

## Can Diversification be a Strategy Towards Commercialisation of Agriculture? Evidence from Rural Urban Interface of Bengaluru

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### ABSTRACT

This study is designed to assess the impact of crop diversification on commercialisation of farm households. While studies find positive effects of diversification and commercialisation on farmers' income, little evidence is found on, the relation between diversification and commercialisation. The Herfindahl index and household crop commercialisation index was used in this study to capture the extent of crop diversification and commercialisation, respectively. The regression adjustment method is utilized because treatment effect estimates are frequently prone to misspecification in either the treatment or outcome equation. Random sampling technique is used to collect data from 180 farm households across rural, transition and urban gradients, 60 each from each gradient of North Bengaluru. The means of Herfindahl index and crop commercialisation index showed that, the rural farmers were highly diversified (0.50) and urban farmers were highly commercialised (33 %), respectively. The farm households in transition were found least commercialized and diversified. The average per cent of commercialisation, if all farmers were not diversified was 11 per cent lower than the per cent of commercialisation if all farmers were diversified, according to regression adjustment results. Diversification barring de-risking strategy also promotes biodiversity and environmental sustainability. In consequence, the initiatives and policy should encourage farm households to become diversified, which will lead to more commercialization.

*Keywords* : Crop diversification, Commercialisation, Herfindahl, Regression adjustment

THE term, 'diversification of agriculture' is as diverse as the name indicates. In literature, the term is used in different contexts. Some authors refer it as mixed cropping or rotational cropping, where some say inclusion of agronomic measures *e.g.* tillage. Sometimes, diversification term is also used to indicate the temporal or spatial distribution of crops. The most simple definition of diversification is, 'adding more crops to existing system of crops' (Feliciano, 2019). Encompassing all these dimensions, Joshi *et al.* (2016) defines diversification as, 'shift of resources from one crop (or livestock) to a larger mix of crops (mix of livestock) activity and adjusting it in such way that it leads to optimum portfolio of income'.

Crop diversification is seen as one of the most ecologically feasible, cost-effective and rational ways of reducing uncertainties in agriculture especially among small-scale farmers (Njeru, 2013).

Diversification enhances resilience in the agro-ecosystem to counteract disruptions by increasing spatial and temporal biodiversity on the farm. Diversification in rural areas not just increases the farmers' standard of living but also check the migration towards urban areas by increasing employment opportunities (Pacheco *et al.* 2018). So, through both direct and indirect pathways, diversification helps to improve the welfare of farmers and reduce the poverty. Feliciano (2019) in his meta-analysis of impact of diversification on poverty reduction concludes that, there is evidence to suggest that diversification has a role in reducing poverty, though the direct pathways are not clear. Early literature on diversification suggested that diversification is constrained by land size and only large farmers have enough resources to adopt it. However, study by Birthal *et al.* (2006), Kumar and Kumar (2018) reported that small farmers have

better potential for diversification, as they have access to labor at a low opportunity cost.

Commercialisation on the other hand, is the market oriented behavior of farmers, where increased quality and quantity of the produce is sold by the farm households (Kidane, 2019). Dalwai committee report (Anonymous, 2018) stated that directing the Indian agriculture towards commercialisation is much needed to reach the goal of doubling the farmer's income. Report also states that diversification is innately a de-risking mechanism capable of negotiating both endogenous and exogenous risks associated with the system. On the contrary, Commercialisation improves the farmer's income but intensive cultivation of crops with high-energy inputs and quality planting materials leads to ecological imbalance. Thus commercialisation does not guarantee the sustainability. Das and Kumar (2019) promotes commercialisation along with intercropping (diversifying) focusing on future needs. To reach commercialisation, diversification can be an efficient strategy. Finding a link between commercialization and diversification is mostly unexplored in the literature.

The construction of an international airport, national highways, a hardware park and a financial city project in our study area *i.e.* Northern Bengaluru, has significantly inflated farm land prices, resulting in high rates of marginalization. As a result, land use, land values, labour markets, lifestyle and livelihood possibilities have all changed. The study in rural urban areas of Bengaluru by Harishkumar and Reddy (2017) showed that, the process of urbanization has led to decrease in the size of land holdings, which in long term can affect the food production. The anticipated population growth rate, increasing demand for diversified crop products, growth in income and income elasticity of demand in the fast growing economy of Bengaluru, entail commercialisation of agriculture. However, this urbanization tendency has the potential to cause farm households to lose all interest in agriculture. (Roopa and Reddy, 2016).

