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Empowerment of farm households in Tumakuru and Chamarajanagara districts of Karnataka: A comparative analysis of irrigated and rainfed farms

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Abstract

Empowerment is essential in enhancing the livelihoods and well-being of farm households, particularly in rural economies like India. Empowerment is a complex concept, which may vary in time and geography. It is one's capacity to make choices and transform them into desired actions and outcomes. It includes autonomy in decision-making, access to productive resources, leadership opportunities, and control over income. This research study investigates the contrasting dynamics of irrigated and rainfed farm households in Tumakuru and Chamarajanagara district of Karnataka. The primary data was collected from 240 farm households, with equal representation from rainfed and irrigated conditions. The data was elicited through survey method during 2022-23. The study employed various statistical tools for analysis, which include descriptive statistics, Farm Household Empowerment Index (FHEI) and Regression analysis. In Tumakuru, the FHEI was 0.810, with irrigated farms (0.83) outperforming rainfed farms (0.76), especially in the resources and leadership domains. Similarly, Chamarajanagara had an FHEI of 0.720, with irrigated farms (0.75) surpassing rainfed farms (0.69). In both Tumakuru and Chamarajanagara districts, irrigated farms consistently demonstrate slightly higher empowerment levels compared to rainfed farms. Irrigation provides a more stable and predictable agricultural environment, which enhances productivity and income stability. This contrasts with rainfed farms, which face greater uncertainties and limited resources, resulting in lower empowerment scores. Improving irrigation infrastructure and resource access could address these disparities and significantly boost the empowerment and well-being of rainfed farms. Addressing these gaps through targeted policies could improve empowerment and livelihoods across farms.

Keywords: Empowerment, decision making, resources, rainfed and irrigated farms

Introduction

Empowerment is a critical dimension in enhancing the livelihoods and well-being of farmers, particularly in a diverse agricultural economy like India. It encompasses various aspects such as decision-making authority, access to productive resources, control over income, leadership opportunities, and time management. Assessing farmer empowerment is essential for understanding the socio-economic dynamics within farming households and identifying the barriers that hinder equitable development. In India, where agriculture supports a significant portion of the population, empowerment plays a pivotal role in ensuring sustainable agricultural growth. It contributes to better decision-making in farming practices, improves resource allocation, and enhances resilience against economic and climatic uncertainties. Empowered farmers are more likely to adopt innovative practices, access credit, and actively participate in community and leadership roles, driving collective progress.

Empowerment is a complex concept, which may vary in time and geography (between continents, between countries and possibly even between rural and urban areas) (Sakamma, 2013) ^[9]. Empowerment is one's capacity to make choices and transform them into desired actions and outcomes (Alsop *et al.*, 2006) ^[2].

The pathways to empowerment are referred to as domains,

which are areas of influence that allow people to organise and mobilise themselves toward the desired social and political change (Alkire *et al.*, 2013 and Malapit *et al.*, 2015) ^[1, 6] defined five empowerment domains to compute empowerment in agriculture (EIA) namely, Decisions on agricultural production, access to productive resources, decisions on income use leadership and time allocation. Empowerment domains are the areas of influence that allow individuals or groups of people to organise and mobilise themselves better toward the desired social and political change (Laverack, 2006). ^[5] A common approach in the literature in analysing the effect of empowerment on household welfare has been the use of the women's empowerment in agriculture index (WEAI), or its abridged version (A-WEAI).

Assessing the differences between irrigated and rainfed agriculture, as well as between agriculturally developed and less developed districts, is essential due to their distinct dynamics. Irrigated agriculture typically provides greater opportunities for crop diversification and intensification, which can result in higher income and enhanced livelihood security for farmers along with farmers happiness. On the other hand, rainfed agriculture is more susceptible to climate change and weather variability, making it crucial to understand the coping mechanisms and adaptation strategies employed by farmers in these regions. Additionally, these

two agricultural systems often differ in their access to resources, markets, and institutional support, necessitating a thorough examination to tailor interventions and policies effectively to each context. Understanding these differences is key to addressing the unique challenges faced by farmers in different agricultural settings and ensuring equitable and sustainable development across diverse regions.

