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Growth performance in Horticulture: Temporal dynamics under different crop groups in India

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Abstract

The present study aims at analyzing the growth performance of Horticulture sector in India. The paper analyzes the growth rates and decomposition analysis of horticultural crop groups' area, production and productivity from 1991-92 to 2020-21. The study period was divided into pre-NHM (1991-92 to 2004-05) and post-NHM (2005-06 to 2020-21). The compound growth rate results show that the growth rate in area, production and productivity of horticultural crop groups are positive and statistically significant during the post-NHM period than the pre-NHM period. From decomposition analysis, area effect and yield effect are positive during the post-NHM period for all the crop groups, interaction effect also shows positive except fruits and flower crops. The overall performance in area, production and productivity is quite satisfactory during the post-NHM period; greater attention needs to be given to the states where the productivity has declined with marginal increments under NHM.

Key words: NHM, horticulture, growth rate, and decomposition.

Introduction

The diverse climatic and soil conditions in India create an ideal environment for cultivating an extensive array of horticultural crops. Throughout the 2018-19, the Indian Horticultural sector played a pivotal role by contributing 15 percent and 11 percent to global fruit and vegetable production, respectively. This remarkable achievement positions India as the second-largest producer worldwide, trailing only behind China (FAO, 2020). As suggested by Engel's law, a significant shift in consumption patterns has been observed, transitioning from staple foods such as cereals to more valuable commodities like fruits and vegetables.

These shifts create demand towards nutritious and high-value commodities (Jha *et al.,* 2019). Therefore, per capita consumption of fruits and vegetables which was only 281 grams/day during 2005-06 has increased to 400 grams /day in 2019-20. So, Indian agriculture contributes to overall economic growth, besides providing nutritional and health benefits through the horticultural sector by implementing different schemes and programmes.

Patil and Hosamani (2017) stated that one of the successful schemes was National Horticulture Mission (NHM) which came into existence in 2005; later, in 2014, these programmes were brought under the Mission for Integrated Development of Horticulture (MIDH). The principle objective of NHM was accomplishing an overall encompassing development of the cultivation with an integrated approach covering the production of planting material, vegetable seed, seed infrastructure in the public and private sector, the establishment of new gardens on farmers' lands, rejuvenation/replacement of senile plantations, technology dissemination through front line demonstrations, postharvest management etc. Implemented through this scheme, the Government of India (GOI) is responsible for contributing 60 percent of the total expenditure for developmental projects in all states, excluding those in the North East and the Himalayan regions. Complementary to this, State Governments actively participate by providing the remaining 40 percent share. As of the current period (2018-19), the scheme's reach extends across 537 districts, encompassing 18 states and 5 Union Territories. Notably, to bolster national-level developmental endeavors, 20 National Level Agencies have been incorporated into the framework (Patnaik, 2020).

Over the last few years, India has witnessed increased horticulture production through significant progress in area expansion resulting in higher production due to Mission intervention. The sharper increase in acreage shifts the production of horticulture crops' were apparent from 2011-12 to 2018-19 (Choudhary, 2013). The production of horticulture crops has increased from 182.81 to 329.90 million tons (mt) from 2005-06 to 2020-21 from an area expansion of 18.71 to 27.20 million ha (MHA), whereas the productivity has increased from 9.77 to 12.31 tonnes per ha (Agricultural Statistics, 2020). The incremental change in area and productivity of horticultural crops resulted in a significant shift in the horticulture output, resulting from its output share, which has become 33 percent of the total Agricultural production, i.e., more than one-third of agriculture GDP. The horticultural area grew by 2.6 percent per annum and annual production increased by 4.8 percent in recent decades. Subsequently, area, production and productivity have increased significantly during this period. India's per capita availability of fruits and vegetables has substantially increased from 114 and 236 to 208 and 394 grams/ day from 2001 to 2018, respectively (Horticultural statistics, 2018).