Not just the economy but the climate change, dwindling human health, declining soil fertility, environmental degradation around Bengaluru emphasize the urge to sustainable agriculture. On the other hand, with small size of holdings, farmers have to commercialise for the sake of livelihood and food security. So the best course of action is to achieve the commercialization through sustainable diversification. However, there is no empirical work which examines the causal link between commercialization and diversification and whether one hinders or promotes the other in the existing ecosystem. In this backdrop, this study focuses on the following two specific objectives, which are expected to extend literature by assessing impact of diversification on commercialization of farm households

#### Objectives of the Study

1. To estimate the degree of crop diversification and degree of commercialisation across rural urban interface of North Bengaluru and
2. To study impact of crop diversification on commercialisation of agriculture

#### MATERIAL AND METHODS

#### Theoretical Framework

Earlier literature implies that rapid technical progress in agricultural output, improved rural infrastructure and diversification in food demand patterns are driving the process of diversification away from staple food production (Pingali and Rosegrant, 1995). The inspection of past works signifies two forces *i.e.* supply side and demand side forces, drive the pace of diversification. Per capita income and urbanization are two demand-side drivers that have been deemed to impact diversification. Infrastructure (markets and roads), technology (irrigation, relative profitability and risk in different commodities), resource endowments (land, water and labour) and socio-economic variables (pressure on land and literacy rate) all influence supply side forces (Joshi *et al.*, 2016; Ahmadzai, 2017). Ethnicity is found

to be affecting diversification (Torres *et al.* 2018) and also commercialization (Tarasconi and Kang, 2015). Additionally the intrinsic factors of farm house holds may make them diversify out of necessity, vulnerability to unforeseen crises (droughts, illness), price swings and most importantly to spread risk. These same variables aggrandize farm households to get more commercialized. Following points are probable stages of agriculture from diversification to commercialisation.

- Diversification encourages intercropping, crop rotation, agro-forestry (Maitra *et al.*, 2021). This leading to better agricultural practices, preventing soil erosion and increasing the soil nutrients. Eventuating sustainable agriculture, preserving biodiversity.
- From diversifying, consumption basket will get diversified leading to increased availability of different nutrients, even diversifying with high value varieties leads to high productivity and resulting in food security (Joshi *et al.*, 2016; Mango *et al.*, 2018) and livelihood security (Kumar *et al.*, 2016) and ameliorating anthropometric outcomes of children (Chen and Salas, 2015). Another attraction of diversified farming is cheap fodder for livestock (Pingali and Rosegrant, 1995).
- Diversification away from cereals leads to participation of farmers in national and inter national markets. Diversifying the exports reduces the volatility of export revenues and boosts the GDP at macro level (Pacheco *et al.*, 2018)
- Marginal effect of diversified farmers being positive in the study by Sen *et al.* (2017) and have shown diversification increases income of farm household. The study by Babatunde and Qaim (2009) has also came up with the same result. The results of study by Makate *et al.* (2016) validated diversification as viable climate smart practice to increase income and livelihood security.
- Diversification increases employment and hence not just the income of farmer increases but also the landless laborers’.

- Income from diversified agriculture can be used to invest to make agriculture more intense and productive leading to commercialise (Pradhan, *et al.*, 2010). The study by Pingali and Rosegrant (1995) also observed diversification leading to commercialization.
- Resulting commercialization is both a cause and a consequence of economic development (Tarasconi & Kang, 2015).

The above literature is depicted in Fig. 1, which provides a schematic diagram, depicting the causal pathways through which diversification of crops grown affects commercialisation

### Primary Data

The research is conducted in rural-urban interface of North Bengaluru. North transect was split into three layers: rural, transitional and urban gradients. The survey stratification index was estimated by examining the percentage of built-up land and its linear distance from the city center to divide the area into rural, transitional and urban gradients (Hoffmann *et al.*, 2017). Vidhana Soudha, the state legislature’s edifice, was chosen as a reference point for measuring the distance. Building density was substantially associated with distance up to around 20 to 25 kilometers from the city center (the closer to the city, the higher the percentage of built-up area). Farther than, the two factors were adversely correlated (Udaykumar and Umesh, 2020). The villages were selected randomly across gradient and farm households were selected through random sampling. From each gradient 60 farmers were selected summing to 180 observations in dataset. Data was collected through personal interview along with pre-tested and well-structured schedule. Data pertaining to crops grown, marketed produce were collected to address the objectives.

### Analytical Tools

*Herfindahl index* : To study the crop diversification Herfindahl index is used, by the following formula (Pal and Kar, 2012).