By studying these factors, the present research aims to identify the key factors influencing empowerment under irrigated and rainfed systems, and analyse the differences in socio-economic characteristics and outcomes between farmers under both systems. In this direction, the study was undertaken with the objective of assessing farm household empowerment in Tumakuru and Chamarajanagara districts of Karnataka.

Methodology

Keeping in view the objectives of the study, a multistage purposive sampling procedure was employed to select the districts and taluks. Subsequently, a purposive random sampling method was used to select the villages and farmers, ensuring representation of both irrigated and rainfed farmers. In the first stage two districts, Tumakuru and Chamarajanagara were chosen to represent high and low levels of agricultural development, respectively, based on the share of agriculture and allied sector to GDP (GDDP) to state agriculture and allied sector GDP (GSDP). In the second stage based on irrigation conditions two taluks were selected from each district purposively, aiming to encompass both irrigated and rainfed farm households. In the third stage, two villages were chosen from each taluk randomly. Further, from each selected village, 30 farmers were selected randomly which includes both irrigated farms and rainfed farms ensuring the representation of 60 irrigated

and 60 rainfed farms from each district, resulting in a total sample size of 120 per district and 240 for the entire study. The data was elicited through a personal interview method utilizing a well-structured and pre-tested schedule for the agricultural year 2022-23. The study employed various statistical tools such as farm household empowerment index for determining level of empowerment of farm households and regression analysis for estimating effect of empowerment in agriculture on farm income. In this study farmers possessing irrigated land is referred to as irrigate farms. Similarly, farmers possessing rainfed land is referred to as rainfed farms.

Farm Household Empowerment Index

Household empowerment in agriculture, which was measured as an index. Present study used the five empowerment domains described by Alkire *et al.* (2013) ^[1], namely time, production, leadership, income and resources, to compute the Women Empowerment in Agriculture Index (WEIA). While Alkire *et al.* (2013) ^[1] propose utilizing 10 indicators, Malapit *et al.* (2015) ^[6] opted for a reduction to six, resulting in the creation of the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI). This study opted for the A-WEAI due to its robustness and ability to yield similar conclusions, while also being less time-consuming and costly in terms of data collection (Malapit *et al.*, 2015) ^[6]. However, the study omitted the term "women" from the index, resulting in A-EAI, as it has not considered empowerment among men and women headed households separately, rather it focused on assessment of empowerment among households with and without irrigation facilities considering farm household empowerment as a unified concept.

Table 1: Domains and indicators of empowerment in agriculture

Domain	Indicator	Adequacy threshold	Weight
Production	Technology use	Household head decided on the crops to grow, either solely or jointly	0.1
		Household head decided on the livestock to keep, either solely or jointly	0.1
Leadership	Group official	Household head was an official in the farmer group	0.2
Income	Control over use of farm income	Household head decided on how to use farm income, either solely or jointly	0.2
Resources	Title deed	Household head had a title deed	0.1
	Access to credit	Household head could have accessed credit if it was needed	0.1
Time	Labour contribution to the farm	Household head contributed farm labour on a part-time basis	0.2

Study also adapted the indicators in the various domains, as follows: For the time domain, we asked farmers whether they contributed labour to their farm operations on a full-time or a part-time basis. This was a departure from Alkire *et al.* (2013) ^[1] and Malapit *et al.* (2015) ^[6], who suggest asking farmers the number of hours they spent on their farm in the previous 24 hours. This departure is logical because some of the farmers had not spent time on their farm in the previous 24 hours for various reasons, such as heavy rain, and attending burials and other social functions, among others. Part-time farming gives farmers some time to seek leisure and complementary income generating off-farm and non-farm activities (Mwololo *et al.*, 2021) ^[7].

