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CHHATRAPATI SHAHU INSTITUTE OF BUSINESS EDUCATION AND RESEARCH (CSIBER), KOLHAPUR, MAHARASHTRA, INDIA

(An Autonomous Institute)
University Road, Kolhapur - 416004, Maharashtra State, India.

website : www.siberindia.edu.in
E-mail : editorsajmr@siberindia.edu.in

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Website: www.siberindia.edu.in
Email: csiberpress@siberindia.edu.in
Editor Email: editorsajmr@siberindia.edu.in

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Growing Opportunities: Unpacking the Horticulture Growth Trend in Manipur

Ringbamlung R Panmei
Research Scholar
Department of Commerce, Manipur University,
Canchipur, Imphal, Manipur, India.

Dr. Robita Sorokhaibam
Professor
Department of Commerce, Manipur University,
Canchipur, Imphal, Manipur, India.

Abstract

Given the increasing demand for food grains and other crops, an important aim of economic growth and development is to achieve self-sufficiency in agricultural production. Manipur, a small hilly state in north-eastern India, is a storehouse of many Indigenous and underutilized horticulture crops that are valuable in bioactive components and are used in ethnomedicine. Fruits, spices, and vegetables have high demand in the market and are rich sources of vitamins. The study analyzes the trend in agricultural land use and the production within horticulture, including fruits, vegetables, and spices. The study investigates using panel data analysis with secondary time series data from 2012-2022. Techniques like regression, fixed effects model, random effects model, and the Hausman test are applied. In the study, it was shown a consistent pattern among agricultural land and its usage over time, but the production of fruits and vegetables underwent radical changes. The regression models reveal a decrease in land area for growing fruits by 138 units yearly. However, concerning the vegetable area, the regression analysis results indicate that the area increases at about 186 units per year, though the significance level is low ($p = 0.082$). The fixed effects model and random effects model show a positive increase of about 186 units annually. For spice, there has been no statistically significant effect on the spice areas through years. The Hausman test believes that the random effects models best fit this type of data analysis, which calls for considering the unobserved variables that are affecting land use. However, the trend in results from the R-square value and high standard errors indicates that various important factors are excluded. The study suggests a need for a greater emphasis on a multifactor approach, which would combine climatic, socio-economic, and geographical features. The paper calls for incorporating additional factors that may help better understand the influence on agricultural patterns in the long run.

Keywords: Horticulture growth, Agriculture Land use, Production trends, Manipur.

Introduction

Horticulture, which is also referred to as the branch of agriculture, is one of the most profitable sectors in the country's economy. India is diverse in agro-climatic and has a rich biodiversity, which is suitable for growing various horticultural crops. India has achieved its second highest position in the production of vegetables and fruits globally. It takes the lead in varieties of horticultural crops such as papaya, banana, and mango (Dar, 2017). The region of northeast India has 50 percent of the country's biodiversity and 7.7 percent of the overall land area of the country. This region is famous for its diverse natural topography, soil, and climate, which results in the cultivation of diverse fruits, vegetables, medicinal plants, flowers, and spices (Deka et al., 2012). The importance of horticulture cannot be overemphasized as it is significant in increasing land productivity, creating jobs, raising the economic status of farmers and entrepreneurs, boosting the export market, and, most importantly, ensuring the nutritional needs of the inhabitants of the desert (Bhandari et al., 2014).

The percentage of vegetable output to the total vegetable and fruit production in Manipur, a small hilly state in north-eastern India, improved from approximately 26% in 2005-06 to roughly 40% in 2015-16. However, the percentage is much lower than the national share of 64%, consistent throughout the period. Vegetables spanned an area of 34,160 ha, producing an average of 315 thousand metric tonnes each year, representing 0.34% and 0.19% of the national totals. The production of vegetables in the state is 9.22 metric tonnes, much below the 16.73 metric tonnes per hectare national average on a per-hectare basis. Nonetheless, the rising patterns in area and output observed since 2000-01 indicate significant potential for Manipur's fruits and vegetable industry (Devi, 2019).

Manipur is a storehouse of many Indigenous and underutilized horticulture crops that are valuable in bioactive components and are used in ethnomedicine. Despite its potential, the sector remains commercially unexploited. In 2014–15, the area cultivated with horticultural crops was 100.01 thousand hectares, yielding a production value of 1,159.03 thousand tonnes (Roy et al., 2018). Manipur is conducive to the development of the fruit and vegetable industry owing to its various agricultural and climatic conditions. The state has significant potential in the development of fruits and vegetables. Nevertheless, owing to insufficient irrigation infrastructure, the agriculture of the state is significantly reliant on the unpredictability of the rainy season and frequently exposed to erratic climate circumstances, leading to substantial variations in output levels. Horticultural crops such as vegetables do not need perpetual watering. These are short-duration crops that generate more output per unit area compared to cereal crops such as rice, hence providing enhanced benefits to smallholder and small-scale farmers in Manipur engaged in vegetable farming. Furthermore, it serves as a significant source of employment owing to its labour-intensive nature. The output from this domain may serve as a stimulus for development by supplying unprocessed materials to emerging small-scale regional agrobusinesses in the state. This field has emerged as the most important and dynamic element of the state's agriculture industry. The changing horticulture scenario in Manipur indicates that there is a need for research and policy support so that the resources available can be optimally exploited and thereby assist in the region's overall economic growth.

