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Analysis of socio-economic and other farm level factors for farmers decision making pattern in adopting agricultural innovations in Karnataka

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Abstract
The present study, investigate the socio-economic and other farm level factors influencing the decision making pattern in adopting agricultural innovations by farmers of Karnataka, India. A secondary data on decision pattern in adoption of agricultural innovations, socio-economic and other farm level factors of 372 farmers was considered. Multinomial logistic regression model was employed to identify potential influencing factors for decision making pattern by farmers. The result revealed that age, family size, socio-economic status (SES total score), yield, cost of cultivation, number of innovations adopted, gross income and net income were found to be significantly (p<0.05) influencing factors for the decision making patterns *viz,* informed and induced categories in adopting agricultural innovations. In conclusion, farmers were facing difficulty in decisions making at several situations towards adoption of any new innovations in agriculture mainly because of inadequate information or awareness about new innovations. Farmers need to have more awareness on their economic status, benefit-cost of different crops, adoption of appropriate innovations which controls the decision making pattern of farmers in perception of any new technology.

Keywords: Socio-economic, decision making pattern, agricultural innovation, multinomial logistic regression, Karnataka

Introduction
One hundred thousand years ago, there were 10,000 people alive on earth. Today, there are almost 7 billion humans sharing the planet (Flannery, 2008) [1]. The activity that covers half the Earth's entire land surface and requires more land, water and human labours than any other is agriculture (Kiers *et al*., 2008) [2]. More than half of all the world's species exist primarily in agricultural landscapes, outside protected areas (World Bank, 2008) [3]. In the past fifty years, global food production more than doubled, keeping pace with population growth but also increasing the environmental footprint of agriculture at the same time (Khan and Hanjra, 2009) [4].

In fact, increased agricultural production is ultimately the result of decisions and actions taken by the lakhs of farmers. Shackle, (1974) [5] wrote that decision is not, in its ultimate nature, calculation, but origination. It requires imagination, because knowledge of the context in which present action will take effect is necessarily imperfect. This is true of farming, where farmers' information needs are extensive because of their roles both as farming practitioners and managers.

Starting in the 1950s, studies began investigating the reasons why people did or did not adopt new agricultural technologies and practices (Klerkx, 2004) [6]. In the 1960s, the development of models of agricultural extension and adoption were being sought after in both academia and policy circles (Leeuwis, 2004) [7]. The 1970s saw greater effort put into understanding the thinking of the farmer, the influence of personal characteristics, goals, values, and how extension could use these factors to achieve increased adoption rates (Barr and Cary, 2000) [8]. From the 1980s, as group rather than individual targeted extension became a more popular approach with policy makers, a gradual awareness of the importance of informal and local networks. With that evolution, studies of decision making and those of agricultural innovation systems are again sharing common areas of inquiry. The traditional approach to decision making in agriculture, largely framed around the question of how best to do 'extension', came under increasing criticism in the 1990s.

Even so, there remains a focus to this day on this aspect and the transfer of knowledge and technologies in order to achieve adoption of new practices as advocated through extension (Koontz, 2001) [9]. Times change and so do communication methods. The effect of proximity in 2011 will differ to that of the 1960s or even the 1990s. Factors such as the level of cohesion within a farming community also play a role and will change over time (Van der Horst, 2011) [10].

The ‘decision making’ paradigms of rural sociology actually have similar origins to that of the innovation systems school of thought. Where innovation systems thinking has tended to focus at the macro level, decision-making studies have tended to focus at the micro level. From the 1950s onwards, there was a strong focus on studies to investigating the reasons why people did or did not adopt new agricultural technologies and practices. Effort was put into understanding the personal characteristics, goals and values of the farmer in order to better target extension programmes. However, there is a whole field of research into farmer decision making, much of which does not cross-reference the literature on innovation and knowledge systems. That said, it still provides important insights.

The farmer’s decision making is a continuous process and is influenced by several factors belonging to socio-economic; different farm level factors and adoption of different types of new innovation in agriculture. The study assessed the decision making patterns in adoption of agriculture innovations and recommended MAX-MIN-FACILITATE extension strategy that implies maximize informed decision making, minimize induced decision making and facilitate imitation decision making (Chandre Gowda *et al*, 2016 and Chandre Gowda *et al*, 2018) [11,12].

Material and Methods

Two years period from 2014-15 to 2015-16 was considered for the purpose of analysing the decision pattern among respondent farmers while adopting agricultural innovations of different crops in Karnataka. The entire study is based on the secondary data. The sources of secondary data were the bestowed data and information under the project entitled ‘Farmers decision making on agricultural innovations: A behavioral analysis’ implemented by the Indian Council of Agricultural Research-Agricultural Technology Application Research Institute (ICAR-ATARI), Main Research Station (MRS), HA farm Post, Hebbal, Bengaluru-24. The basic data from 372 farmers covering socio-economic status; adopted new innovation, year of adoption, time taken to adopt new innovation, source of new innovation, and other farm level factors which influenced the decision pattern *viz*., induced, informed and imitation of adopting new innovations in agriculture in Karnataka.