To compute the farm household empowerment index, the indicators that met the adequacy criteria in Table 1 were coded one, and zero otherwise. To derive the indicator score, we multiplied the indicator code by its weight for all

the indicators. Using the technology-use indicator in the production domain as an example to demonstrate how adequacy or lack of it was arrived at, farmers were asked: "who makes decisions on the crops to grow?" The possible responses were (1) head, (2) spouse, (3) both, and (4) others. A respondent was to choose a single option and a response was adequate if the 'head' or the 'both' option was chosen. The third and fourth options were considered to contribute zero points to empowerment and therefore to be inadequate. The final empowerment index was computed as an aggregate of the individual indicator scores for each household, as specified in equation (1).

$$I_i = \sum_1^n X_s \text{ -----(1)}$$

Where, for the i^{th} household, I_i is the household

empowerment index and ranges from 0 to 1, and $\sum_1^n X_i$ is the sum of all individual indicator scores.

Regression Analysis

The OLS regression model is a method used to estimate the linear relationship between a dependent variable Y_i and one or more independent variables X_i . To assess the effect of empowerment in agriculture on farm income in the study area, the following regression model was used.

In general Y_i is defined as: $Y_i = \beta_0 + \sum \beta_i X_i + e_i$,

Where,

Y_i = Dependent variables

β_i = Regression parameters/coefficients

e_i = Error term,

X_i = Vector of explanatory variables

The model specification for the OLS regression model for estimation of the effect of empowerment in agriculture on farm income is given as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e_i \text{ ----} \\ \text{---(2)}$$

Where,

Y_i = Farm income of household (log of Rs.)

X_1 = Household empowerment index (ranges between 0 to 1)

X_2 = Education of household head (0=Illiterate, 1=Primary,

2=High school, 3=PUC/Diploma, 4=Degree)

X_3 = Agricultural land holding (acres)

X_4 = Irrigation facilities in the farm (=1 if irrigated, 0 otherwise (rainfed))

X_5 = Membership in the farmer group (=1 if Yes, 0 otherwise)

X_6 = No. of different enterprises adopted by farmers

X_7 = Access to credit (1=Yes, 0 otherwise)

Results and Discussion

Status of empowerment of farm households

Farm household involvement in decision-making across different activities in Tumakuru district

The distribution of decision-making roles within farm households in Tumakuru district among irrigated and rainfed farm households across different activities: crop production, livestock raising, wage and salary, and household expenditure is presented in Table 2.

For crop production activity, among irrigated farms, decisions were made solely by the household head in 45.00 per cent of the households, while 55.00 per cent of households made decisions jointly with other family members. In comparison with rainfed farms, the household head made decisions solely in 40.00 per cent of the households. Decisions were made by the spouse alone in 6.67 per cent of the households, and in 53.33 per cent of the households, decisions were made jointly with other family members.

Table 2: Farm household involvement in decision-making across different activities in Tumakuru district

Activity	Irrigated (n=60)				Rainfed (n=60)			
	No. of households	Household head	Spouse	Jointly	No. of households	Household head	Spouse	Jointly
Crop production	60	27 (45.00)	0 (0.00)	33 (55.00)	60	24 (40.00)	4 (6.67)	32 (53.33)
Livestock raising	46	14 (30.43)	0 (0.00)	32 (69.57)	48	21 (43.75)	8 (16.67)	19 (39.58)
Wage and salary	24	8 (33.33)	1 (4.17)	15 (62.50)	38	11 (28.95)	3 (7.89)	24 (63.13)
Household expenditure	60	22 (36.67)	4 (6.67)	34 (56.67)	60	30 (50.00)	2 (3.33)	28 (46.67)

Note: Figures in parentheses represents percentage to total number of households of corresponding activity

Decision making for livestock rearing varied between irrigated and rainfed farms

In irrigated conditions, nearly a third (30.43%) of households made livestock-related decisions solely by the household head, while majority (69.57%) made decisions jointly. Among rainfed farms, 43.75 per cent of decisions were made solely by the head, while spouses were involved in just over one-sixth (16.67%) of cases. The remaining households (39.58%) shared decision-making responsibilities among family members. The higher proportion of joint decisions in irrigated farms could be attributed to the more significant investments and labour involved in maintaining livestock, which requires collective action. In rainfed areas, the decision-making might involve more individual choices due to varying levels of resource availability.

