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RESEARCH ARTICLE

Adoption of Farming Systems Approach to Increase Farmers' Income in Tarai Region of Uttar Pradesh

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ABSTRACT

The present study was carried out in the Tarai region of Uttar Pradesh. The interview schedule was used to obtain data from 400 respondents. Use of practices of increase income in farmers in the Tarai region of Uttar Pradesh. The recommended practices were categorized into ten i.e. Seeds, Manures, weed management, Crop rotation, Mulching, Plant protection measure, Market management, Vegetable cultivation practices, Scientific Dairy Husbandry Practices and Goat healthcare management practices among the farmers. Revealed that the farmers of the study aria in adoption level followed the important practices of improving farming systems and livestock. Majority of the respondents were found category of seeds in sub category Certified seed, Local/ resistant varieties 97.5 per cent and Improved seed 89.05 per cent high level adoption of farmers in the increase income. Adoption was higher for farmers and increased farms income in use practices of Manures 97.5 per cent. The practice-wise adoption was calculated, and it found that procedures related to farming obtained more Adoption of the of low-level goat healthcare management practices of goat farming in sub category, Personal hygiene 8 per cent, keeping sick in dry and clean place 9.75 per cent, Regular deworming 5.75 per cent and consult veterinary doctors immediately when sick 32.75 per cent. Among the characteristics examined, education, income and marketing orientation showed a highly significant and positive correlation with adoption levels. The study presents a suggestion that strategies aimed to encourage adoption should consider the interconnection of the various technologies. In order to reduce partial adoption, it is also necessary to provide farmers who cannot afford the cost of inputs with support in the form of input subsidies.

Keywords*: *Adoption; Tarai region; Farming system approach; Uttar Pradesh; Income.

In India, women account for 65.00 per cent of the workforce in farming systems, which remain the backbone of the country's economy and the primary source of livelihood for rural households, particularly small and marginal farmers, ensuring food and nutritional security (*Kumar et al., 2020*). However, despite being a leading country in terms of agricultural area and production, India lags behind in terms of productivity compared to other leading nations, mainly due to various factors. Weed infestation is one of the significant limiting factors affecting productivity (*Singla and Singh, 2020*). The world has witnessed a substantial shift in population distribution, with urban areas projected to accommodate over 60 per cent of the global population by 2030, totaling more than 1.4 billion people, primarily in the developing world (*Kumari and Shirisha 2021*). This rapid urbanization trend is a crucial demographic phenomenon of the 21st century.

Integrated farming systems refer to the combination of two or more farming components to form a cohesive system. Integrating livestock with fishery has become a modern trend within farming systems involving fish and horticulture. Vegetable-based farming is also gaining prominence in India, offering higher income potential compared to other agricultural practices within a shorter timeframe. To minimize losses and enhance returns, farmers should adopt cost-effective postharvest technologies that help maintain the freshness of perishable produce for longer periods or process them into durable products. Goats account for 26.40 per cent of the livestock population

in India, with Uttar Pradesh and West Bengal being the leading states in goat population (*GOI, 2012*). To achieve desirable outcomes, goat producers should implement scientific feeding, breeding, healthcare, management, and marketing practices. While modern agricultural systems based on high-yielding seed varieties, chemical fertilizers, water resource control, pesticides, and fungicides have primarily benefited larger farmers, certain regions, specific crops, and small and marginal farmers have been left behind, contributing to rural sector disparities.

Farmers' adoption of new technologies is influenced by their demands and the compatibility of the technology with biophysical, socio-cultural, and geographic factors. Fertilizer usage is a significant technology, but it also contributes to nitrous oxide emissions and global warming. Enhancing soil fertility through the addition of essential nutrients is crucial, with synthetic (inorganic) fertilizer playing a primary role alongside organic matter, crop residues, wet and dry deposition, and biological nitrogen fixation. Effective weed management is essential for optimizing crop output. Both government and non-governmental organizations in India are working to disseminate weed management methods among farmers. A study conducted in Ghana evaluated the factors affecting the adoption of Crop Protection and Soil Fertility (CPSF) management practices and the intensity of adoption among soybean producers (*Anang et al., 2021*). The use of plastic mulch in agriculture has gradually increased in many countries over time. This practice offers agronomic benefits such as increased crop yields, reduced weed pressure, moisture conservation, decreased insect pests, and improved soil nutrient utilization.