Regression analysis is a method for investigating functional relationship among dependent and independent variables. Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent or outcome variable. Multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables. The independent variables can be either dichotomous (i.e., binary) or continuous (i.e., interval or ratio in scale). Like binary logistic regression, multinomial logistic regression uses maximum likelihood estimation to evaluate the probability of categorical membership (Stark weather and Amanda, 2011) [13].

In the present study, influence of different factors on the decision making pattern (three categories *viz*., induced, informed and imitation) in adopting agricultural innovations by the farmers was investigated by fitting the multinomial logistic regression model using SPSS version 22.

Results and Discussion

The different factors influencing, decision making pattern of farmers was assessed and Odds ratio associated with each outcome were reported and interpreted. The factors age (p = 0.046, OR =1.025), family size (p = 0.023, OR =0.403), socio-economic status (SES total score) (p = 0.002, OR =1.159), yield (p = 0.041, OR =0.985), cost of cultivation (p<0.001, OR =0.999), gross income (p<0.001, OR =1.01), and net income (p<0.001, OR = 0.999) were significantly influencing the informed category of decision pattern compare to imitation category (Table 1). Whereas, farming experience (p = 0.028, OR =0.808), education (p =0.037, OR =0.974), earning members (p =0.044, OR =0.597), family size (p =0.009, OR =0.327), socio-economic status (SES total score) (p =0.024, OR =1.09), innovations adopted (p =0.039, OR =0.824) and yield (p =00.043, OR =0.985) with induced category (decision pattern) were statistically significant (Table 1). Several studies were witness in the aspect of decision making process and pattern in agriculture and allied sector in India and other contries. The study conducted by Lobell *et al.* (2005) [14] evaluated decision making criteria on sources of between-field wheat *(Triticum aestivum* L.) yield variability for two growing seasons in the Yaqui Valley, Mexico is significant but year-dependent impacts of management on yields. Other study (Darnhofer *et al.* 2005) [15] conducted on farmers’ decision making choice between organic and conventional farm management. The variables such as crop insurance, extension visits, crop diversification and income were significance contribution to make decisions by farmers into adopters and non-adopters in Kolar district of Karnataka (Gowda and Singh, 2016) [16]. The study conducted to determine the factors that influence smallholder farmers’ decision to adopt soil conservation practices revealed that farmers who obtained knowledge on soil conservation through extension/training seminars as well as those with secure land ownership were likely to adopt soil conservation technologies (Kalineza *et al.* 1999) [17]. The earlier study conducted on relationship between the socio-economic profile of farmers and their choice of drought-coping strategies (Rakgase and Norris, 2014) [18] revealed that farm type and literacy level influenced the choice of drought-coping strategies. The study conducted to ascertain different adoption behaviour of farmers revealed that extension contact, annual income, innovation proneness and positive attitude towards farm diversification of farmers had positively significant relationships with the extent of adoption of improved rice cultivation practices under different farming systems in Sonitpur district of Assam (Sangha and Baruah, 2011) [19]. The study conducted by Chandan (2014) [20] on adoption of farm technology revealed that sources of information, socio-economic factors, family size and family types were interrelated and had more strategic effect on adoption of farm technology in West Tripura. Whereas, study conducted in Gujarat on identifies of socio-economic and biophysical factors associated with heterogeneous cropping decisions in response to weather variability by Meha *et al.* (2015) [21] revealed that farmers adopted a variety of strategies to cope with delayed monsoon onset, including increasing irrigation use, switching to more drought-tolerant crops, and/or delaying sowing. A behavioural analysis of farmers' decision making on agricultural innovations in Gujarat and Karnataka states revealed that farmers decision making process is based in adoption of agricultural innovations is based on the different process initiation, type and pattern (Chandre Gowda *et al.* 2016) [11]. The study investigated by Ng'ombe *et al.* (2014) [22] on the major factors affecting adoption of conservation farming by smallholder farm households in Zambia revealed that household size; age of household head; marital status; labour availability; distance to access of vehicular roads; location in agro-ecological regions (AER) I, AER II; in-kind income and off-farm income significantly affect adoption of conservation farming.