Doddamani *et al.* (2014) observed that a major part of these

improvements is from 2005-06 onwards. The initiation of NHM has a synergistic effect on the State Department of Horticulture's ongoing programs. With due respect to these achievements, there is a need to make horticulture production more sustainable in the long term. Based on the above literature, there is a need to find the significant growth of horticulture production after implementing NHM. The development of horticulture is not only due to NHM but also other programmes contribute to them. This research mainly concentrates on finding out the growth performance of horticultural crop groups in India with the following objectives: to study the growth rates and measure the relative contribution of area and productivity in their production growth. This study emphasise more on growth rate and also concentrates on decomposition analysis.

Materials and methods

The present study has been entirely based on the secondary data collected from the National Horticulture Board database, Agricultural Statistics, Department of Horticulture, and other published sources. The time-series data on India's area, production, and productivity of horticulture crop groups were collected from 1991-92 to 2020-21. The study period was divided into the pre-NHM period (1991- 92 to 2004-05), post-NHM period (2005-06 to 2020-21) and overall period (1991-92 to 2020-21).

Compound growth rates (CGR): It was computed by applying the formula: $Yt = ab^t$

In the log form, it is written as $\text{Log } Y_t = \text{Log } a + t \log b$

Where Y_t = Area/production/productivity in the year 't', t = time element which takes the value 1, 2, 3, ……. N, a = intercept and b = regression coefficient.

The value of b is computed by using the OLS method. Further, the value of CGR was worked out as follows: CGR (r) = (antilog b-1) x 100

Student's test was used to check the significance of the CGR (Udhayakumar *et al.,* 2021).

Decomposition analysis: Using decomposition analysis, Agarwal *et al*. (2016) measured the relative contribution of area and yield to the total output change for the horticultural crop groups. The method states that the A_0, P_0 and Y_0 are area, production and productivity, respectively, in the base year and A_n, P_n and Y_n are values of the respective variable in n^{th} year *i.e.*:

$P_0 = A_0 \times Y_0$, and $P_n = A_n \times Y_n$ (1)

A_0 and A_n represent the area, and Y_0 and Y_n represent the yield in the base year and n^{th} year, respectively.

$P_n - P_0 = \Delta P$, $A_n - A_0 = \Delta A$ and $Y_n - Y_0 = \Delta Y$ (2)

Upon simplification of equations (1) and (2), it could be written:

$P_0 + \Delta P_n = (A_0 + \Delta A_n)(Y_0 + \Delta Y_n)$ and $\Delta P_n = (A_0 + \Delta A_n)(Y_0 + \Delta Y_n) - P_0$

Substituting P_0 from (1) rearranging the terms gives:
$\Delta P_n = (A_0 \Delta Y_n) + (Y_0 \Delta A_n) + (\Delta A_n \Delta Y_n)$

Production change = area effect + yield effect + interaction effect

Thus, the total change in production can be decomposed into three components *viz.*, area effect, yield effect and the interaction effect due to the change in yield and area from the base period (Narmadha and Kandeepan, 2017).

Results and discussion

Performance of NHM on Horticulture in India: The NHM has focused on increasing production and productivity by expanding cultivation areas and introducing new technologies to ensure quality and the production of new horticultural crops. Adopting an area-based approach is being emphasised to cultivate regionally acclimatized crops better suited to that region or state. In addition, a strong emphasis is being placed on ensuring the availability of high-quality planting material by building appropriate infrastructure, such as establishing nurseries and tissue culture labs (Nabi and Bagalkoti, 2017).

There was impressive growth in the area, production and productivity of total horticulture crops during the post-NHM period than pre-NHM period (Fig. 1). The growth period's area, production and productivity of the pre-NHM rate was 2.65, 4.21 and 1.82 percent, almost doubling in post-NHM with a growth rate of 4.68, 7.46 and 2.54 percent, respectively. Initially, the scheme was implemented in 371 districts but expanded to 537 districts (2018-19). This shows area expansion under horticultural crops has facilitated the expansion in horticultural crop production in India. Jadhav *et al.* (2016) also reported that the production of most horticultural crops has increased between the pre and post-NHM period.