Therefore, this paper adds to the growing literature and aims to assess the performance related to the area and output of fruits, vegetables, and spices in the horticulture sector of Manipur. In addition, this paper also makes a comprehensive study of the significance of area and production in the growth of horticultural crops. Our study answers the following research questions:

What is the trend in the area allocation of horticulture cultivation in Manipur, mainly fruits, vegetables, and spices?

How has Manipur's horticulture output (fruits, vegetables & spices) changed?

Are there significant differences in the performance of horticulture crops, i.e., fruits, vegetables, and spices, in terms of their area and output?

What is the significance of area and production in the growth of horticultural crops in Manipur?

Review of Literature

Kamei (2013) provided an overview of the function of horticulture in historical contexts and international, national, regional, and state challenges, focusing on the Tamenglong district. An in-depth review is carried out in hilly and mountainous regions and the rural developmental challenges associated with it. Numerous academicians, scientists, governments, and NGOs have recognized the significance of horticulture and its related fields.

In the districts of Manipur and Bishnupur, Devi (2019) established positive growth rates for the area and yield of certain vegetables grown in the area. The study provides valuable insight into the growth trend of vegetables over a decade. Cabbage was the largest vegetable crop growing in the state of Manipur. The increase in vegetables was mainly because of area expansion rather than the improvement in productivity. The study brings out the significance of the area in planting vegetables. The study provides valuable insight into the growth trend of vegetables over a decade.

Singh and Bera (2017) showed that net cropping, cropped area, and planting rose between the years 1987 and 2012-13 but showed a decline in irrigated areas. The share of fruits, vegetables, and spices has risen to 14.78% per hectare. All main crops have positive growth rates but are subject to medium to high uncertainty. For food grains and vegetables, the area effect leads to increased output expansion, while productivity expansion has high contributions to greater yields for fruits and spices.

According to Zou and Muan (2020), the varied agro-climatic circumstances in India and agricultural products are significant drivers of the country's finances, making it ideal for agro-based industries. Rapid industrialisation and literacy growth have created new market opportunities. Indians spend almost half of their household budget on food items, which makes the agro-based food manufacturing sectors attractive to young entrepreneurs and farm workers.

Biswas et al. (2020) study found that some of the cultivated areas in Manipur, which is not more than 10% of the total area available, need to increase so that food requirements are met. This paper, covering the period 1997 to 2016, is covered by the authors with respect to ten different crops comprising grains, corn, oilseeds, legumes, fruits, vegetables, pineapple, citrus, ginger, and turmeric crops. The trends determined for the rice yield, total oilseeds, and turmeric are cubic polynomials; corn has quadratic trends; the trends for total pulses are linear; and the trends for chili and veggies are complex.

Kumar (2022) in his study, reveals that the consumption of fruits and vegetables increased in rural areas by 18-23% and 10-20%, respectively, between 1993-94 and 2011-12. He mentioned challenges regarding low productivity growth, export limitation, and poor value realization. The study suggests the need to improve productivity growth, diversify export destinations, and encourage value addition and entrepreneurship in processing to improve the performance of India’s horticulture sector.

Study by Gupta (2022) reveals that there is a rise in the growth of production for fruits and vegetables with low instability and moderate instability for spices. It indicates that fruits can be cultivated in Meghalaya, Manipur, and Assam, which have low instability indices. The study mentioned that horticulture has the prospects of enhancing the north-east economy significantly.

Research Gap

Research in many aspects regarding Manipur's agricultural and horticultural development has been pursued, but there are gaps to fill. Different studies have focused on specific crops like vegetables or staple crops. On the other hand, the overall group of fruits, vegetables, and spices has attracted little research attention, with a specific focus on the differences in growth and productivity throughout the years. In addition, although the area is considered a significant factor influencing production development, productivity, and yield, especially with respect to fruits and spices, it receives inadequate attention. There is a lacuna in understanding the factors that have shaped Manipur's unexplored horticultural development until now and the specific requirements that need to be fulfilled to ensure continued agricultural development in various regions of Manipur.

Objective of the study

The main objective of the study is to analyses the trend in agricultural land use and the production within horticulture, including fruits, vegetables, and spices. Therefore, the following are the specific objective of the study:

1. To assess the performance related to the area and output of fruits, vegetables, and spices in the horticulture sector of Manipur.