Table 1: Relationship between socio-economic and other farm level influencing factors with decision making pattern in adopting agriculture innovations by farmers in Karnataka

Category	Variables	Coefficients (B)	S.E.(B)	Wald statistic (χ^2)	p value	Exp.(B)	95% C.I. for Exp. (B)	
							Lower	Upper
Informed	Intercept	- 3.628	1.658	4.786	0.029	-	-	-
	Age	0.024	0.014	3.270	0.046	1.025	0.998	1.052
	Farming Experience	- 0.016	0.013	1.546	0.214	0.985	0.961	1.009
	Holding size (Ha)	- 0.043	0.033	1.748	0.186	0.958	0.898	1.021
	Cropping area	0.112	0.166	0.454	0.500	1.118	0.808	1.548
	Education	- 0.146	0.121	1.463	0.226	0.864	0.682	1.095
	Earning members in the family	- 0.306	0.272	1.268	0.260	0.736	0.432	1.254
	Family size	- 0.909	0.400	5.152	0.023	0.403	0.184	0.883
	SES total score	0.147	0.047	9.928	0.002	1.159	1.057	1.270
	Innovations adopted (No.)	- 0.096	0.116	0.687	0.407	0.908	0.723	1.141
	Yield (quintals /Ha)	- 0.015	0.007	4.175	0.041	0.985	0.972	0.999
	Cost of cultivation	- 0.001	0.000	15623.025	<0.001	0.999	0.999	0.999
	Gross income	0.001	0.000	30392.335	<0.001	1.001	1.001	1.001
	Net Income	- 0.001	0.000	18261.024	<0.001	0.999	0.999	0.999
Induced	Intercept	0.551	1.786	0.095	0.758	-	-	-
	Age	- 0.008	0.013	0.328	0.328	0.993	0.964	1.023
	Farming Experience	- 0.213	0.112	3.616	0.028	0.808	0.786	1.018
	Holding size (Ha)	- 0.032	0.039	0.688	0.407	0.968	0.898	1.045
	Crop area in 2014-15 (Ha)	0.105	0.196	0.288	0.592	1.111	0.756	1.633
	Education	- 0.256	0.115	4.853	0.037	0.974	0.753	1.261
	Earning members in the family	- 0.516	0.299	2.978	0.044	0.597	0.332	1.073
	Family size	- 1.118	0.428	6.821	0.009	0.327	0.141	0.757
	SES total score	0.086	0.052	2.804	0.024	1.090	0.985	1.206
	Innovations adopted (No.)	- 0.193	0.108	3.204	0.039	0.824	0.633	1.038
	Yield (quintals /Ha)	- 0.015	0.008	3.729	0.043	0.985	0.971	1.000
	Cost of cultivation	-0.001	0.003	0.029	0.864	0.999	0.993	1.006
	Gross income	0.001	0.003	0.031	0.859	1.001	0.995	1.007
	Net Income	- 0.001	0.003	0.031	0.860	0.999	0.993	1.006

Note: All assumptions are based on "IMITATION" as the reference category in this analysis.
All results are generated at 95% confidence level; $p<0.05$ indicates significant

Log- likelihood value of the model with the intercept only (null model) is 584.764 while the full model with age and work status is 537.275 (Table 2). The reduction shows that the model is better at predicting a decision pattern using significant variables. The chi-square value χ^2 = 47.489, $p<0.05$ is statistically significant shows that the overall model is predicting whether someone's decision pattern better than it was with intercept only. Therefore, Age, Number of children, Socio-economic status (SES total score), Yield, cost of cultivation, number of innovations adopted, Gross income and Net income are contributed significantly to fit of the model. The R-Squared values, McFadden, Cox-Snell/ML and Nagelkerke are treated as measure of the effect of size, however unlike in standard multiple regression, it doesn't represent the amount of variance in the outcome variable. However bigger values would indicate a better fit (Samwel *et al*. 2015 and StarkWeather & Amanda, 2011) [23, 13].

Table 2: Summary of the model fit

Log likelihood	
Intercept Only	584.764
Final	537.275
Chi-square; LR (df=26)	47.489
p-value	0.006
Pearson chi-square (goodness- of-fit) (df=512)	537.275
p-value	0.212
Pseudo- R^2	
McFadden	0.283
Cox-Snell	0.412
Nagelkerke	0.681

Conclusion
The major determinants of decision pattern from best fitted model in current research were Age, Number of children, Socio-economic status (SES total score), Yield, cost of cultivation, number of innovations adopted, Gross income and Net income which were controls the decision pattern of farmers in perception of any new technology. Multinomial logistic regression model shows better fit to the data and conclude that model is fitting good for classification and prediction for the considered data. This implies that farmers face a complex situation while deciding adoption of agricultural innovations in various stages due to influence of various factors such as locale, crop technology, year of adoption and time gap in adoption. Farmers need to have more awareness on their economic status, benefit-cost of different crops, adoption of appropriate innovations which controls the decision making pattern of farmers in perception of any new technology.

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