Regarding decision making for wage and salary management among irrigated farms, over a third (33.33%) of wage and salary decisions were made solely by the household head, while a small portion (4.17%) were made by the spouse alone. The majority (62.50%) were joint decisions involving other family members. Rainfed farms exhibited a similar pattern, with 28.95 per cent decisions by the household head and a slightly higher involvement of the

spouse (7.89%) in decision-making, and 62.50 per cent jointly with the other family members. The high level of joint decision-making in both cases may reflect the collective nature of managing household finances where both partners and other family members were actively involved in financial planning.

Regarding household expenditure decisions, among irrigated farms, nearly 36.67 per cent of households made decisions solely by the household head, with a small percentage (6.67%) made by the spouse. The majority (56.67%) were joint decisions along with other household members. Rainfed farm households displayed a more balanced pattern, with half of decisions made solely by the household head, a minimal involvement of the spouse (3.33%), and the remaining decisions made jointly (46.67%). This suggests that managing household expenses was a collective effort, with varying degrees of involvement depending on the specific needs and financial conditions of the household.

Farm household involvement in decision-making across different activities in Chamarajanagara district

Distribution of decision-making roles within farm households in Chamarajanagara district is presented in

Table 3.

For crop production activity, among irrigated farms in Chamarajanagara district, decisions were made solely by the household head in 45.00 per cent of the households, while 55.00 per cent of households made decisions jointly with other family members. In comparison, among rainfed farms, the household head made decisions solely in 36.67 per cent of the households. Decisions were made by the spouse alone in 6.67 per cent of the households, and in 56.67 per cent of the households, decisions were made jointly with other family members.

Decision making for livestock raising in irrigated farms was around 29.17 per cent of by the household head. 29.17 per cent of households by the spouse alone, and 41.67 per cent households jointly with other family members. Among households of rainfed condition, 30.56 per cent of decisions were made solely by the household head, 11.11 per cent by the spouse, and 58.33 percent jointly with other family members. The higher proportion of joint decisions in rainfed farms may be attributed to the shared efforts required to manage livestock with limited resources.

Table 3: Farm household involvement in decision-making across different activities in Chamarajanagara district

Activity	Irrigated (n=60)				Rainfed (n=60)			
	No. of households	Household head	Spouse	Jointly	No. of households	Household head	Spouse	Jointly
Crop production	60	27 (45.00)	0 (0.00)	33 (55.00)	60	22 (36.67)	4 (6.67)	34 (56.67)
Livestock raising	24	7 (29.17)	7 (29.17)	10 (41.66)	36	11 (30.56)	4 (11.11)	21 (58.33)
Wage and salary	39	8 (20.51)	3 (15.79)	28 (63.16)	57	12 (21.05)	9 (15.79)	36 (63.16)
Household expenditure	60	24 (40.00)	6 (10.00)	30 (50.00)	60	19 (31.67)	7 (11.67)	34 (56.67)

Note: Figures in parentheses represents percentage to total number of households of corresponding activity

In terms of wage and salary management, a similar decision-making pattern was observed among both irrigated and rainfed farm households. Approximately 21 per cent of households relied solely on the household head for decision-making, while around 15 per cent relied on the spouse alone. Notably, majority of households (63.16%) made decisions jointly with other family members, indicating a cooperative approach to financial management.