2. To comprehensively study the significance of area and production in the growth of horticultural crops.

Methodology

The study was conducted for Manipur to track the growth of horticulture by using panel data regression analysis using different techniques such as Fixed effects Model (FEM), Random Effects Model (REM) (Hung et al., 2023; Zhai & Guyatt, 2024), focusing on secondary time series data on fruits, vegetables, and spices. The study was conducted using the Stata tool, enabling it to assess the trends in agricultural land use and production throughout Manipur. This approach allows us to observe the change in horticulture growth over the years. The steps in methodology include:

Data collection

The data for this research were obtained from secondary sources provided by the Department of Horticulture and Soil Conservation, Government of Manipur. The study covered a period of ten years, from 2012-13 to 2021-22. The study primarily aims to collect data on multiple years of agricultural records, such as cultivated area and production of fruits, vegetables, and spices. This study is limited to secondary data due to its reliability, feasibility, and comprehensiveness.

Model Specification: Constructing a regression model where the year serves as the independent variable and the areas dedicated to fruits, vegetables, and spices are treated as dependent variables.

Model Estimation: To estimate the regression model using Fixed Effects Model (FEM) and Random Effects Model (REM).

Model Selection: Hausman test is aimed at assessing which of the Fixed Effects Model or the Random Effects Model is suitable for assessing the data.

Hypothesis Testing: Testing the hypothesis that year and area have a significant impact on agricultural development and production by evaluating the p-values and confidence intervals associated with the regression coefficients.

Robustness Checks: Carrying out further tests to verify the reliability of the results, which involves evaluating multicollinearity, heteroskedasticity, and autocorrelation.

Scope of the study: The scope of the present study is limited to the horticulture sector of Manipur, which focuses specifically on fruits, vegetables, and spices from 2012-2013 to 2021-2022.

Results & Discussion:

Fruits:

Table 1 Regression

Fruits Area	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
YEAR	-138.0458	88.47978	-1.56	0.122	-313.881	37.78918
_cons	283816.5	178419.7	1.59	0.115	-70755.1	638388.1

Table 1. Using Stata, regression analysis was done to examine the connection between YEAR (the independent variable) and Fruits Area (the dependent variable). The negative coefficient YEAR indicates that the fruit area under cultivation is decreasing by about 138 units. The commonly accepted significance criterion is 0.05, although YEAR's p-value of 0.122 is higher, indicating that this trend is not statistically significant. The lack of solid proof against the null theory that YEAR does not affect the fruit area is suggested. For YEAR, the 95% confidence interval is from -313.88 to 37.79. Although the constant (_cons) is 283,816.5, it is not statistically significant (p = 0.115). Regarding these numbers, the model doesn't prove beyond a reasonable doubt that YEAR has a big effect on the fruit area.

Table 2 Fixed Effect Model

Fixed-effects (within) regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.2067		min =10				
between = .		avg =10				
overall = 0.0269		max =10				
corr(u_i, Xb) = -0.0000		F(1,80) =20.85				
		Prob > F =0				
Fruits Area	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Year	-138.0458	30.23385	-4.57	0	-198.213	-77.8785
_cons	283816.5	60966.63	4.66	0	162489	405144

Table 2. Based on the fixed-effect (within) regression model, it has 90 observations spread out over 9 groups, with an average of 10 observations in each group. This means the independent variable (Year) can explain about 20.67% of the difference in the dependent variable (Fruits Area) within the groups. The within-group R-squared number is 0.2067. The total R-squared value of 0.0269 and the between-group R-squared numbers are not helpful in this case. The model seems to be very important, with an F-statistic of 20.85 and a p-value of 0.000. The value for the variable "Year" is -138.0458, which means that if all other factors stay the same, the area used for growing fruit declines by an average of 138.05 units per year as time goes on. The 95% confidence range for this result is between -198.213 and -77.8785, which means it is statistically significant negative effect of "Year" on "Fruits Area" ($p < 0.05$). The value of the constant term (_cons) is 283,816.5, which is the average amount of the Fruits Area when the Year variable is set to 0. This model shows that the Fruits Area has been going down over time.

Table 3 Random Effect Model

Random-effects GLS regression			Number of obs =90			
Group variable: id			Number of groups =9			
R-sq:			Obs per group:			
within = 0.0000			min =10			
between = 0.0000			avg =10			
overall = 0.0269			max =10			
corr(u_i, X) = 0 (assumed)			Wald chi2(1) =20.85			
			Prob > chi2 =0			
Fruits Area	**Coef.**	**Std. Err.**	**z**	**P>z**	**[95%Conf.Interval]**	
Year	-138.046	30.23385	-4.57	0	-197.303	-78.7885
_cons	283816.5	60971.78	4.65	0	164314	403319

Table 3. The results of the R-squared numbers demonstrate that the model fails to account for any variation within or across groups (R-squared values: 0.0000 for both the within and between groups). The model accounts for 2.69 per cent of the total variance in the dependent variable, indicated by an R-squared value of 0.0269. The model fits the data correctly because the Wald chi-squared measure is significant ($\chi^2 = 20.85$, $p < 0.001$). "Year" has a value of -138.046, which is of statistical significance ($p < 0.001$). In other words, the relationship between the year and the area of crops is inversely related., with a 95% confidence range of -197.303 to -78.7885. Also, the constant term (_cons) is important ($p < 0.001$); it has a value of 283816.5 and shows the expected fruit area when all other factors stay the same.

