



FPO Member Farmer Empowerment: Socio-economic Insights via Canonical Correlation Analysis

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ABSTRACT

A multivariate analysis was undertaken in this study using canonical correlation analysis. The aim was to investigate the association between socio-economic variables and the empowerment of member farmers who are part of Farmer Producer Organizations (FPOs). A total of 186 member farmers were selected from 6 FPOs located in two districts, namely Kalahandi and Cuttack, in Odisha. The selection process involved choosing 5% of member farmers from each FPO, with 4 from Kalahandi and 2 from Cuttack, using proportionate random sampling. Data was collected through a well-structured and pre-tested interview schedule. The analysis revealed that 30.98 per cent of the variance in empowerment was attributed to the socio-economic variables considered in the present study. The findings indicated that an increase in education level and active participation in FPO activities led to enhanced social empowerment among farmers. Similarly, factors such as larger family size, greater market orientation, and larger cultivated land area were associated with increased economic empowerment. Additionally, the study found that a higher extent of cultivated land contributed to cultural empowerment among the farmers.

INTRODUCTION

Canonical Correlation Analysis (CCA) is a widely employed method in diverse fields to examine the intricate relationships among multiple sets of variables, both independent and dependent (Martin et al., 2005). This statistical technique allows researchers to derive canonical variables, which are combinations of two variable groups (X and Y), with a primary focus on understanding the correlation between these newly formed variables (Hair Júnior et al., 2009). Farmer Producer Organizations (FPOs) involve the grouping of producers, particularly small and marginal farmers, into organized entities. Recently, FPOs have gained prominence as a model in various organizations, aiming to unite small and marginal farmers for mutual benefits through collaborative efforts (Singh et al., 2021; Kumari et al., 2022). The collectivization of small and marginal farmers into FPOs has emerged as a significant approach,

offering various benefits such as reduced transaction costs, economies of scale, knowledge sharing, and risk reduction in cultivation and marketing (Parthiban et al., 2015; Kanitkar, 2016; NABARD, 2019; Kumar et al., 2021; Venkatasubramanian et al., 2023). The inception of the FPO concept resulted from the recommendations of a high-powered committee led by Y.K. Alagh, aiming to overcome the limitations of traditional cooperatives by integrating features of both cooperatives and companies (Kakati & Roy, 2018). Recognizing FPOs registered under the special provisions of the Companies Act, 1956 as the most suitable institutional form to mobilize farmers and strengthen their collective production and marketing capacities. (Policy and Process Guidelines for farmer producer organization, 2013). Farmer Producer Organizations (FPOs) are collaborative entities established by farmers to enhance their collective bargaining power, gain access to resources, and improve their socio-economic conditions to

support this objective, the Central government introduced the “Formation and Promotion of Farmer Producer Organizations (FPOs)” scheme. This initiative, backed by a budget allocation of Rs. 4496.00 crore for the period from 2019-20 to 2023-24 and an additional commitment of Rs. 2369.00 crore for the subsequent period from 2024-25 to 2027-28, aims to establish and promote 10,000 new FPOs nationwide [Cabinet Committee on Economic Affairs (CCEF), PIB Delhi, 2020].

Canonical Correlation Analysis (CCA) provides a means for researchers to explore the connections between two sets of variables, specifically socio-economic factors and empowerment indicators within Farmer Producer Organizations (FPOs). It identifies the linear combinations of variables from each set that exhibit the highest correlation. The resulting canonical coefficient signifies the strength and direction of the relationship between these two sets of variables (Keskin & Yasar, 2007). CCA is instrumental in pinpointing the socio-economic variables most strongly linked to the empowerment of FPO members. The insights derived from CCA offer valuable guidance for FPOs, policymakers, and development practitioners, enabling them to make informed decisions and devise targeted interventions aimed at improving the socio-economic conditions and empowerment of FPO members. By identifying the crucial variables influencing empowerment, resources can be allocated efficiently, and customized programs can be formulated to address the specific needs of FPO members. With these considerations, the current study was undertaken with the objective of “analyzing canonical correlation to determine the relationship between socio-economic variables and the empowerment of member farmers in Farmer Producer Organizations (FPOs).”