When it comes to making decisions on household expenditures, a combined approach was evident in both irrigated and rainfed farms. In irrigated farms, the household head made decisions alone in 40 per cent of cases, while the spouse makes decisions alone in 10 per cent of cases, and joint decisions were made in 50 per cent of cases. Similarly, in rainfed farms, the household head makes decisions alone in 31.67 per cent of cases, the spouse in 11.67 per cent of cases, and joint decisions were made in 56.67 per cent of cases. This suggests that managing household expenses is a shared responsibility, with the level of collaboration adapting to the unique financial circumstances and needs of each household.

Farm households in Tumakuru and Chamarajanagara districts exhibit a mix of individual and joint decision-making processes, influenced by the type of activity and resource availability. Irrigated farms had a higher proportion of joint decision-making, possibly due to higher incomes and more secure livelihoods, while rainfed farms rely slightly more on individual decisions, particularly by the household head. This pattern may be attributed to patriarchal norms, perceived expertise, or varying levels of resource security. Overall, managing household finances and expenses is a collaborative effort, with varying levels of involvement depending on specific needs and financial conditions.

Farm household empowerment in agriculture in Tumakuru district

The empowerment of households in agriculture can be assessed across various domains, including production, leadership, income, resources, and time. Table 4 provides a comprehensive overview of the domains and indicators used

to measure empowerment in agriculture, highlighting the corresponding adequacy thresholds and weights for each indicator.

Table 39 provides insights into the Farm Household Empowerment Index (FHEI) and its components across different agricultural activities in Tumakuru district, with distinctions made between irrigated and rainfed farms. The overall farm household empowerment index for the Tumakuru district stands at 0.810. However, a closer look reveals disparities between irrigated and rainfed farms. Irrigated farms exhibited a higher FHEI of 0.83, whereas rainfed farms had a slightly lower index of 0.76. This discrepancy indicates that irrigated farms generally experience greater empowerment in agricultural activities, likely due to more stable and predictable water sources, leading to enhanced productivity and income.

The overall score for the production domain was 0.185, with irrigated farms scoring slightly higher at 0.19 compared to 0.18 for rainfed farms. This domain considers the household head's decision-making power regarding crop and livestock management, suggesting that both types of households have a similar level of control. The minor difference might be due to the greater stability and predictability in crop yields provided by irrigation, which can encourage more confident and autonomous decision-making by household heads.

In terms of leadership, which measures the household head's role as an official member in farmer groups, the overall score was 0.135. Irrigated farms had a marginally higher score of 0.14 compared to 0.13 for rainfed farms. This indicates that household heads in irrigated areas may have slightly more opportunities or inclination to take part within their agricultural communities. Access to better resources and higher incomes in irrigated areas might provide household heads with the means and motivation to participate more actively in leadership roles.

Control over farm income was a critical component of empowerment, overall score was 0.185 and irrigated household scores at 0.19. Rainfed farm households again trail slightly with a score of 0.18, reflecting that while both groups had considerable control over their farm income, those in irrigated areas might had a slight advantage in

financial autonomy. The predictability and often higher income from irrigated farming could lead to better financial stability, allowing household heads greater control over their financial decisions.

Table 4: Farm household empowerment in agriculture in Tumakuru district (n=120)

Variables	Overall (n=120)	Irrigated (n=60)	Rainfed (n=60)
Production	0.185	0.19	0.18
Leadership	0.135	0.14	0.13
Income	0.185	0.19	0.18
Resources	0.145	0.16	0.13
Time	0.145	0.15	0.14
Farm household empowerment index	0.810	0.83	0.76
t-statistic	0.66 ^{NS}		

Note: NS=Non-Significant

The overall resource domain score was 0.145, with irrigated farms scoring higher at 0.16 compared to 0.13 for rainfed farms. This domain includes possession of a title deed and access to credit, suggesting that irrigated farms had better access to critical resources, enhancing their overall empowerment. Access to water resources in irrigated areas often leads to higher productivity and income, making it easier for these households to secure credit and invest in land, thus improving their overall resource base and empowerment.