METHODOLOGY

The study was conducted in the Tarai region of Uttar Pradesh, focusing on districts that encompassed over 50 per cent of the Tarai area. The selected districts for the study were Pilibhit, Shravasti, Bijnor, and Saharanpur. To ensure representation, eight blocks were randomly chosen from these districts. Sixteen villages were then selected from each block using random sampling. From each village, 25 farmers were randomly selected, resulting in a total sample size of 400 respondents. Data collection was carried out using an interview schedule. The collected data were coded, tabulated, and analysed using appropriate statistical tools and techniques in line with the study's objectives. Analysis involved the use of frequency, per centage, arithmetic mean, standard deviation, and correlation analysis.

RESULTS AND DISCUSSION

Adoption of Seed Practices: The findings of the study indicate that most of the farmers adopted certified seeds and local/resistant varieties (97.5%). Improved seeds were also adopted by a significant proportion of farmers (89.5%), while non-BT seeds were adopted by 7 per cent of farmers. The use of treatments such as bio-fertilizers before sowing crops in improved farming practices was observed among 77.75 per cent of farmers. The findings of the study are consistent with the findings of *Singh et al. (2010)* and *Singh et al. (2012),* who utilized chemical technologies to control P. minor and wild oat in wheat. The study revealed that over 60 per cent of the moth bean growers fully adopted the recommended practices, including the use of improved seed sowing time.

Adoption of manure practices: The adoption of manure practices was assessed and presented in Table 1. The results revealed that farmyard manure was widely adopted (97.5%), followed by vermicompost (75.25%), compost (64.25%), poultry and sheep manure (42%), and oil-cake (37.5%). Organic manures were also available through Krishi Vigyan Kendras (67.75%). The findings of the study are consistent with the findings of *Ahmad et al. (2014)* where respondents reported using the recommended dose of FYM (Farm Yard Manure) at a rate of 68.00 per cent.

Adoption of weed management: Weed management practices were adopted based on the benefits they provide in farming systems. These benefits include increased crop production and productivity (68.5%), reduced chemical hazards (57%), maintenance of soil fertility (60.75%), and preservation of soil moisture content (75.25%). Suitable methods of weed management in farming systems included the use of bio-herbicides (56.5%), hand weeding (58.25%), crop rotation (54%), bio-predators (26.5%), and intercropping (69.25%).

Adoption of crop rotation: Crop rotation practices were observed to involve different combinations of crops in farming systems. The adoption of crop rotation included cereal crop-leguminous crop-vegetables (63%), cereal crop-oil crop-vegetables (69.25%), and fiber crop-cereal crop-leguminous crop (59.25%).