Fig. 1: Area, production and yield of horticulture crops in India

This shows after the introduction of NHM, diversification is taking place towards highly valued horticultural crops replacing cereals. To meet the growing food demand, the National Food Security Mission (NFSM) was launched in 2007-08 with an outlay of Rs 4,882.48 crore for the 11^{th} Five Year Plan (2007-12) and succeeded in meeting its objective of raising food-grains output by 20 (mt) and allocated of Rs 12,350 crore with the additional foodgrains target of 25 mt in the 12^{th} FYP (2012-17) period. The rate of growth in the cereals has relatively lesser than the area under horticultural crops despite the implementation of NFSM-like programmes through area expansion and productivity enhancement activities by the Department of Agriculture. It could also be inferred from Fig. 2, 3 and 4, clearly indicating that horticultural crop production surpassed the food grains production even with one-fifth of the food grains area due to six to seven times higher productivity realized in the case of horticultural crops in 2020-211 (Jha *et al.*, 2019). Agarwal *et al.* (2016) reported economic reforms and policies of the 1990s further increased the speed of diversification in favour of horticulture crops. This profound growth performance in horticultural crops compared with food grains was mainly due to the low initial productivity and higher potential productivity against foodgrains.

Growth in area, production and productivity of horticultural crop groups in India: The Mission's efforts can be seen in the growth patterns from Table 1 shows that the National Horticulture Mission has a positive impact in terms of area, production, and productivity, specifically in most of the crop groups.