METHODOLOGY

The present research was conducted in the state of Odisha, specifically in two randomly selected districts: Kalahandi and Cuttack. For the study, four FPOs from Kalahandi district and two FPOs from Cuttack district were chosen. Employing a proportionate random sampling method, a sample of 5 per cent member farmers was selected from each FPO. In total, 186 farmers from the six selected FPOs participated in the study. Data collection was executed using a well-structured and pre-tested interview schedule. The collected data was then analyzed through the canonical correlation analysis method.

Two sets of variables considered for the study, one set with 10 independent or socio-economic variables (X) and another set of 3 dependent variables (Y).

$$X = x_1, x_2, x_3, \dots, x_{10} \text{ and } Y = y_1, y_2, y_3$$

x_1 =age, x_2 =education, x_3 =family type, x_4 =family size, x_5 =area under cultivation, x_6 =occupation, x_7 = participation in FPOs activities, x_8 = economic motivation, x_9 = risk orientation and x_{10} = market orientation, y_1 = social empowerment, y_2 =economic empowerment and y_3 = cultural empowerment

The number of canonical correlation pair is equal to the number of character in the smallest set so, in the present study 3 canonical correlation pair estimated that is (U_1, V_1), (U_2, V_2) and (U_3, V_3). U_1 and V_1 is the linear combination of independent and dependent variables, respectively called as canonical variates.

$$U_1 = a_{11}x_1 + a_{12}x_2 + \dots + a_{1p}x_p \quad V_1 = b_{11}y_1 + b_{12}y_2 + b_{13}y_3$$

$$U_2 = a_{21}x_1 + a_{22}x_2 + \dots + a_{2p}x_p \quad V_2 = b_{21}y_1 + b_{22}y_2 + b_{23}y_3$$

$$\cdot \quad V_3 = b_{31}y_1 + b_{32}y_2 + b_{33}y_3$$

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$$U_p = a_{p1}x_1 + a_{p2}x_2 + \dots + a_{pp}x_p$$

Where $p=10$ (no of characters in set 1 or independent variable), $a_{11}, a_{12}, \dots, a_{1p}$ and b_{11}, b_{12}, b_{13} are the standardized canonical coefficient of x and y variables, respectively. These coefficients indicates the relative importance or magnitude of variables in set one (independent variables) in determining the variables in set two (dependent variables) (Balkaya et al., 2011). Due to the potential presence of multi-collinearity in the data, the coefficients obtained from canonical correlation analysis can be unstable. To address this issue, researchers often rely on the interpretation of canonical loadings. These loadings are considered to offer a more meaningful understanding of the contribution of each variable to the canonical variables. By examining the canonical loadings, researchers can gain insights into the substantive importance of each variable in relation to the canonical variables (Akbas and Takma, 2005).

$$\text{The canonical correlation between } U_1 \text{ \& } V_1 \text{ is } (U_1, V_1) = \frac{\text{Cov}(U_1, V_1)}{\sqrt{\text{Var}(U_1)\text{Var}(V_1)}}$$

RESULTS

The statistical analysis in Table 1 reveals significant results at the 0.01 level for all three pairs of canonical variates, as indicated by the likelihood ratio test. The first pair ($U_1 V_1$) has the highest coefficient (0.5566553) followed by $U_2 V_2$ (0.466971) and $U_3 V_3$ (0.42419926). The square of canonical correlation highest for $U_1 V_1$ (0.309865) followed by $U_2 V_2$ (0.218062) and $U_3 V_3$ (0.179945).

Table 1. Canonical correlation analysis of socio-economic variables with different empowerment of the farmers

Pair of canonical variate	Canonical correlation	Square of canonical correlation	Probability
$U_1 V_1$	0.5566553	0.309865	<0.001
$U_2 V_2$	0.4669711	0.218062	<0.001
$U_3 V_3$	0.42419926	0.179945	<0.001

From the Table 2, by seeing the canonical weight, except age all other independent variables have positive weight with U_1 . Similarly, in case of dependent variables social and economic empowerment have positive and cultural empowerment has negative weight with V_1 .