Adoption of mulching: Mulching practices were

Table 1. Distribution of respondents according to adoption level

Statements	Fully	Partial	No	Total Adoption	MS
Seeds					
Non-BT	7.00 (1.75)	0.00 (00)	0.00 (00)	7.00	0.07
Certified seed	189 (47.25)	201 (50.25)	10.00 (2.5)	390 (97.5)	0.97
Local/ resistant varieties	263 (65.75)	127 (50.25)	10.00 (2.5)	390 (97.5)	0.97
Improved seed	243 (60.75)	115 (28.75)	42.00 (10.5)	358 (89.5)	0.89
Are you use treat the seed which elements used before sowing the crops?					
Bio-fertilizer	109 (27.25)	202 (50.5)	89 (22.25)	311 (77.75)	0.77
Panchgavya	83 (20.75)	181 (45.25)	136 (34.0)	264 (66)	0.66
Cow-urine	16 (4.00)	252 (63)	131 (32.75)	268 (65.5)	0.67
Wood ash	66 (16.5)	163 (40.75)	171 (42.75)	229 (57.25)	0.57
Manures					
In farming system approach which bulky organic manures should be used?					
Farm yard manure	244 (61)	146 (36.5)	10 (2.5)	390 (97.5)	0.97
Compost	18 (4.5)	239 (59.75)	143 (35.75)	257 (64.25)	0.64
Vermi-compost	81 (20.25)	220 (55)	117 (29.25)	301 (75.25)	0.75
Oil-cake	00 (00)	150 (37.5)	250 (62.5)	150 (37.5)	0.37
Poultry and sheep manure	101 (25.25)	67 (67.75)	232 (58)	168 (42)	0.42
please tell the two sources at which the organic manures is usually available					
KVKs	112 (28)	159 (39.75)	129 (32.25)	271 (67.75)	0.67
Weed management					
Benefits of weed management					
It increases crop production and productivity.	113 (28.25)	161 (40.25)	126 (31,5)	274 (68.5)	0.68
Decrease the chemical hazards.	14 (3.5)	214 (53.5)	172 (43)	228 (57)	0.57
It maintains soil fertility.	40 (10)	203 (50.75)	157 (39.25)	243 (60.75)	0.60
It maintains the moisture content in soil.	38 (9.5)	191 (47.75)	171 (42.76)	229 (57.25)	0.57
Suitable methods of weed management					
Use bio-herbicide	6.00 (1.5)	220 (55)	174 (43.5)	226 (56.5)	0.56
Hand weeding	131 (32.75)	102 (25.5)	176 (44)	233 (58.25)	0.58
Crop rotation	195 (48.75)	21 (5.25)	184 (46)	216 (54)	0.54
Use of bio-predators	7.00 (1.75)	99 (24.75)	294 (73.5)	106 (26.5)	0.26
Intercropping	2.00 (0.5)	275 (68.75)	123 (30.75)	277 (69.25)	0.69
Crcrop rotation					
Crop rotation					
Cereal crop-leguminous crop-vegetables	133 (33.25)	119 (29)	148 (37)	252 (63)	0.63
Cereal crop-oil crop- vegetables	153 (38.25)	124 (31)	123 (30.75)	277 (69.25)	0.69
Fiber crop-cereal crop- leguminous	27 (6.75)	210 (52.5)	163 (40.75)	237 (59.25)	0.59
Mulching					
Mulching should be used					
Plastic film	43 (10.75)	228 (57)	129 (32.25)	271 (67.75)	0.67
Crop residue	122 (30.5)	139 (34.75)	139 (34.75)	261 (65.25)	0.65
Soil mulch	158 (39.5)	85 (21.25)	157 (39.25)	243 (60.75)	0.60
Saw dust organic product	102 (25.5)	155 (38.75)	143 (35.75)	257 (64.25)	0.64
Please state the four benefits of mulching					
Improve the soil structure.	36 (9)	156 (39)	208 (52)	192 (48)	0.48
Decreasing water loss due to evaporation.	53 (13.25)	202 (50.5)	145 (36.25)	255 (63.75)	0.63
Reducing the weed problem.	4.00 (1)	195 (48.75)	201 (50.25)	199 (49.75)	0.49
Preventing soil erosion.	34 (8.5)	204 (51)	162 (40.5)	238 (59.5)	0.59
Plant protection measure					
Methods of disease and pest management					
Cultural control	112 (28)	169 (42.25)	119 (29.75)	281 (70.25)	0.70
Physical and mechanical control	65 (16.25)	195 (48.75)	140 (35)	260 (65)	0.65
Biological control	2 (0.5)	253 (63.25)	145 (36.25)	255 (63.75)	0.63
Pest management through plant product	71 (17.75)	189 (47.25)	140 (35)	260 (65)	0.65
Disease and pest management by cultural practices?					
Time of sowing, planting and harvesting	154 (38.5)	95 (23.75)	151 (37.75)	249 (62.25)	0.62

