"Assessing the Impact of Farmer Producer Organization (FPOs) on Agricultural Outcomes: A Binary Logit Model Analysis"

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Abstract: The Investigation was carried out during 2022-23 to study the Impact of Farmer producer organizations by using binary logit model. The multistage sampling method was used for selection 252 samples from the Western Region of Maharashtra. The results revealed that several factors appear to influence FPO participation. These include age, experience, access to marketing and input facilities provided by FPOs, and income level. However, other factors like gender, marital status, education, landholding, and family size didn't show significant associations with FPO participation.

Highlights:

- Present study is impact of FPO membership on famers income and other socio- economic characters.
- Low value of AIC showed best fit of binary Logistic model.
- Age , income, marketing facilities and input facilities provided by FPOs were significant at 5 % level.

Key Words: Logit model, AIC- Akaike Information Criterion, Farmer Producer Organizations, Logit Regression.

Farmer Producer Organizations (FPOs) are essential for achieving the goal of sustainable income to the farmer. These nodal organizations connected with large networks of small holders and facilitate faster dissemination of information and technology. To make FPOs sustainable in the long run, strategic government intervention are necessary. Capacity building for FPO management teams, facilitating intra-FPO learning and development, accelerating credit disbursement and establishing post-harvest infrastructure are few ways to create a more robust FPO ecosystem. The main aim of the Farmer Producer Organization is to ensure the better income for the producers through an organization of their own. Small producers do not have the volume individually to get the benefit of economies of scale. Through accumulation, the primary

producers can avail the benefit of the economies of scale. Besides, in agricultural marketing, there is a long chain of intermediaries who very often work non-transparently leading to the situation where the producer receives only a small part of the value that the ultimate consumer pays. They will also have better bargaining power vis-à-vis the bulk buyers of produce and bulk suppliers of inputs. Farmers Producers Organization provides end-to-end support and services to the small farmers, and cover technical services, marketing, processing and other aspects of agriculture inputs. The goal is to enhance the farmers' competitiveness and to increase their advantage in emerging the market opportunities. The major operations of Farmer Producer Organization (FPO) include the supply of seed, machinery, market linkages & fertilizer, training, networking, financial and technical advice.

Methodology:

Multistage sampling design was adopted for the selection of samples, in which Western region of Maharashtra was selected as leading state in number of FPOs. From western region of Maharashtra Pune, Sangli, Satara, and Solapur were purposefully chosen for the research. As the farmer producers organizations was established earlier in this district. The institutes were established in these areas with the goal of improving the economic condition of farmers, thus it was necessary to examine how well they were performed. From above selected district total seven Farmer Producer Organizations was selected purposefully because these FPOs were completed five years of establishment. In total seven FPOs three from Pune district, two from Sangli District, one from Satara district and one from Solapur district were selected, as they were adequately represented successful and assessable case studies. Eighteen member farmers and eighteen non-members farmers were selected, thus total 252 sample farmers were selected for the study.

Collection of data: Cross sectional data were collected from the member farmers of FPOs and non-member farmers by personal interview method with the help of Pre-tested schedule. Data pertained for the year of 2022-23.

Table 1: Details of sample farmers

District	Name of FPOs	Member Farmers	Non-Member Farmers
Pune	Naturofresh Farmers Producer Company Limited	18	18
	Fresh Express Farmers Producer Company Limited	18	18
	Maxx Grow Farmers Producer Company Limited	18	18
Sangali	Manganga Agro Farmer Producer Company	18	18
	Shetakari Praja Farmers Producer Company Limited	18	18
Satara	Gopalkrushna Farmer Agro Producer Company Limited	18	18
Solapur	Green Horizon Farmers Producer Company	18	18
		126	**126**
Total Number of Samples		**252**	

Analysis of data: In order to assess the impact of FPO on farmer's income Logit or Logistic regression model was used in this study. Binary Logistic regression is an extension of regular linear regression. It was used because dependent variable, Y i.e. Membership of FPO was categorical. Y variable was YES/NO type variable which typically refers to two categories of Y as "1"and "0" so that they were represented numerically.

General form of regression model

$$\text{In } Y = f(x_1, x_2, x_3 \ldots\ldots\ldots\ldots x_n)$$

Where,

Y = Membership of farmer (Yes/No)

X_1 - Age in years,

X_2 - Farm size in ha,

X_3 - Experience in year,

X_4 - Gender Male / Female,

X_5–Income in Rupees

X_6 - Marketing Facilities Yes/ No,

X_7 - Input Facilities Yes/ No,

X_8 - Education Illiterate/ Literate

The Logit model is specified as:

$$\textbf{Logit} = L_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu$$

Where,

Y = Membership of farmer (Yes/No)