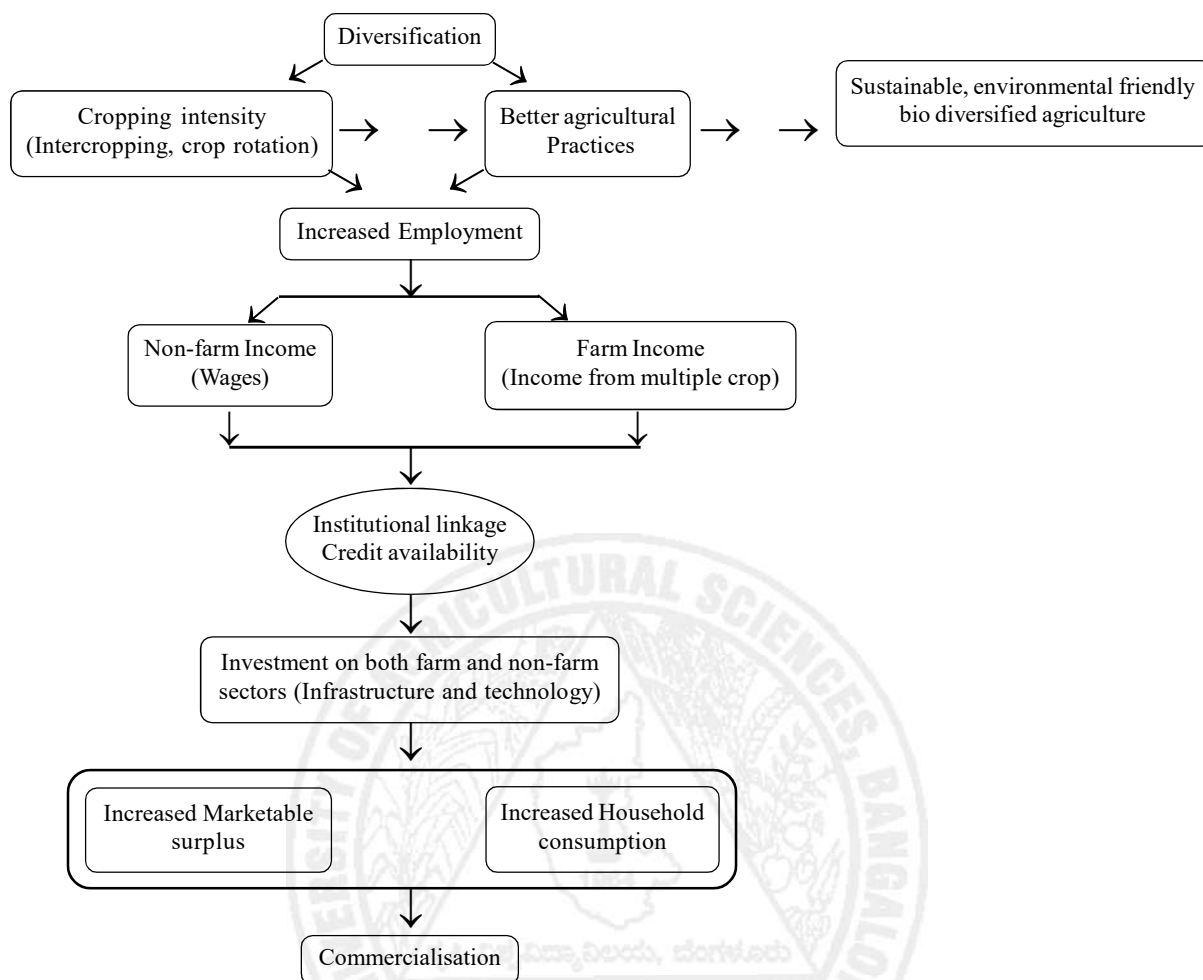


Fig. 1. Pathway of impact of diversification on agriculture commercialization

$$HI = \sum_{i=1}^N P_i^2$$

Where,

$N$  = number of crops cultivated

$P_i$  = area under  $i^{th}$  crop in total area of cultivation

The index takes a value of one under total specialization and moves towards zero for increasing diversification. Hence the range of index is zero to one. The farmers with index value less than 0.5 is grouped under zero category indicating diversified farmers and farmers with value more than 0.5 are taken under category one, indicating farmers growing monocrops.