The contribution of household heads to farm labour, as indicated in the time domain, scores an overall 0.145. Irrigated farms score slightly higher at 0.15, compared to 0.14 for rainfed farms. This suggests that household heads in rainfed farms face a slightly excessive workload, leaving them with little time for rest, leisure, or other personal activities. This imbalance can lead to burnout and reduced well-being, highlighting a marginally greater involvement in farm labour among heads of rainfed farms.

Farm household empowerment in agriculture in Chamarajanagara district

The farm household empowerment index in Chamarajanagara district (Table 5) reveals variations between irrigated and rainfed farms. Overall, the empowerment index for the district stands at 0.720. When broken down by household type, irrigated farms exhibit a slightly higher empowerment index of 0.75, compared to rainfed farms index score of 0.69.

Table 5: Farm household empowerment in agriculture in Chamarajanagara district

Variables	Overall (n=120)	Irrigated (n=60)	Rainfed (n=60)
Production	0.185	0.19	0.18
Leadership	0.115	0.12	0.11
Income	0.170	0.17	0.17
Resources	0.130	0.14	0.12
Time	0.120	0.13	0.11
Farm household empowerment index	0.720	0.75	0.69
t-statistic	0.69 ^{NS}		

Note: NS=Non Significant

In the production domain, both irrigated and rainfed farms show almost similar levels of empowerment. The overall

score was 0.185, with irrigated farms scoring 0.19 and rainfed farms 0.18. Leadership shows a slight discrepancy between the two household types. The overall score was 0.115, with irrigated farms scoring slightly higher at 0.12 compared to 0.11 for rainfed farms. This indicates that household heads in irrigated farms were marginally more involved within farmer groups. The income domain presents a uniform empowerment score of 0.17 for both irrigated and rainfed farms. This consistency implies that control over the use of farm income was similarly distributed, irrespective of the type of farming practice.

The resources domain reveals a noticeable difference between irrigated and rainfed farms. The overall score was 0.130, with irrigated farms scoring higher at 0.14 compared to 0.12 for rainfed farms. This disparity suggests that household heads in irrigated farms had higher title deed and had better access to credit, contributing to higher empowerment in this domain. The time domain, reflecting household head's contribution to farm labor, shows an overall score of 0.120. Irrigated farms score 0.13, slightly higher than the 0.11 scored by rainfed farms. This indicates that household heads in rainfed farms had a slightly excessive workload, leaving them with less time for rest, leisure, or other personal activities.

In both Tumakuru and Chamarajanagara districts, irrigated farms consistently demonstrate slightly higher empowerment levels compared to rainfed farms. Irrigation provides a more stable and predictable agricultural environment, which enhances productivity and income stability. This stability allows household heads to make more autonomous decisions, take on leadership roles, and access better resources, including credit and land ownership. This contrasts with rainfed farms, which face greater uncertainties and limited resources, resulting in lower empowerment scores. Improving irrigation infrastructure and resource access could address these disparities and significantly boost the empowerment and well-being of rainfed farms.

In Tumakuru district, the Farm Household Empowerment Index (FHEI) was 0.810, while in Chamarajanagara district, the overall FHEI was 0.720. Therefore, the hypothesis that empowerment is more in agriculturally developed district compared to least developed district has been accepted. However, the hypothesis that there is significant difference in empowerment between irrigated and rainfed farm households has been rejected for both districts.

Effect of farm empowerment in agriculture on farm income in Tumakuru district

Table 6 outlines the descriptive statistics for several key variables used in the regression model for estimation of effect of farm empowerment on farm income covering both Tumakuru and Chamarajanagara districts. The farm income variable measures the logarithm of farm household income reflecting financial resources available to households. The empowerment index ranges from 0 to 1, assessing the level of farm household empowerment. Other variables considered were, education, agricultural land holding, irrigation facilities available in the farm, institutional participation, number of enterprises adopted, access to credit and non-farm income. These variables highlight differences between the districts in terms of financial resources,

empowerment, education, land use, irrigation, group involvement, enterprise adoption, and credit access.