In the case of fruit crop groups, the CAGR for area and

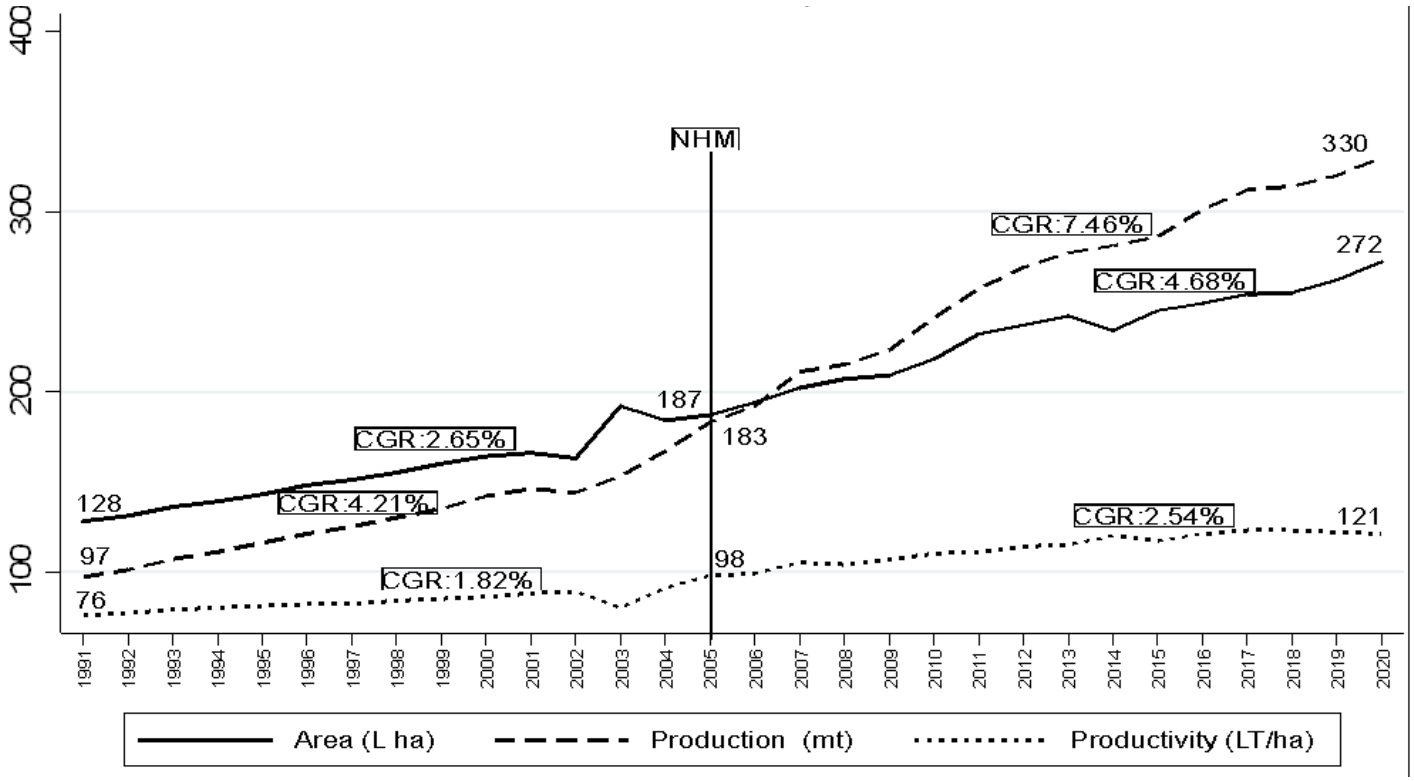

Fig. 1. Area under horticulture vs food grains in India for past two decades

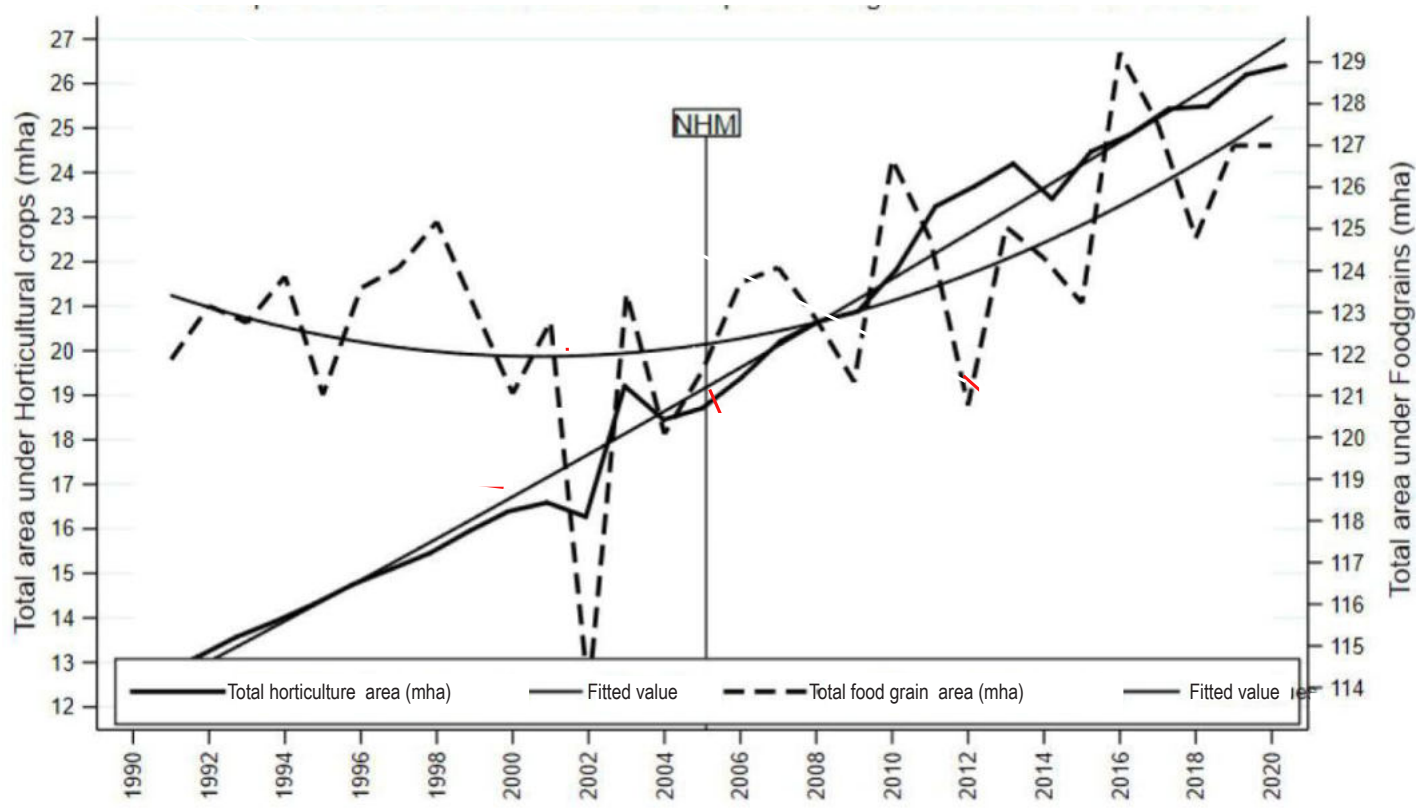

Fig. 2. Area under horticulture vs food grains in India for past two decades

production significantly increased from 1.29 and 3.01 percent in the pre-NHM era to 2.9 and 7.85 percent in the post-NHM period, respectively. The effect is more predominant in the case of productivity, with the CAGR moving from 4.01 percent to a significantly encouraging level of 13.31 percent. The overall period growth rate of fruit crops was 3.81, 5.85 and 9.88 percent of the area, production and productivity, respectively.

The vegetable crop group reported significant growth in the area (3.55%), production (5.63%) and productivity (2.94 %) during 1991-92 to 2018-19 in India. The pre and post NHM analysis for the vegetable crop group indicated significant negative growth in area (-0.96%) and positive productivity growth (2.16%), but production was non-significant growth with 4.08 percent during pre-NHM period while in the post-NHM period area, production