β_0 = Intercept

β_1 = Regression coefficient

X_1 - Age in years

X_2 - Farm size in ha,

X_3 - Experience in year,

X_4 - Gender Male / Female,

X_5 - Marital Status Married/Unmarried

X_6 - Marketing Facilities Yes/ No,

X_7 - Input Facilities Yes/ No,

X_8 - Education Illiterate/ Literate

μ = Error term

The basic model of logit estimation (Gujarathi, 2004) is as follows-

$$P_i = E(Y = 1/X_i) = \frac{1}{1+e^{-(\beta_1+\beta_2 x_i}} \quad \text{---------- (1)}$$

For ease of exposition, we right (1) as

$$P_i = \frac{1}{1+e^{-z_i}} = \frac{e^z}{1+e^z} \quad \text{----------(2)}$$

Where, $Z_i = \beta_1+\beta_2 X_i$

Where Pi is the probability that farmers are FPO members and then (1-Pi) is the probability that farmers are non FPO members and e is the exponential constant. Equation (2) represent as cumulative logistic distribution function. In which it is easy to verify that Zi ranges from -∞ to + ∞, pi ranges between 0 to1 and the logit goes from -∞ to + ∞. The dependent variable, membership of farmers in FPO has a dichotomous nature. The effect of FPO membership on income depends on several socio, demographic and economic characteristics. The explanatory

variables used in the model include different socio-economic and demographic factors based on the literature on impact of FPO membership on farmer's income. The variables included in the analysis are age of the farmer, gender of farmer, farmers marital status, total family size, level of education, farming experience, farm size in hectares, and facilities of marketing and input provided by FPOs.

Table: 3 Variables which were used in the Binary Logit Regression Model

Variable modeled	Variable Measurement	Nature of Variable
Dependent variable		
Membership of farmer	1=member 0=non-member	Qualitative
Independent variable		
Age	No. of years	Quantitative
Farm size	Size of land in Hectors	Quantitative
Experience	No. of years	Quantitative
Gender	Male = 1 Female = 0	Qualitative
Income	In Rupee	Quantitative
Marketing Facilities Provided by FPOs	Yes = 1, No =0	Qualitative
Input Facilities Provided by FPOs	Yes =1, No = 0	Qualitative
Education	Illiterate = 1, Literate = 0	Qualitative

Akaike Information criterion was used to evaluate the best fit of model. AIC – Akaike Information Criterion is the mathematical method for evaluating how well a model fits the data it was generated from. Model with the lowest AIC offers best fit. (Akaike,1974).

Results and Discussions:

From table 4 it was seen that total cost of Pomegranate Production was more in case of non member farmers (₹ 310926.34) than Member farmers of FPOs (₹ 270380.43). The Benefit cost ratio for member (3.15) and non member farmer (2.0) profitable for member farmers compared to non-member farmers. This resulted from FPOs providing free lab testing services and slurry culture to their member farmers, which helped the farmers save money on fertilizers and pesticides for plant protection.

Table: 4 Per hectare costs and returns of pomegranate cultivation under FPO Membership and non membership

Sr. No.	Particulars	Member Farmer	Non Member farmers
1	Amortized cost (₹)	61501.61	68212.61
2	Maintenance cost	208878.82	242713.73
3	Total Cost (1+2) (₹)	270380.43	310926.34
4	Production (T)	13.98	12.29
5	Gross Returns (₹)	1123688.00	935142.02
6	Net Returns (₹)	853307.57	624215.68
7	Input-output ratio	3.15	2.00

Logit Estimates of Impact of Farmer Producer Organization: Table 5 represents the impact of Farmer producer organizations with the help of binary logit model in Western Region of Maharashtra, India.

Table : 5 Logit Estimates of Impact of Farmer Producer Organization

Sr. No.	Particulars	Logit Estimates	Std Error	Z value
1	Constant	-26.01	165400	0.000
2	Gender	21.57	165400	0.000
3	Marital Status	-21.35	9318	-0.002
4	Education	-26.05	9295	0.003
5	Age	0.26**	0.2235	2.182
6	Land Holding	1.632	2.312	0.706
7	Experience	-1.13**	0.9674	-1.174
8	Family Size	-0.1126	0.8268	-0.136
9	Marketing Facilities Provided by FPOs	0.421*	13040	0.003
10	Input Facilities Provided by FPOs	1.56**	15400	3.012
11	Income of Farmer	1.91**	0.000002156	2.089

AIC - 32.168

Notations-

*** :1 percent significance level

** :5 percent significance level

* :10 percent significance level

AIC – Akaike Information Criterion: is the mathematical method for evaluating how well a model fits the data it was generated from . Model with the lowest AIC offers best fit. (Akaike,1974)

The table 2 presents the Logit Estimates of the impact of various factors on Farmer Producer Organizations (FPOs). These estimates were derived from a logistic regression model, and each variable's coefficient represents its effect on the log-odds of the outcome variable (likely participation in FPOs). Below is a discussion of the results:

Binary logit regression was used to analyse the factors influencing the farmers to join membership of FPOs. The result of logit model suggested that most significant factors were age, education, marital status, gender, land holding, experience, family size, marketing facilities provided by FPOs, input facilities provided by FPOs, and income of farmer etc. Age, experience, marketing facilities, input facilities provided by FPOs and income of farmer were five variables found to be significant out of total ten variables considered in model.