Hausman test:

Table 4 Hausman Test

Dependent variable	p-value	Chi-square test	Test of summary
Fruits Area	>0.05	>0.05	Random effect

Table 4. Because the p-value exceeds 0.05, it indicates that the random effects model is more appropriate for the data, enabling the acceptance of the null hypothesis. This analysis shows that the individual-specific effects do not correlate with the regressors, suggesting that we should opt for the random effects model.

Table 5 Regression

Fruits Production	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
year	53.62686	858.1559	0.06	0.95	-1651.78	1759.031
_cons	-54791.19	1730473	-0.03	0.975	-3493743	3384161

Table 5. The regression analysis aimed to determine how output fruit is related to the variable year. Since the finding is statistically unimportant ($P > 0.95$), the estimate for the year variable is 53.63, which suggests that fruit production has gone up over time, but not by much. There is much variation around the number, as shown by the big standard error (858.16). The confidence range is also very large (-1651.78 to 1759.03), which shows that the number is not certain. The constant (_cons) is -54791.19, and the standard error is even bigger. This means that there is no meaningful relationship ($P > 0.975$). The study shows that the year does not greatly affect this model's ability to predict fruit production.

Table 6 Fixed Effect Model

Fixed-effects (within) regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0003		min =10				
between = .		avg =10				
overall = 0.0000		max =10				
corr(u_i, Xb) = 0.0000		F(1,80) =0.02				
		Prob > F =0.8811				
Fruits Production	Coef.	Std. Err.	t	P>t	[95% Conf.Interval]	
Years	53.62686	357.4098	0.15	0.881	-657.641	764.8951
_cons	-54791.19	720717.7	-0.08	0.94	-1489065	1379483

Table 6. The fixed-effects regression model was calculated using 90 observations spread across 9 groups, with 10 observations on average per group. Very little information was explained by the model (0.0003) about the changes in fruit production within groups over time. Additionally, the total R-squared was very small (0.0000), demonstrating that the model struggled to provide clear explanations. According to the model, the F-statistic was 0.02, and the p-value was 0.8811. This indicates that the predictor variable (Years) does not significantly explain the difference in fruit production. Although the "Years" coefficient was 53.63, the finding was not statistically significant ($p = 0.881$), and the 95% confidence interval was very large, spanning from -657.64 to 764.90. Furthermore, the fixed term (_cons) was not important. According to the results, "Years" is not a good indicator of fruit output in this fixed-effects model.

Table 7 Random Effect Model

Random-effects GLS regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0000		min =10				
between = 0.0000		avg =10				
overall = 0.0000		max =10				
corr(u_i, X) = 0 (assumed)		Wald chi2(1) =0.02				
		Prob > chi2 =0.8807				
Fruits Production	**Coef.**	**Std. Err.**	**z**	**P>z**	**[95% Conf.Interval]**	
year	53.62686	357.4098	0.15	0.881	-646.884	754.1373
_cons	-54791.19	720756	-0.08	0.939	-1467447	1357865

Table 7. The GLS regression model with random impacts was run on 90 observations spread out over 9 groups, with an average of 10 observations in each group. The outcomes reveal that the model fails to provide any explanation in the domains of within, between, and overall effects since all three R-squared values are 0.0000. The Wald chi-squared statistic is 0.02, with a corresponding p-value of 0.8807. This indicates that the model is not statistically significant. Since the p-value for this variable is 0.881 and the coefficient for the variable "year" is 53.63, we can conclude that the effect of the year on fruit production is not statistically significant. The parameter as a constant (_cons) and a standard error of -54791.19 is very high. This is another sign that the model is not very accurate or meaningful. Ultimately, it was decided that the model does not explain any major changes in fruit output over time.

Hausman test:

Table 8 Hausman Test

Dependent variable	p-value	Chi-square test	Test of summary
Fruits Production	>0.05	>0.05	Random effect

Table 8. A p-value in excess of significance level 0.05 concludes that the random effects model is more appropriate and affirms the null hypothesis. Consequently, it implies that no strong proof exists to show any link between random effects and the explanatory variables. It is clear that the random effects model is a more appropriate fit for the data.