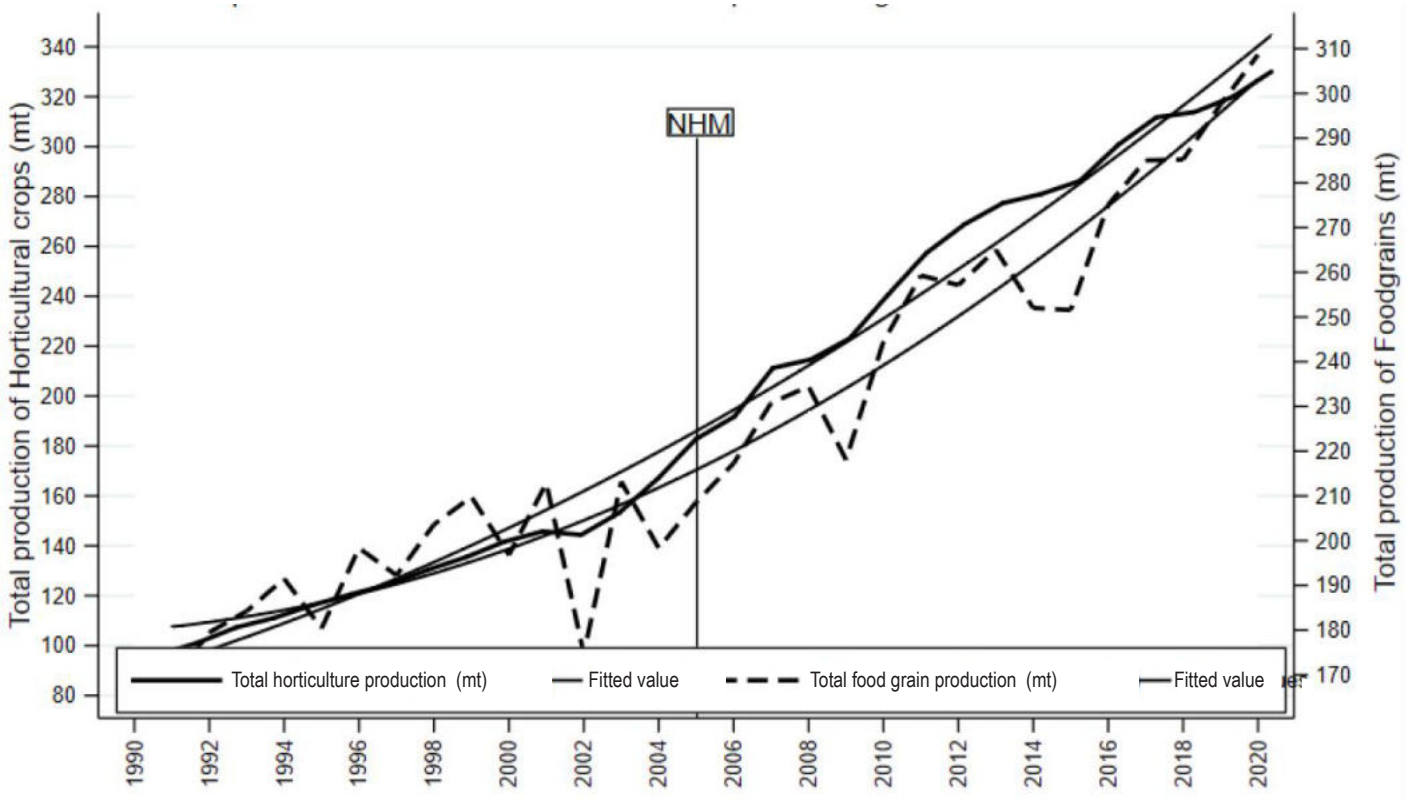

Fig. 3. Total production horticulture vs food grains in India for past two decades