Coming to the canonical loading with U_1 and V_1 it was found that education (0.6700) and participation in FPO activities (0.6410) had higher correlation with U_1 and in dependent variables social empowerment (0.5482) highest correlation with V_1 . Similarly, by analyzing canonical loading of U_2 and V_2 , land under cultivation (-0.409) higher correlation with U_2 and cultural empowerment (-0.984) highest correlation with V_2 . Canonical loading of U_3 and V_3 indicates family size (0.613), market orientation (0.550) and land under cultivation (0.451) have higher correlation with U_3 and economic empowerment (0.842) has highest correlation with V_3 .

Table 2. Canonical weight, loading and cross loading analysis of socio-economic variables with different empowerment of the farmers

Independent variables	Canonical weight			Canonical loadings			Canonical cross-loading		
	U_1	U_2	U_3	U_1	U_2	U_3	V_1	V_2	V_3
Age	-0.018	0.011	-0.011	-0.348	-0.109	-0.110	-0.193	-0.051	-0.046
Education	0.240	0.145	0.044	0.670	0.207	0.110	0.372	0.096	0.047
Family Type	0.084	0.535	-0.268	0.271	0.245	0.333	0.150	0.114	0.141
Family Size	0.126	0.005	0.327	0.101	0.173	0.613	0.056	0.081	0.260
Land under cultivation	0.084	-0.146	0.098	0.182	-0.409	0.451	0.101	-0.191	0.191
Occupation	0.041	0.267	-0.044	0.202	0.168	-0.001	0.112	0.218	-0.0006
Participation in FPO activities	0.261	0.009	-0.067	0.641	0.118	-0.016	0.356	0.055	-0.006
Economic motivation	0.024	-0.113	-0.107	0.214	-0.159	-0.167	0.119	-0.074	-0.071
Risk orientation	0.064	-0.013	-0.061	0.324	-0.177	-0.188	0.180	-0.082	-0.079
Market orientation	0.007	-0.061	0.147	0.179	-0.290	0.550	0.099	-0.136	0.233
Dependent variables	V_1	V_2	V_3	V_1	V_2	V_3	U_1	U_2	U_3
Social empowerment	0.049	0.001	-0.031	0.984	-0.162	-0.059	0.548	-0.075	-0.025
Economic empowerment	0.024	0.041	0.284	0.537	-0.016	0.842	0.299	-0.007	0.357
Cultural empowerment	-0.034	-0.213	0.017	0.115	-0.984	0.134	0.064	-0.459	0.056

Canonical cross loading of V_1 highest with education (0.372) and participation in FPO activities (0.356) and for U_1 correlation higher with social empowerment (0.548). Similarly, correlation of V_2 highest with occupation (0.218) land under cultivation (-0.191) and for U_2 highest with cultural empowerment (-0.459). correlation of V_3 highest with family size (0.260) followed by market orientation (0.233) and land under cultivation (0.191) and for U_3 highest with economic empowerment (0.056).