Vegetables:

Table 9 Regression

Vegetables Area	**Coef.**	**Std. Err.**	**T**	**P>T**	**[95% Conf.**	**Interval]**
Year	186.0237	105.5806	1.76	0.082	-23.7956	395.8429
_Cons	-371251	212903.5	-1.74	0.085	-794352	51850.18

Table 9. Regression analysis was used to examine how the year and the area of vegetables were related. A Year has a value of 186.0237 and 105.5806 as the standard error. This indicates the link between the two, which means that the area of veggies grows by about 186 units for every extra year. Concurrently, however, with a p-value of 0.082, we surpass the generally acknowledged 0.05 threshold for significance. Statistical significance is almost at hand at the 10% level, but it is not evident at the 5% level. The constant's (_Cons) standard error is 212,903.5 and its coefficient is -371,251, indicating a negative intercept. The intercept is not statistically significant (p=0.085), with a significance level of 5%. There is a 95% CI for Year, and the constant shows a range of possible values, but they both include zero, which shows that this model does not have much statistical significance. Generally, there is a solid association between the year and the vegetable area, but the outcomes are unimportant.

Table 10 Fixed Effect Model

Fixed-effects (within) regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0790		min =10				
between = .		avg =10				
overall = 0.0341		max =10				
corr(u_i, Xb) = 0.0000		F(1,80) =6.86				
		Prob > F =0.0106				
Vegetables Area	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
year	186.0237	71.03294	2.62	0.011	44.66361	327.3837
_cons	-371251	143238.1	-2.59	0.011	-656304	-86198

Table 10. The results of the Fixed Effect regression model are presented, with the dependent variables as Vegetables area. Analysis has revealed that the R-squared value is 0.0790, meaning the independent variable (year) explains about 7.9% of the variance observed in the dependent variable. The model's F-statistic, which was also found to be strong, had a value of 6.86 with 0.0106 as its p-value. The variable "year" coefficient is 186.0237, and the standard error is 71.03294. The t-value= 2.62 and p-value= 0.011 provide evidence of a strong relationship between these two variables. Holding other factors constant, there is an annual increase of roughly 186.02 in the area designated for vegetables. On the other hand, the constant term (_cons) is -371,251, which is also statistically significant (p = 0.011). The fixed effect model outlines the strong and favorable connection between the two variables "year" and "vegetable areas," indicating that the areas for vegetables have increased.

Table 11 Random Effect Model

Random-effects GLS regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0000		min =10				
between = 0.0000		avg =10				
overall = 0.0341		max =10				
corr(u_i, X) = 0 (assumed)		Wald chi2(1) =6.86				
		Prob > chi2 =0.0088				
Vegetables Area	**Coef.**	**Std. Err.**	**z**	**P>z**	**[95% Conf.Interval]**	
year	186.0237	71.03294	2.62	0.009	46.80166	325.2457
_cons	-371250.8	143240	-2.59	0.01	-651996	-90505.6

Table 11. The effects of probability GLS regression study of a dataset with 90 observations spread across 9 groups revealed important information about how the variable "year" affected the result related to vegetables. The model shows a statistically significant positive coefficient for "year" (Coef. = 186.02, p = 0.009). This means that the result related to vegetables goes up by about 186.02 units for every extra year, with a 95% confidence interval spanning from 46.80 to 325.25. It is also that the intercept term (_cons) has a statistically significant value of -371250.8 (p = 0.01), which means it has a baseline effect. The Wald chi-squared test measure (chi2(1) = 6.86, p = 0.0088) denotes on the whole, the model is generally significant, but the R-squared values show that it does not explain much within or between groups (within = 0.0000, between = 0.0000). So, even though the model shows results that are statistically significant, the low R squared values suggest that other factors may need to be looked at in order to better understand the differences in the results for vegetables.

Hausman test:

Table 12 Hausman Test

Dependent variable	p-value	Chi-square test	Test of summary
Vegetables Area	>0.05	>0.05	Random effect

Table 12. The results of the Hausman test suggest that the Random Effects model is appropriate for the data because there is no correlation observed between the random error term and the independent variables. A p-value in excess of significance level 0.05 concludes that the random effects model is more appropriate and affirms the null hypothesis.

Table 13 Regression

Vegetable production	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
year	1886.023	723.6077	2.61	0.011	448.0051	3324.042
_cons	-3767163	1459156	-2.58	0.011	-6666929	-867396

Table 13. A regression study of vegetable production shows that the variable "year" has a strong positive relationship with vegetable output, as shown by a coefficient of 1886.023. This means that vegetable output increases by 1886 units for every additional year. The p-value of 0.011 shows statistical significance. The standard error for this number is 723.6077, which shows good accuracy. This coefficient shows that the 95% confidence interval ranges between 448.0051 and 3324.042 shows the reliability of the estimate. If all the variables are zero, conversely, the intercept (_cons) is negative at -3767163 with a p-value of just 0.01. It proves that the starting point is of statistical significance. In general, the data show that vegetable production has increased over the years, which shows how time may affect farming outputs.