Using resistant varieties.	14 (3.5)	217 (54.25)	169 (42.25)	231 (57.75)	0.57
Using good quality seeds.	38 (9.5)	245 (61.25)	117 (29.25)	283 (70.75)	0.70
Use pest- disease free seeds.	35 (8.75)	223 (55.75)	142 (35.5)	258 (64.5)	0.64
Suitable method for the use of bio-pesticide					
By spraying.	120 (30)	160 (40)	120 (30)	280 (70)	0.70
Botanical pesticides					
Neem oil	18 (4.5)	246 (61.5)	136 (34)	264 (66)	0.66
Neem leaves	1.00 (0.25)	262 (66)	133 (33.25)	263 (65.75)	0.65
Castor oil	0.00 (00)	189 (47.25)	211 (52.75)	189 47.25	0.47
Market management					
Cost of product	57 (14.25)	162 (40.5)	181 (45.25)	219 (54.75)	0.54
Places for selling the organic products.					
Super market	2.00 (0.5)	144 (36)	254 (63.5)	146 (36.5)	0.36
Specialty stores	7.00 (1.75)	203 (50.75)	190 (47.5)	210 (52.5)	0.52
Domestic organic market	5.00 (1.25)	216 (54)	179 (44.75)	221 (55.25)	0.55
Vegetable cultivation practices					
Nursery Raising	32 (8)	11 (2.75)	357 (89.25)	43.00 (10.75)	0.10
Improved varieties	129 (32.25)	14 (3.5)	257 (89.25)	143 (35.75)	0.35
Application of manures and fertilizer	80 (20)	61 (15.25)	259 (64.75)	142 (35.5)	0.35
Seed rate	88 (22)	120 (30)	192 (48)	208 (52)	0.52
Agronomic practices	129 (32.25)	103 (25.75)	168 (42)	232 (58)	0.58
Disease management	146 (36.5)	145 (36.25)	109 (27.25)	291 (72.75)	0.72
Scientific dairy husbandry practices					
Breeding	173 (43)	52 (13)	175 (43.75)	225 (56.25)	0.56
Feeding	160 (40)	69 (17.25)	171 (42.75)	229 (57.25)	0.57
Health-Care	195 (48.75)	94 (23.5)	111 (27.75)	289 (72.25)	0.72
Management	160 (40)	67 (16.75)	173 (43.25)	227 (56.75)	0.56
Fodder Production	162 (40.5)	117 (29.25)	121 (30.25)	279 (69.75)	0.69
Goat healthcare management practices					
Personal hygiene	20 (5)	12 (3)	368 (92)	32 (8)	0.08
Keeping sick in dry and clean place	23 (5.75)	7.00 (1.75)	370 (92.5)	30 (9.75)	0.07
Regular deworming	14 (3.5)	9.00 (2.25)	377 (94.25)	23 (5.75)	0.05
Consultancy with vet.doctors	15 (3.75)	116 (29)	269 (67.25)	131 (32.75)	0.32

Table 2. Distribution of farmer respondents based on the Adoption in Rank Wise

Practices	MS	Ranks
Seed	7.99	II
Manure	5.43	IV
Weed Management	3.49	VI
Crop Protection	2.69	VII
Mulching	6.17	III
Plant Protection Measure	9.27	I
Market Management	2.18	VIII
Vegetable	1.06	IX
Dairy	4.99	V
Goat	0.46	X

Table 3. Correlation coefficient (r) between selected characteristics of the respondents their Adoption level.

Independent variable	('r')
Age	-0.001
Education	0.0406**
Gender	-0.063
Family Type	0.062
Caste Category	0.28
Economically active family members	-0.132**
Type of dwelling	0.101*
Household size (No.)	-0.149**
Annual expenditure	0.123*
Cultivable land	-0.003
Farming Experience	0.030
Income Rs.	0.183**
Social Participation	0.111*
Access to credit:	0.044
Crop insurance:	0.070
Innovativeness	-0.17
Risk orientation	0.099*
Economic motivation:	0.81
Marketing orientation	0.249**
Extension Contact	-0.029
Informal sources	0.003
Mass media exposure	0.096
Agricultural Implements	0.038
Vehicles	0.110
Household gadgets	0.062

* Significant at 0.01 level of probability,
**Significant at 0.05 level of probability

recommended in farming systems, with different types of mulch being adopted. These included plastic film (67.57%), crop residue (65.25%), soil mulch (60.75%), and sawdust organic products (64.25%). The benefits of mulching in farming systems included improved soil structure (48%), reduced water loss through evaporation (63.75%), decreased weed problems (49.75%), and prevention of soil erosion (59.5%).

Adoption of plant protection measures: Plant protection measures were adopted to manage diseases and pests in farming systems. Cultural control (70.25%), physical and mechanical control (65%), biological control (63.75%), and pest management through plant products (65%) were commonly adopted. Cultural practices such as timing of sowing, planting, and harvesting of crops (62.25%), use of resistant varieties (57.75%), use of good quality seeds (70.75%), and use of pest-disease-free seeds (64.5%) were identified as suitable steps for disease and pest management. The use of bio-pesticides through spraying (70%) and botanical pesticides such as neem oil (66%), neem leaves (65.75%), and castor oil (47.25%) were also found to be effective.

Adoption of market management: Market management practices were influenced by factors such as the perceived cost of products from farming systems (54.75%). Suitable avenues/places for selling organic products included supermarkets (36.5%), specialty stores (52.5%), and the domestic organic market (55.25%).