Age , input facilities provided by FPOs and income of farmers were the only three variables found to be significant at five percent level with positive sign in regression model implying that as age, input facilities provided by FPOs and income of farmer increases the probability of farmers to join FPO membership also increases.

Age has a coefficient of 0.26, which was statistically significant at the 5 percent level. This indicates that as age increases, the log-odds of joining an FPO also increase, though the effect size is relatively small.

Input Facilities Provided by FPOs has a coefficient of 1.56 and is statistically significant at the 5 percent level. Farmers with access to input facilities provided by FPOs were more likely to join FPOs.

Income has a coefficient of 1.91 and was statistically significant at the 5 percent level. Higher-income farmers were more likely to participate in FPOs.

The marketing facilities provided by FPOs found to be significant at en percent level with positive sign. This variable has a coefficient of 0.421 and was statistically significant at the 10 percent level. Farmers who have access to marketing facilities provided by FPOs were more likely to participate in them. It implies that as increase in marketing facilities provided by FPOs will leads to increase in membership of FPOs.

Experience has a coefficient of -1.13 and was statistically significant at the 5 percent level. This suggests that as experience increases, the log-odds of participating in FPOs decrease. The experience was only one variable which was significant at 5 percent level with negative sign, implies that farmers with more experience would be less willing to go for membership of FPOs than less experienced farmers. The reason might be that experienced farmers had more knowledge and were well settled in their farming business. The people with high farming experience are rather reticent to Pomegranate cultivation which is unfamiliar to their habits. Or may be Experienced farmers may have different preferences or alternative opportunities.

The rest other variables were non significant, which didn't contribute to the increase in membership of FPOs. Land holding has a coefficient of 1.632, but it was not statistically significant (p-value > 0.05). Thus, the amount of land a farmer owns does not appear to have a significant impact on FPO participation. Family size has a coefficient of -0.1126, it was also not statistically significant (p-value > 0.05). Therefore, family size does not seem to influence FPO participation. The coefficient for gender was 21. This suggests that being male (coded as 1) significantly increases the log-odds of joining an FPO compared to being female (coded as 0). Marital status has a coefficient of -21.35, which was not statistically significant (p-value > 0.05). Therefore, marital status did not appear to have a significant impact on FPO participation. Education has a coefficient of -26.05, which was also not statistically significant (p-value > 0.05). This suggests that education level didn't significantly affect FPO participation in this context.

The constant term represents the baseline log-odds when all other predictors were zero. In this case, the constant was -26.01, indicating that without any other information, the log-odds of participating in FPOs.

In general we could validate these model results as testifies by low value of AIC i.e. 32.168. Akaike Information criterion was used to evaluate the best fit of model. AIC – Akaike Information Criterion is the mathematical method for evaluating how well a model fits the data it was generated from. Model with the lowest AIC offers best fit. (Akaike,1974). Akaike Information Criterion was 32.168 which indicate that model is best fit the data.

Conclusion:

In summary, several factors appear to influence FPO participation. These include age, experience, access to marketing and input facilities provided by FPOs, and income level. However, other factors like gender, marital status, education, landholding, and family size didn't show significant associations with FPO participation. So the government can take steps to improve the efficiency and performance of FPOs. The policy makers could have scope to improve the FPOs efficiency and productivity as member farmers were educated, young and active and experienced. It was important to consider these results in the context of the specific population and region under study. The model's goodness of fit can be assessed using the AIC (Akaike Information Criterion), which is -32.168 in this case, indicating the model's adequacy in explaining the variation in FPO participation within the given dataset.

These findings are valuable for policymakers and FPOs to tailor their strategies and outreach efforts to target specific demographics and provide relevant services to encourage greater FPO participation among farmers. It is essential to remember that these results were based on the specific dataset and context under study and may not be universally applicable across all regions or populations. Further research and local considerations are needed for a comprehensive understanding of FPO dynamics. The similar studies were conducted by Prishila Kajur *et.al.* (2019), Manswi *et.al.(*2019), Venkateson *et.al*. (2020), Sita Devi *et.al*. (2009), Padaria *et.al.*(2009), Jaza *et.al*.(2018) in different area and in different industries.

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Ethics, Consent to Participate, and Consent to Publish

The research project titled " Assessing the Impact of Farmer Producer Organization (FPOs) on Agricultural Outcomes: A Binary Logit Model Analysis " is conducted

with the utmost dedication to ethical standards and transparency. In order to maintain the integrity and objectivity of our research, it is essential to disclose any potential conflicts of interest that may arise during the course of this study. We emphasize our unwavering commitment to conducting this research with the highest degree of integrity, objectivity, and transparency. Any potential conflicts of interest, whether financial or non-financial, have been disclosed to maintain the credibility and reliability of our findings. We encourage the scrutiny and critical evaluation of our research by peers and the public to ensure the utmost validity of our results. I consent to the publication the data collected from me during the research study.