The impact of various factors on per capita income in Tumakuru district using Ordinary Least Squares (OLS) regression is presented in Table 7. The results revealed several significant influences on income. The farm household empowerment index had a positive and statistically significant coefficient of 0.325 at 5 per cent probability level, indicating that higher levels of household empowerment were linked to increase in per capita income. The regression coefficient suggests that a one percent increase in the empowerment index would increase farm income by 32.50 per cent. This underscores the value of enhanced decision-making capabilities, resource access, and leadership roles in boosting income. Similar result was found by Mwololo *et al.* (2021)^[7].

Agricultural land holding had a positive and significant impact, with a coefficient of 0.052, reflecting that each additional unit increase in agriculture land would increase farm income by 5.2 per cent. Similarly, irrigation

significantly affected income with a coefficient of 0.138, highlighting that access to irrigation facilities boosts productivity and income by mitigating water scarcity issues. Agricultural land holding and irrigation were significant at one per cent level.

The analysis reveals that non-farm income had a significant positive impact on farm income, with a coefficient of 0.528. This implies that for every additional unit increase in non-farm income, farm income increases by 52.80 per cent. The model explains 58 per cent of the variability in per capita income, indicating a moderately strong relationship between the variables. The findings underscore the importance of empowering farmers, improving educational opportunities, increasing access to land, and enhancing irrigation facilities. These factors are crucial for significantly boosting farm income, thereby bringing substantial economic benefits to households in Tumakuru district. By focusing on these areas, policy interventions can help uplift the economic well-being of farm households, leading to a more sustainable and prosperous agricultural sector.

Table 6: Descriptive statistics of the variables used in the regression models for the study area

Variable	Description	Coefficient	Tumakuru (n=120)		Chamarajanagara (n=120)	
			Mean	Std. Dev.	Mean	Std. Dev.
Farm income	Farm income of household (log of Rs.)	Y ₁	5.34	0.33	5.19	0.29
Empowerment Index	Household empowerment index (ranges between 0 to 1)	X ₁	0.76	0.16	0.69	0.21
Education	Education of household head (0=Illiterate, 1=Primary, 2=High school, 3=PUC/Diploma, 4=Degree)	X ₂	1.5	1.2	1.18	0.95
Agricultural land holding	Total agricultural land holding (acres)	X ₃	2.41	2.97	2.45	1.44
Irrigation	Irrigation facilities in the farm (=1 if irrigated, 0 otherwise (rainfed))	X ₄	0.5	0.5	0.5	0.5
Institutional participation	Access to institutional participation (=1 if Yes, 0 otherwise)	X ₅	0.76	0.43	0.68	0.47
No. of enterprises adopted	No. of different enterprises adopted by farmers	X ₆	2.7	1.06	1.76	0.69
Access to credit	Access to credit (1=Yes, 0 otherwise)	X ₇	0.58	0.50	0.88	0.41
Off farm and non-farm income	Farmer having off farm and non-farm income source (=1 if Yes, 0 otherwise)	X ₈	0.68	0.48	0.75	0.43

Table 7: Ordinary least squares estimates of the effect of empowerment in agriculture on farm income in Tumakuru district (n=120)

Variable	Log income			
	Parameter	Coefficient	Std. Error	P>t
Empowerment Index	X ₁	0.325**	0.145	0.027
Education	X ₂	0.024	0.019	0.194
Agricultural land holding	X ₃	0.052***	0.007	0.000
Irrigation	X ₄	0.138**	0.055	0.013
Institutional participation	X ₅	-0.050	0.075	0.506
No. of enterprises adopted	X ₆	0.038	0.024	0.115
Access to credit	X ₇	0.006	0.057	0.922
Off farm and non-farm income	X ₈	0.528***	0.055	0.000
Constant	β ₀	4.427	0.117	0.000
R ²		0.58		

Note: ***, ** indicates significance at one and five per cent probability level, respectively

Effect of farm empowerment in agriculture on farm income in Chamarajanagara district

The empowerment index had a coefficient of 0.007, but was not statistically significant, indicating no meaningful impact of empowerment levels on farm income in Chamarajanagara district (Table 8). In contrast, agricultural landholding

showed a positive and statistically significant coefficient of 0.034. This suggests that an additional acre of agricultural land results in a 3.4 per cent increase in farm income, highlighting the value of land as a crucial resource for farming households. Similar results of farm size positively impacting farm income found by Noack and Larsen (2019)^[8] and Anang and Apedo (2023)^[3].