Table 14 Fixed Effect Model

Fixed-effects (within) regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.3573		min =10				
between = .		avg =10				
overall = 0.0717		max =10				
corr(u_i, Xb) = -0.0000		F(1,80) =44.48				
		Prob > F =0				
Vegetable production	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
year	1886.023	282.7834	6.67	0	1323.267	2448.78
_cons	-3767163	570233.3	-6.61	0	-4901963	-2632362

Table 14. Vegetable production has a strong positive link with the variable "year," as shown by the coefficient of 1886.023. With a statistical significance p-value of 0.011. This indicates that annual vegetable output increases by around 1,886 units. We can see that this coefficient has a good level of accuracy because its standard error is 723.6077. The estimate is more likely to be correct since, for this coefficient, the 95% CI falls somewhere in the middle. 448.0051 and 3324.042. The intercept (_cons), on the other hand, is negative at -3767163, together with a p-value of just 0.011. The baseline value is, therefore, significantly different from zero when all indicators are zero. Overall, the data show that veggie production has increased over the years, which shows how time may affect farming outputs.

Table 15 Random Effect Model

Random-effects GLS regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0000		min =10				
between = 0.0000		avg =10				
overall = 0.0717		max =10				
corr(u_i, X) = 0 (assumed)		Wald chi2(1) =44.48				
		Prob > chi2 =0				
Vegetable Production	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Year	1886.023	282.7834	6.67	0	1331.778	2440.269
_Cons	-3767163	570268.6	-6.61	0	-4884869	-2649457

Table 15. The random-effects generalized least squares (GLS) regression analysis was done on 90 values spread out over 9 groups. The goal of the model was to look at how the variable "Year" affected the growth of vegetables. The model has very little power to explain things because both the within-group and between-group R-squared values are 0.0000, and the total 0.0717 is the R-squared value. For vegetables, this proves that the framework does not explain the vast majority of yield fluctuations. The variable "Year" has a value of 1886.023, which means that it possesses a statistically significant positive relationship with vegetable production ($z = 6.67$, $p < 0.001$). The constant term (_Cons), on the other hand, is -3767163, a very significant negative number in statistics. finding ($z = -6.61$, $p < 0.001$). This means that the average vegetable production is much lower when the offset is considered. This is because the model may not have considered everything that may have impacted the output. The results show how important time is for figuring out how vegetable production changes over time, even though the model does not fit perfectly.

Hausman test:

Table 16 Hausman Test

Dependent variable	p-value	Chi-square test	Test of summary
Vegetable Area	>0.05	>0.05	Random effect

As the p-value is greater than 0.05, it is possible to accept the null hypothesis when using the random effects model. Since the individual effects are not correlated with the regressors.

Spices:

Table 17 Regression

SpicesArea	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
year	11.17542	64.22764	0.17	0.862	-116.464	138.8144
_cons	-21096.8	129515.2	-0.16	0.871	-278481	236287.4

Table 17. The Spice area's regression analysis shows a standard error of 64.228 and a coefficient of 11.175 for the "year" variable. According to the findings, the year hardly influences the t-value (0.17) and p-value (0.862). spices area at the conventional level. There is a 95% chance that the year is between -116.464 and 138.814, which is a large range with little strong evidence of an effect. The constant has a -21096.8 as the coefficient and 129515.2 as the standard error; these statistical values are t= -0.16, p=0.871, and a confidence range from - 278481 to 236287.4. The results indicate that neither the "year" nor the intercept are significant predictors of the "spice area."

Table 18 Fixed Effect Model

Fixed-effects (within) regression		Number of obs =90				
Group variable: id		Number of groups =9				
R-sq:		Obs per group:				
within = 0.0005		min =10				
between = .		avg =10				
overall = 0.0003		max =10				
corr(u_i, Xb) = 0.0000		F(1,80) =0.04				
		Prob > F =0.8469				
Spices Area	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
year	11.17542	57.69311	0.19	0.847	-103.638	125.9884
_cons	-21096.8	116338.3	-0.18	0.857	-252617	210423.8

Table 18. A dataset of 90 observations, divided into 9 groups of 10, was subjected to the fixed-effects (inside) regression model. The R-squared values reveal a poor match (0.0005 for within-group and 0.0003 for outside-group) and no mention of the between-group. With a value of 0.0000 for Corr (unit, Xu), we may conclude that the explanatory variables do not contribute to the group effects. A p-value of 0.8469 and an F-statistic of 0.04 for the model suggest that there is no statistical significance. A margin of error of 57.69311 is linked with the dependent variable "year" and its coefficient is 11.17542. This has given a t-value of 0.19 and a p-value of

0.847, is a statistically significant impact. The constant term has a standard error of 116338.3 and a co-efficient of -21096.8. Its p-value of 0.857 suggests the intercept is not significant. The 95% confidence ranges for the year, and constant terms are very large and include zero, proving that there is no statistical significance.