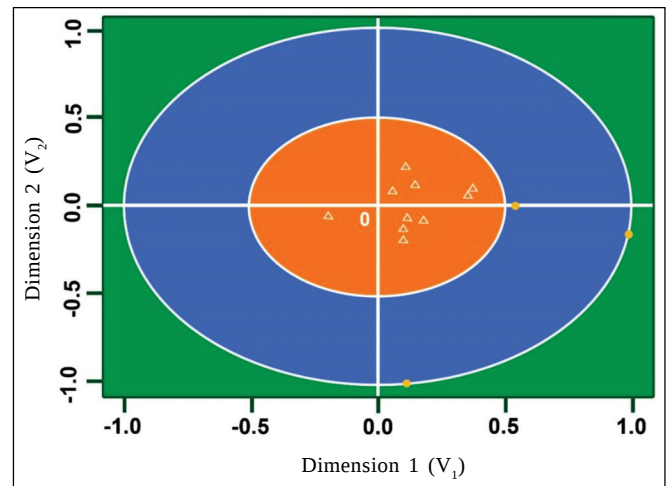
DISCUSSION

Canonical correlation analysis of the FPOs member farmers reveals that 30.98 percent of the variation in the dependent canonical variable (V_1) can be explained by the independent canonical variable (U_1). Which means nearly 31 per cent variation in the empowerment of the FPOs member farmers was due to the different socio-economic variables considered in the study. The first canonical pair (U_1V_1) is particularly noteworthy because of high coefficient and a significant explanatory power (30.98%). This suggests a strong relationship between the independent variables (U_1) and the dependent variable (V_1). While U_2V_2 and U_3V_3 also exhibit significant results, their coefficients are lower than U_1V_1 , indicating relatively weaker relationships.

Canonical weight indicates the magnitude of effect of different independent variable on the different types of empowerment of the farmers through the independent canonical variate. In the study through canonical weight analysis, the variables like education, family type, family size, land under cultivation, occupation, participation in FPO activities, economic motivation, risk orientation and market orientation had positive impact on social and economic empowerment of farmers. Age negatively affect social and economic empowerment positive impact on cultural empowerment of the farmers. Canonical loading indicates the correlation between the variables with their respective canonical variables (Hidalgo et al., 2014). That is correlation of independent variables (X) with U_1 and correlation of dependent variables (Y) with V_1 . The variables with larger canonical loading contribute more to the multivariate relationship between socioeconomic profile

and empowerment of the farmers. The findings of the present study reveals that education and participation in FPO activities have more effect on social empowerment of the farmers. Similarly, occupation and land under cultivation affect more to cultural empowerment, whereas family size, market orientation and land under cultivation affect more to the economic empowerment of farmers. Support the findings of Sahoo et al., (2022). The canonical cross loading provides the direct relation between the independent and dependent variables (Hair Júnior et al., 2009). Similar result found as in case of canonical cross loading as that of canonical loading but only difference was less in magnitude seen in case of canonical cross loading.

Figure 1 illustrates the relationship between socio-economic variables and empowerment. Dimension 1 corresponds to V_1 , while dimension 2 corresponds to V_2 . Triangles represent independent variables (socio-economic variables), and orange dots represent dependent variables (social, economic, and cultural empowerment). The conclusion drawn from the figure is that all independent variables, except age, exhibit a negative correlation with V_1 . This implies that

**Figure 1.** Relation between the socio-economic variables and different empowerment

younger farmers with higher education levels, nuclear family structures with smaller family sizes (up to 4 members), more land under cultivation, involvement in both agriculture and horticultural operations, higher participation in FPO activities, economic motivation, risk orientation, and market orientation, experience higher levels of empowerment through FPOs. This aligns with the findings of Sahoo et al., (2022). Regarding dependent variables, all three variables show a positive correlation with V_1 , suggesting that an increase in social, cultural, and economic empowerment contributes to an overall enhancement in farmers' empowerment.

CONCLUSION

The study's findings, based on the canonical analysis, indicate that socio-economic variables significant relationships with different empowerment dimensions of farmers. The first canonical pair (U_1V_1) is particularly influential, highlighting the importance of variables such as education and participation in FPO activities for social empowerment. Additionally, family size, market orientation, and land area under cultivation were linked to greater economic empowerment whereas land under cultivation and occupation play crucial roles in cultural empowerment of the farmers. These insights provide a foundation for informed policymaking and targeted interventions. Policymakers and development practitioners can use this information to craft strategies that focus on educational opportunities, FPO engagement, market access, increasing cultivated land, and preserving cultural ties to effectively promote farmers' empowerment. Such nuanced approaches hold the potential to contribute to sustainable agricultural development by addressing specific socio-economic factors influencing empowerment.

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