The coefficient for irrigation was positive at 0.126 and statistically significant, suggesting that a one percent increase in irrigation facilities would lead to a 12.60 percent increase in farm income, underscoring the importance of land as a vital asset for farming households. This finding highlights the critical impact of irrigation on agricultural productivity and income generation. Access to credit had a positive and highly significant coefficient of 0.218. This means that each additional unit increase in access to credit would increase farm income by 21.80 per cent, underlining the critical role of financial access in supporting agricultural activities and enhancing income. The estimation also shows that agricultural credit access improves farm performance (Haryanto *et al.*, 2023)^[4]. Non-farm income has a significant positive impact on farm income, with a coefficient of 0.367. This implies that for every additional unit increase in non-farm income, farm income increases by 36.70 per cent.

Overall, the regression model explains 41 per cent ($R^2 = 0.41$) of the variance in farm income, suggesting that while the included variables do have some explanatory power, other factors not captured in this model also influence farm income in Chamarajanagara district.

Table 8: Ordinary least squares estimates of the effect of empowerment in agriculture on farm income in Chamarajanagara district (n=120)

Variable	Log income			
	Parameter	Coefficient	Std. Error	P>t
Empowerment Index	X ₁	0.007	0.104	0.943
Education	X ₂	0.032	0.025	0.198
Agricultural land holding	X ₃	0.034**	0.017	0.050
Irrigation	X ₄	0.126***	0.048	0.010
Institutional participation	X ₅	-0.004	0.052	0.938
No. of enterprises adopted	X ₆	0.050	0.034	0.140
Access to credit	X ₇	0.218***	0.060	0.000
Non-farm income	X ₈	0.367***	0.057	0.000
Constant	β_0	4.453	0.110	0.000
R ²	0.41			

Note: ***, ** indicates significance at one and five per cent probability level, respectively

Conclusion

Empowerment is essential in enhancing the livelihoods and well-being of farm households, particularly in rural economies like India. It includes autonomy in decision-making, access to productive resources, leadership opportunities, and control over income, all of which contribute to more resilient and sustainable farming practices. Empowered farmers are better positioned to tackle challenges, make informed decisions, and support the development of their communities. This study emphasizes the critical role of irrigation in boosting farm household empowerment in Tumakuru and Chamarajanagara districts of Karnataka. The Farm Household Empowerment Index (FHEI) revealed notable differences between irrigated and rainfed farms, with irrigated farms showing consistently higher empowerment scores. Irrigation fosters a more stable and predictable agricultural environment, leading to greater income stability and empowering household heads to make independent decisions and assume leadership roles. In contrast, rainfed farms, characterized by greater unpredictability and limited resources, had lower empowerment levels.

The findings also indicated that while Tumakuru (0.810) had a higher FHEI compared to Chamarajanagara (0.720), there was no significant empowerment gap between irrigated and rainfed farms. Regression analysis identified farm household empowerment, landholding size, access to irrigation, and non-farm income as key factors influencing farm income, highlighting the need for a multifaceted approach to enhance livelihoods. Non-farm income was particularly important, underscoring the value of diversifying income sources for improved economic stability. To reduce the empowerment gap between irrigated and rainfed farms, policies should focus on improving irrigation infrastructure, expanding access to credit, and addressing the resource limitations faced by rainfed farmers. Through targeted interventions, it is possible to foster more equitable empowerment, enhance the well-being of farm households, and contribute to the sustainable development

of agriculture.

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