Table 19 Random Effect Model

Random-effects GLS regression			Number of obs =90			
Group variable: id			Number of groups =9			
R-sq:			Obs per group:			
within = 0.0000			min =10			
between = 0.0000			avg =10			
overall = 0.0003			max =10			
corr(u_i, X) = 0 (assumed)			Wald chi2(1) =0.04			
			Prob > chi2 =0.8464			
Spices Area	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
year	11.17542	57.69311	0.19	0.846	-101.901	124.2518
_cons	-21096.8	116338.6	-0.18	0.856	-249116	206922.7

Table 19. The R-squared numbers (within = 0.0000, between = 0.0000, total = 0.0003) show that there is no difference that can be explained within or between the groups. The model does not detect a relationship between the group-specific effects and the independent variable (Corr (unit, X) = 0), as shown with a p-value of 0.8464 and Wald chi-square of 0.04. The absence of any statistically significant information in the model is evident from this. The "year" variable has a margin of error of 57.69311 and a coefficient of 11.17542. The results show that there is no effect that is statistically significant (p=0.846, z=0.19). As a constant term, there is no discernible result (p = 0.856). (cons), which is -21096.8 and has a large standard error of 116338.6. Both the "year" coefficient and the constant have 95% confidence ranges that are very large amounts of uncertainty about the intercept.

Hausman test:

Table 20 Hausman Test

Dependent variable	p-value	Chi-square test	Test of summary
Spice Area	>0.05	>0.05	Random effect

Table 20. The p-value exceeds 0.05, which means we accept the null hypothesis. This indicates that the random effects model more adequately represents the data, as the individual effects do not correlate with the independent variables. Therefore, the random effects model is favored based on these findings.

Table 21 Regression

Spices Production	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
year	120.2223	547.8492	0.22	0.827	-968.513	1208.958
_cons	-227986	1104739	-0.21	0.837	-2423423	1967450

Table 21. According to the regression analysis for spice production, the variable "year" had led to a 120.22-point coefficient, 547.85-point standard error. There is no statistical significance (p = 0.827) with a t-value of 0.22. A 95% confidence interval for this number shows that there is a lot of variation in how "year" affects the production of spices. There is no statistical significance for the _cons constant term, with a t-value of -0.21, a standard error of 1104739, and a coefficient of -227986. This model can't accurately predict the link because the confidence range for the constant term is very large, spanning from -2423423 to 1967450.

Table 22 Fixed Effect Model

Fixed-effects (within) regression	Number of obs =90
Group variable: id	Number of groups =9
R-sq:	Obs per group:

within = 0.0010			min =10			
between = .			avg =10			
overall = 0.0005			max =10			
corr(u_i, Xb) = -0.0000			F(1,80) =0.08			
			Prob > F =0.7751			
Spices Production	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
year	120.2223	419.4067	0.29	0.775	-714.424	954.8682
_cons	-227986	845734.4	-0.27	0.788	-1911052	1455079

Table 22. Based on 90 observations split into 9 groups of 10, the fixed-effects (within) regression model was calculated. With an R-squared value of 0.0010 for within, 0.0010 for between, and 0.0010 for total, this model does not capture much variation in spice production between the groups. The study shows no statistically significant correlation with the model and time invested in cultivating spices (t=0.29, p=0.775). (p=0.08) (0.7751). The coefficient for the year variable is 120.2223 and standard deviation of 419.4067. The t-value is -0.27, the p-value is 0.788, and the constant term standard error (_cons) is 845734.4. The findings were determined to be statistically insignificant. Large confidence bands for both factors show that the predictions are inaccurate.

Table 23 Random Effect Model

Random-effects GLS regression			Number of obs =90			
Group variable: id			Number of groups =9			
R-sq:			Obs per group:			
within = 0.0000			min =10			
between = 0.0000			avg =10			
overall = 0.0005			max =10			
corr(u_i, X) = 0 (assumed)			Wald chi2(1) =0.08			
			Prob > chi2 =0.7744			
Spices Production	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
year	120.2223	419.4067	0.29	0.774	-701.8	942.2443
_cons	-227986	845741.1	-0.27	0.787	-1885608	1429636

The random-effects GLS regression model, with 90 observations spread across nine groups, shows that the R-squared values are 0.0000 within and between groups, with a value of 0.0005 for the whole set. The least, most, and average observations per group are all 10. The “year” variable does not correlate with the group effects. The p-value of 0.7744 and a Wald chi-square value of just 0.08 show no statistical significance. The standard error for the "year" variable is 419.4067, and the coefficient is 120.2223. Its z-score of 0.29 and p-value of 0.774 cannot be considered significant. The 95% confidence interval for the year coefficient is -701.8 and 942.2443, which includes zero, indicating the true effect of year on spices production could possibly be zero indicating no relevant effects.