Adoption of vegetable cultivation practices: Vegetable cultivation practices encompassed various aspects such as nursery raising (10.75%), use of improved varieties (35.75%), application of manures and fertilizers (35.5%), seed rate (52%), agronomic practices (58%), and disease management (72.75%). The results of the study are in line with the findings given by (*Singh at al. 2010*) Nearly 50 per cent of the total respondents had adopted the recommended practices like method of sowing (53%), intercultural operations (48%) and land preparation (46%). The practices like seed treatment (13%), disease management (14%), pest management (18%), time of fertilizer application (19%), spacing (24%) were found to have lower adoption.

Adoption of scientific dairy husbandry practices: Scientific dairy husbandry practices covered breeding (56.25%), feeding (57.25%), and health care (72.25%), management (56.75%), and fodder production (69.75%). The results of the study are consistent with the findings reported by *Singh et al. (2010)* and *Tiwari et al. (2003)*. In terms of healthcare practices, a significant majority (78.79%) of landless dairy farmers belonged to the medium level of adoption.

Furthermore, approximately 53.77 per cent of respondents reported that improved animals were costly, while 43.39 per cent mentioned that the availability of artificial insemination facilities for improving the existing breeding of animals was limited.

Adoption of goat healthcare management practices: Goat healthcare management practices included personal hygiene (8%), keeping sick goats in a dry and clean place (9.75%), regular deworming (5.75%), and immediate consultation with veterinary doctors when goats are sick (32.75%). The findings of the study are consistent with the findings of *Yadav (2019)*. The study reported that the highest mean score for the adoption of improved health practices was recorded for the treatment of sick goats (0.740) and deworming for endoparasites (0.68).

The adoption of different practices by farmers is presented in Table 2. Plant Protection Measures, Weed Management, Seed Practices, Mulching, Manure Practices, Vegetable Cultivation, Scientific Dairy Husbandry Practices, Market Management, Crop Rotation, and Goat Healthcare Management were ranked as 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, and 10th, respectively. The findings of the study are consistent with the findings of *Kumawat and Yadav (2012)*. The study revealed that out of forty-one practices of improved dairy husbandry, the highest adoption rate was observed for the practice of "Feeding of balanced ration" with a score of 79.33 MPS.

The correlation analysis presented in Table 3 provides insights into the relationship between selected characteristics of the respondents and their adoption levels. Among the characteristics examined, education (r=0.0406**), income (r=0.183**), and marketing orientation (r=0.249**) showed a highly significant and positive (0.01 level) correlation with adoption levels. This suggests that farmers with higher levels of education are more likely to embrace farming systems approaches, leading to increased adoption rates. Similarly, respondents with higher incomes and a greater focus on marketing their agricultural products demonstrated higher levels of adoption.

On the other hand, the economically active family members (r= -0.132**) and household size (r= -0.149**) were negatively and highly significantly (0.05 level) correlated with the adoption levels. This

implies that larger households with a higher number of economically active family members may face challenges in adopting farming systems approaches due to various constraints, resulting in lower adoption rates.

It is important to note that correlation does not imply causation, and further research is needed to establish the causal relationships between these characteristics and adoption levels. Nonetheless, the findings highlight potential factors that can influence farmers' decisions to adopt farming systems approaches, thereby impacting their income levels.

To promote the adoption of farming systems approaches and enhance farmers' income in Uttar Pradesh, policymakers and agricultural extension agencies can focus on providing educational opportunities and training programs to improve farmers' knowledge and skills. Additionally, efforts can be made to facilitate access to credit, promote marketing strategies, and create awareness about the benefits of adopting innovative agricultural practices.

CONCLUSION

The study highlights the importance of adopting a farming system approach for income generation in the Tarai zone of Uttar Pradesh. It suggests that strategies aimed at encouraging adoption should consider the interconnectedness of various technologies and practices. Furthermore, to address partial adoption, providing support in the form of input subsidies to farmers who face financial constraints is crucial. Among the characteristics examined, education, income and marketing orientation showed a highly significant and positive correlation with adoption levels. This suggests that farmers with higher levels of education are more likely to embrace farming systems approaches, leading to increased adoption rates. Similarly, respondents with higher incomes and a greater focus on marketing their agricultural products demonstrated higher levels of adoption. It can be inferred that by promoting the adoption of recommended practices, farmers can improve their farming systems and enhance their income potential in the Tarai region of Uttar Pradesh.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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