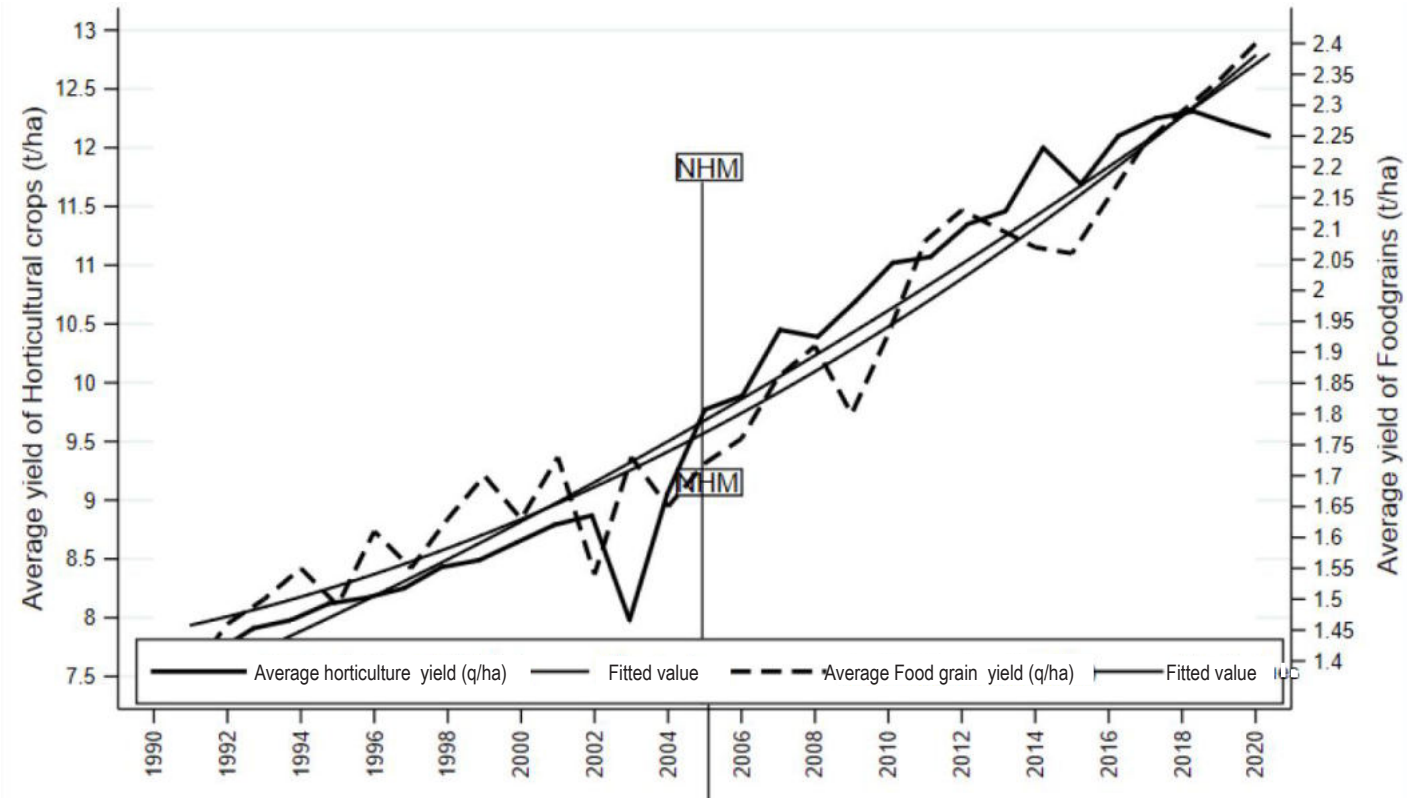

Fig. 4. Average yield (q/ha) horticulture vs food grains in India for past two decades

and productivity growth found significant positive annual compound growth with 2.92, 5.55 and 3.38 per cent, respectively.

Good potentialities exist for cultivating flower crops, indicating that area, production and productivity of post-NHM show significant positive annual compound growth rates with 715, 12.30 and 5.16 percent, respectively, benefited enormously from NHM interventions. In contrast, the growth of pre-NHM was negatively significant in the area (-3.26 %), and productivity (-0.61%) but positively substantial growth in production with 2.01 percent. The noticeable achievement growth in the overall period for flower crops with 12.84, 11.79 and 3.56 percent in area, production and productivity, respectively.

Table 1. CGR (%) of Horticultural crop groups in India

Crop groups	Periods	Area	Production	Productivity
Fruits	Pre NHM	1.29*	3.01**	4.01
	Post NHM	2.99*	7.85**	13.31**
	Over all	3.81*	5.85*	9.88*
Vegetables	Pre NHM	-0.96*	4.08	2.16*
	Post NHM	2.92**	5.55**	3.38*
	Over all	3.55*	5.63**	2.94**
Flowers	Pre NHM	-3.26**	2.01*	-0.61**
	Post NHM	7.15*	12.30*	5.16*
	Over all	12.84*	11.79**	3.56*
Plantation	Pre NHM	2.65	-2.61*	0.96*
	Post NHM	1.81*	4.27**	2.67*
	Over all	1.60	3.32*	2.28*
Spices	Pre NHM	4.85*	7.08*	1.45*
	Post NHM	4.10*	7.46*	3.12*
	Over all	2.08*	6.63*	2.93**
Total horticultural crops	Pre NHM	2.65*	4.21	1.82
	Post NHM	4.68*	7.46*	2.54**
	Over all	3.54*	5.68**	2.08**

** 1 percent significance level and * 5 percent significance level
Source: Author's calculation based on data from Agricultural statistics, 2020

Growth patterns of plantation crops indicate that the pre-NHM period of the area shows non-significant growth with 2.65 percent, production shows significant negative growth (-2.61%) and productivity was significant positive growth with 0.96 percent. In contrast, the post-NHM period shows significant positive annual compound growth rates with 1.81, 4.27 and 2.67 percent respectively. The overall period of the plantation crops area shows non-significant while production and productivity show significant.

Increasing trends in the area, production and productivity of spices has been observed in pre-NHM period show significance with 4.85, 7.08 and 1.45 percent, respectively. Similarly, during the post-NHM and overall period, the growth in the area, production and productivity were significant with 4.10, 7.46 and 3.12 percent, respectively.