Discussion

The research observed a trend in agricultural land and its use over the years. For the purposes of fruit production, the regression predicts that the area allocated for growing fruits has been shrinking at an average rate of about 138 units per year, which is still not an important statistical finding. This shows that the variables in the data are not sufficient to draw firm conclusions, which helps to explain the decreasing trend. The fixed effects model confirms the trend and shows a statistically significant decline of -138.05 units per year. However, the random effects model supports the downward trend while only explaining 2.69% of the variance in the dependent variable. Random effects model would be a better model for this data according to the Hausman test (Gil-García & Puron-Cid, 2014), which means a need to account for unobserved factors into consideration when calculating fruit area. A regression study of fruit output indicates that the year has no significant effects on fruit production, indicating the complexity of agriculture trends in this field.

There is a positive correlation between the year and the area of land set aside for vegetable growing, among other crops. The regression analysis results indicate that though the level of significance is low, the area increases by 186 units per year. The trend for both fixed and random effects models is statistically significant, which means that vegetable area has increased constantly over different time periods. According to Fajar et al. (2020), the F-statistics of both the FEM and REM indicate the model's validity and show a significant relationship. The positive influence of the year on vegetable production is supported in regression models by the coefficient of 1886.023 units per year, indicating a substantial rise in vegetable production. However, despite a strong correlation, both the models of R-squared values are rather low, suggesting that certain variable factors are not covered in the study. The Hausman test has indicated the need to adopt random effects models for fruits and vegetables.

Likewise, in spices, the regression analysis results show that the year coefficient does not have a significant impact on the spices area. The p-value for the fixed and random effects models, which is above the acceptance level, indicates that the year has no statistically significant impact on the spice areas. The Hausman test results suggest that the random effects models are a better fit and appropriate for analyzing the data.

Contribution and Implication of the Research

The study contributes significantly to expanding our understanding and focuses on highlighting the complexity of land uses in horticultural sectors like fruits, vegetables, and spices. The study offers a valuable understanding of the dynamic trends of land use and an understanding of nuances carried out by using econometric models like regressions, fixed effects models, random effects models, and the Hausman test.

Using multiple analytical models helps provide a robust understanding of the underlying factors affecting land use and make appropriate decisions. This study contributes to the current body of literature by evaluating the relationship between land areas and production, which are imperative in making choice decisions by the farmers. The study shows the use and applicability of this technique for future decision-making choices.

The study identifies the unobserved variable factors that are important in influencing the results. It suggests that future researchers and policymakers should consider not only the historical data but also take into account various external factors (socio-economics, market demand, climate) that may influence future land use decisions. The horticulture sector encounters various challenges like market structure, geographical discrepancies, sinking of arable land, urbanization, and economic concerns (Basa & Sahu, 2021; Nabi & Bagalkoti, 2017). This analysis would help in decision-making processes in a more rational manner and suggest the most appropriate combinations of factors that should be used for more robust study.

Recommendation

1. Unobserved variable:

From both the fixed effects and random effects analysis, the study indicates the exists of unexplained variability, the future study should identify and make into account for unobserved variables that influence the agricultural sectors. This could be from factors like government policies, land use, consumers preferences. These could give a deeper insight in to the study for more accurate of agriculture dynamics.

2. Enhance cross regional studies:

To better understand the variation and trends of the development of horticulture growth, cross regional comparison could help provide valuable insights on how others factors like economic factors, land development and agricultural activities. It can also help us to understand how each region adapt to certain challenges when it comes to agricultural development.

3. Participation of stakeholders in decision making:

In order to have a quality and reliable source of data, farmers, agricultural businesses and local stakeholders should be involved. This will help us to capture accurate information and valuable context to the study.

Conclusion

The study carried out for different types of horticulture crops (fruits, vegetables, and spices) leads to the conclusion that the land use and production of agriculture development are dynamics that is rather complex and determined by multiple variables, which remain unexplored in the current study. It is accepted that some of the changes, for instance, the area under fruit production, are decreasing, whereas the vegetable areas have been gradually increasing, but these changes are not always statistically significant or completely substantiated by the available data. According to the Hausman test random effects model is appropriate for analyzing the data.

Nonetheless, the low R-squared and high standard errors suggested that an extensive study of agricultural trends is yet to be developed in this area.

Limitation and Future scope

This study, like many other researches, is not free from limitations despite the proper care being taken. First, this study relies on the available data for land area and production by statistical models without analyzing the causal factors that can influence the results, such as climatic, socio-economic factors, technological incorporation, market volatility, and geographical elements, to evaluate long-term development patterns in horticulture. To better understand the various factors that influence the trend of agricultural land use and production variations, the study calls for incorporating wider factors that may help understand the influence on agricultural patterns. Future research can incorporate these factors to better understand how horticulture development is affected over an extended period.

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