.

The income of farmers (r=0.204) was found a positive and significant correlation with the extent of adoption of the maize-based cropping system. This indicates the extent of adoption of maize-based cropping systems increases with increases in farmer's income. It may be interpreted that high-income category farmers had a high level of adoption. The findings are in line with findings reported by *Ebojei et.al (2012), Nathanel et al. (2015), Kudi et al. (2011), Abubakar et al. (2019)* and Gupta, et al (2010).

Predictive factors of the extent of adoption of maize-based cropping system : In order to assess the predictive factors for the extent of adoption SMLR analysis was run in SPSS**.** Table 5 reveals that eleven explanatory variables significantly contributed to explaining the variation of the extent of adoption and they will predict about 87 per cent variation in the extent of adoption of maize-based cropping system (R^2 = .878). Age, operational land holding and flood proneness were found a negative significant relation with the extent of adoption. The coefficient value of age is 0.179, which indicates that with the increase in age by one year of the respondent the extent of adoption will decrease by 0.179 times. Likewise, a unit change in operational land holding and flood proneness will lead to a decrease in the extent of adoption by 2.311 and .463 times

Table 5. The relative contribution of independent variables to the extent of adoption

Independent variables	Unstandardized coefficients		Standardized coefficients	Sig.
	B	SE	Beta	
Intercept	14.026	10.270		.175
Age (X_1)	-.179**	.043	-.226	.000
Educational experience (X_2)	.064	.102	.029	.529
Family size (X_3)	.088	.272	.013	.747
Farming experience (X_4)	.459**	.071	.462	.000
Operational land holding(X_5)	-2.311*	.329	-.543	.000
Maize covered area (X_6)	.381**	.025	.819	.000
Flood proneness (X_7)	-.463**	.123	-.302	.000
Cropping intensity (X_8)	.274**	.048	.459	.000
Resource status (X_9)	.217**	.047	.217	.000
Information source relevancy (X_{10})	-.030	.106	-.012	.777
Institutional linkage (X_{11})	-.055	.047	-.055	.241
Farmers visit to the market (X_{12})	.305	.366	.043	.407
Market agents visit to the farmer(X_{13})	-.126	.262	-.043	.631
Training exposure (X_{14})	-.176	.200	-.033	.381
Economic motivation (X_{15})	.223*	.114	.097	.050
Degree of innovativeness (X_{16})	.003*	.153	.124	.034
Risk orientation (X_{17})	.122	.128	.043	.342
Perceived effectiveness (X_{18})	.613**	.377	.147	.000
Income of farmers (X_{19})	.000006*	.000	.203	.037

R^2 = .878 Adjusted R^2 = .858 *Significant at .05 level **Significant at .01 level respectively. Except for these three variables, the other variables were positively significant with the extent of adoption. A unit change in farming experience will lead to an increase in the extent of adoption level by .459 times. Likewise, unit changes for maize covered area, cropping intensity, resource status, economic motivation, degree of innovativeness, perceived effectiveness and income will be increasing in the level of extent of adoption. The findings are supported by the findings of *Nathanel et al. (2015), Kudi et al. (2011)*, *Abubakar et al. (2019), Sharma et al. (2014)* and *Kiranmayi. et.al. (2016).*

The best predictive model from the selected explanatory variables for the predictor variable extent of adoption is

$$Y= 14.026-0.179 X_1 + 0.459 X_4 - 2.311 X_5 + 0.381 X_6 - 0.463 X_7 + 0.274 X_8 + 0.217 X_9 + 0.223 X_{15} + .003 X_{16} + 0.613 X_{18} + 0.000006 X_{19} -e$$

Where-

X_1=Age, X_4 = Farming experience, X_5 =Operational land holding, X_6 = Maize cultivated area, X_7 = Flood proneness, X_8 = Cropping intensity, X_9 = Resource status, X_{15} = Economic motivation, X_{16} = Degree of innovativeness, X_{18} = Perceived effectiveness, X_{19} = Income

CONCLUSION

The prominent maize-based cropping 'maize – maize/mustard-vegetable' cropping system was found in sample areas. Farmers cultivated maize crops twice a year keeping land fellow during the *kharif* season to escape flood damage. The major share of the area was occupied by maize crops in all maize-based cropping systems. This indicates in flood-affected areas maize maize-based cropping system replaced the rice-based cropping system. Maize crops now become remunerative crops in flood-affected areas. The adoption of a maize-based cropping system in flood-affected areas was influenced by farmers' socio-economic characteristics like age, farming experience, operational land holding, maize cultivated area, flood proneness, cropping intensity, resource status, economic motivation, degree of innovativeness, perceived effectiveness, and income. Since the adoption level was found to decrease with an increase in the age of farmers young farmers who started farming as a livelihood option may be considered as participating farmers for rapid diffusion of maize cultivation in flood-affected areas. Moreover, the adoption of maize cultivation may be higher in less intensive flood-prone areas so, an area expansion programme on maize-based cropping systems may be implemented to reduce the flood damage in those areas. Extension agencies may consider these factors for planning and implementation of extension programmes to expedite the adoption process of maize-based cropping systems among farmers of flood-affected areas.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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