*Crop commercialization index* : The household Crop Commercialization Index by Strasberg *et al.*

(1999) is used to measure per cent of commercialization. The value zero indicating complete subsistence and value near hundred as commercialized.

$$CCI = \frac{\text{Gross value of crop sales}_{hhi}}{\text{Gross value of all crop production}_{hhi}} \times 100$$

CCI = Household crop commercialization index

### Regression Adjustment

The objective of this study is to assess the effect of diversification on commercialisation. Here diversification is the treatment, which is not randomized. The diversified farmers could differ significantly on potentially confounding factors, compared to non-diversified farmers. This



difference leads to biases, while estimating the impact of diversification on commercialisation. Even the randomized treatment assignment may not justify the bias (Freedman, 2008). Hence forth, Regression adjustment model is used, most commonly utilized and can be very efficient in estimating the effects by minimizing the bias (Myers and Thomas, 2010). Wooldridge and Negi (2018) in their joint work on regression adjustment stated that RA possibly improves precision by regressing on covariates that predict the out come.

Regression adjustment is interested in estimating the ‘average treatment effect on the treated’ households (ATET), defined as the average difference in commercialization (outcome) of commercialized farm households with and without the diversification. Following Horner and Wollni (2011), the ATET is written as :

$$\begin{aligned} \text{ATET} &= E \{Y_{iC} - Y_{iN} | T_i = 1\}, \\ &= E(Y_{iC} | T_i = 1) - E(Y_{iN} | T_i = 1) \end{aligned}$$

Where,  $E\{\cdot\}$  is the expectation operator,  $Y_{iC}$  is predicted outcome (commercialization) for diversified farm household  $i$ ,  $Y_{iN}$  the predicted

outcome of the same household under non-diversified situation, while  $T_i$  represents the treatment groups (diversification) status taking zero for non-diversified and one for diversified. However, while the extent of commercialization for the diversified household from the diversified group, *i.e.*,  $E(Y_{iC} | T_i = 1)$  can be observed from the data, the counterfactual outcome  $E(Y_{iN} | T_i = 1)$ , commercialization of the same household not been diversified cannot be observed. Regression adjustment is used to solve this problem (Horner and Wollni 2011).

The RA technique creates separate linear regression models for treated and untreated observations, then predicts covariate-specific outcomes for each subject for each treatment status. These predicted average outcomes for each subject and treatment level reflects the POMs (Potential Outcome Mean). The difference of these averages provides estimates of ATEs. The ATETs are obtained by limiting the computation of means to the subset of treated individuals. In the study, the difference between projected outcomes in diversified and non-diversified situations are averaged to get average treatment effect (Anonymous, 2013).

TABLE 1  
Description of variables used in study

Variables	Description	Measurement	Mean	Standard deviation
Age	Age of household head	Number of years	48	16
Gender	Gender of household head	1=male 0=female	0.8	0.4
Education	Number of years of formal education of the household head	Number of years	7	5
Household size	Number of household members including children	Numbers	5	3
Community active	Participation in any formal (KVK, NGO, Credit groups) or informal (faith based or general political activities)	1= Participated 0= Not participated	0.12	0.3
Asset value	Approximate present value of all agricultural equipment owned by family	Rupees	1,10,901	58,904
Land size	Size of land holdings	Acre	2.78	3.84
Survey Stratification Index (SSI)	Index	0 to 1	0.731	0.13

RA equation is expressed as following by Manda *et al.* (2018)

$$ATET_{RA} = n_A^{-1} \sum_i T_i [r_c(X, \delta_c) - r_N(X, \delta_N)]$$

Where,  $n_A$  is the number of diversified farm households, and  $r_i(X)$  describes the regression model for commercialised and non-commercialised farm households with covariate  $X$  and estimated parameters  $\delta_i (\alpha_i \beta_i)$ .

The Stata command ‘teffects’, with default takes linear full (separate) regression adjustment (FRA). The study by Negi and Wooldridge (2021) suggests full regression adjustment to be used rather than pooled, the opinion is also same with Sloczynki (2018). The average treatment effect is measured between treatment vs. control to examine association between crop diversity and dietary diversity in the study by Snapp and Fisher (2015). The study stated that a unit increase in the average number of intercrops leads to two per cent increase in household dietary diversity score. The covariates used in the Table 1 are the variables which may influence diversification and can be different between treatment and control groups.

Table 2 indicates that the rural farmers are highly diversified with moderate level of

TABLE 2

Extent of commercialisation and diversification across gradient

Variable	Rural	Transition	Urban
Commercialisation index	32	12 *	33
Diversification index	0.50	0.68 *	0.54

\*least value along row

commercialisation. The urban farmers are highly commercialised compared to other two. The transition farmers are least commercialised and diversified, probable reason may be the income from non-farm activities.

### RESULTS AND DISCUSSION

It is evident from the results (Table 3) that variables like gender, community active, asset value and land

TABLE 3

Summary of the covariates across diversified and non-diversified farms

Variable	Rural	Transition	Urban
Age	48.85	47.94	0.91
Gender	0.85	0.745	0.11 *
Education	6.81	6.34	0.46
Household size	4.89	5.14	-0.24
Community active	0.184	0.08	0.09 **
Asset value	210000	43000	167000 *
Land size	3.93	1.95	1.98 ***
SSI	0.72	0.733	-0.005

size vary significantly across treatment and control group. The difference among these variables between groups will lead to biasedness if regular regression is used. The columns mean one and two are depicting the mean values of diversified farm households and non-diversified farm households, respectively. The values showed that the diversified farmers much older in terms of age compared to non-diversified farm households, showing with the increase in years of experience farm households are going diversified. Further diversified farm households found to be more educated with high asset value and land holding. Diversified farmers were also found to be active in community groups. Non-diversified farmers were found to be not so active in community groups with less education possessing less valued assets and land size.

As mentioned in the methodology, category zero indicates diversified farmers and one indicates specialized farmers. By regression adjustment it is showed that, the extent of commercialisation would have been 31.29 per cent if all the farmers were diversified. The average per cent of commercialisation would have been 11.44 per cent less if all the farm households would be not diversified *i.e.* 19. 85. (Table 4). So, the results portray that diversification is leading farm households towards commercialization.

The diversified potential outcome means (POM) for farm household’s commercialization was 33 per

TABLE 4  
Effect of diversification on the commercialization of farm households

Commercialisation	Coefficient	Std. Error	z	P> Z
ATET Diversification (1 vs 0)	-11.44	5.73	-1.99	0.046
PO means (POM) Diversification 0	31.29	5.01	6.24	0.00

Note: ATET-Average treatment effect of treated  
POM-Potential Outcome mean

cent (Table 5), which means if all the farm households are diversified, the expected average percent of commercialization is 33 per cent. The percent of commercialization if all the farm households were not diversified is 24 per cent,

TABLE 5  
Table showing potential outcome across diversified and non-diversified farmers

Commercialisation	Coefficient	Std. Error	z	P> Z
PO means Diversification				
0	33.88	4.47	7.56	0.00
1	24.00	3.88	6.17	0.00
OME0				
Age	0.11	0.32	0.33	0.73
Gender	-11.74	11.41	-1.03	0.30
Education	1.01	0.99	1.02	0.30
Household size	3.54	2.03	1.74	0.08
Community active	15.89	9.84	1.61	0.10
Asset value	0.00	0.00	2.03	0.04
Land size	2.60	1.07	2.44	0.01
SSI	-22.51	27.05	-0.83	0.40
_____cons	19.90	32.40	0.61	0.53
OME1				
Age	0.12	0.24	0.52	0.60
Gender	12.56	7.16	1.75	0.07
Education	0.44	0.69	0.06	0.94
Household size	0.29	0.79	0.37	0.71
Community active	11.80	14.30	0.82	0.40
Asset value	0.00	0.00	1.21	0.22
Land size	1.41	1.78	0.79	0.42
SSI	-13.89	32.13	-0.43	0.66
_____cons	7.74	25.71	0.30	0.76

Note : ATET-Average treatment effect of treated  
POM-Potential Outcome mean  
OME0-Outcome mean of diversified  
OME1-Outcome mean of non-diversified

a difference of 9 per cent. The ATET (Average treatment effect of treated) and POM calculations both depicted the presence of diversification increases the per cent of commercialisation. The coefficients in Table 5, labeled OME0 represents the linear equation used to estimate the diversified POM and the coefficients for the equation labeled OME1 represents the linear equation used to estimate the non-diversified POM. The results clearly depicts that, the diversified farmers are commercialising.

Crop diversification around Bengaluru keeping the goal of commercialisation to double farmer's income is the predominant strategy. Diversification is said to have a number of advantages from shifting consumption patterns, increasing food security, stabilizing income over seasons, generating employment opportunities, alleviating poverty, improving productivity of scarce resources, promoting export and improving environmentally sustainable farming systems. From the results of study it is evident that the diversified farmers are in the process of commercialisation, evincing need of diversification to commercialise. Transitional farmers are found to be least diversified and commercialised, there is imperative need to commercialise them for which diversification can be the initial stage. This can address the demand of population, stabilize economy in balancing with farm households and environments health. Urban farmers are highly commercialised and complete specialization can be a threat and risky. It is worth taking note of the suggestion made by Das and Kumar (2019) to have three different crops as optimum number of standing crops on the field. Hence, urban farmers should be educated to break the monoculture practice. Regarding rural area, another attraction of diversification is to attract rural industrialization. Study eventually suggests diversification as an opportunity and as a pathway to reach commercialisation. Also to maintain certain percent of diversification even after commercialising completely to have sustainable and environment friendly agriculture.

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