In the pre-NHM period, only the area's growth rate showed significance, with 2.65 percent, while the production and productivity growth of total horticulture crops was non-significant, with 4.21 and 2.52 percent, respectively. Similarly, during the post-NHM period, the growth in area, production and productivity were significant with 4.68, 7.46 and 2,54 percent, respectively. The overall period of total horticulture growth shows importance in area (3.54%), production (5.68%) and productivity (2.08%) with relatively slower growth in area expansion. Doddamani *et al.* (2014) broadly point to a concerted effort to increase efficiency through technical interventions under the NHM scheme.

The above results show that area under horticulture improves acreage, coverage, and productivity in potential regions, adopts a structured approach and promotes cooperation, integration, and synergy among public and private-sector research and development, manufacturing, processing and market agencies. It assured appropriate returns to the producers by promoting the Research and Development of technologies for production and productivity, like postharvest management and processing in potential regions. It was made possible by the efforts of the State Government, which operates under the NHM scheme (Patil and Hosamani, 2018).

Table 2. Decomposition analysis of horticultural crop groups in India

Crop groups	Particulars	Pre-NHM (1991-2004)	Post-NHM (2005-2019)	Overall (1991-2019)
Fruits	Area effect	1.18	6.36	2.38
	Yield effect	-0.17	2.30	1.86
	Interaction effect	-0.30	-0.30	-0.13
Vegetables	Area effect	3.61	4.08	4.14
	Yield effect	2.00	6.61	3.62
	Interaction effect	0.01	0.68	0.14
Flowers	Area effect	0.13	0.23	0.20
	Yield effect	-0.05	0.15	0.09
	Interaction effect	-0.01	-0.09	-0.03
Plantation crops	Area effect	0.20	0.75	0.35
	Yield effect	-0.13	0.22	0.18
	Interaction effect	0.01	0.05	0.01
Spices	Area effect	0.22	0.28	0.21
	Yield effect	0.19	0.21	0.25
	Interaction effect	0.01	0.08	0.02
Total Horticultural crops	Area effect	5.70	11.57	6.36
	Yield effect	4.33	5.81	5.41
	Interaction effect	0.05	0.36	0.13

Source: Author's calculation based on data from Agricultural statistics, 2020

Decomposition analysis: The analysis of the factors affecting the total production of horticultural crop groups was calculated by decomposition analysis and results were presented in Table 2. It indicates a trend in production changes, the contribution by area has been positive in all crops for the period and productivity has been only positive in case of vegetables and spices crops during the pre-NHM period, but in the post-NHM period all major crop groups are positive. The interaction effect is positive for all crop groups except fruit and flower crops.

By comparing pre-NHM with the post-NHM period, the maximum area effect was found in fruits from 1.18 to 6.36 percent, followed by plantation and flower crops and the minimum in spices and vegetable crops. Total horticultural crops area and yield effect increased from 5.70 to 11.57 percent and 4.33 to 5.81 percent, respectively. The yield effect was negative to positive in fruit crops from -0.17 to 2.30 percent, plantation (-0.13 to 0.22 %) and flowers (-0.05 to 0.15%), whereas vegetables and spices yield effect is positive, but spice crop shows very low yield effect. In the case of an interaction effect, vegetables (0.01 to 0.68 %) exhibit the highest interaction effect, followed by spices and plantation crops, whereas fruits and flower crops show a negative interaction effect and total horticulture crops increased from 0.05 to 0.36 percent.

So during the overall period, total horticultural crops recorded 6.36, 5.41 and 0.13 percent of area effect, yield effect and interaction effect, respectively. Among horticultural crop groups, vegetables were found to be highest with area effect (4.14%), yield effect (3.62%) and interaction effect (0.14%) followed by fruits, flowers, plantation and spice crops.

Results revealed that the area and productivity were more responsible for increasing production during the post-NHM period than the pre-NHM period through the transfer of improved technologies, the establishment of nurseries, tissue culture labs and gardens, production and distribution of plant material, protected cultivation, creation of water resources, mechanization,

Integrated Pest Management/Integrated Nutrient Management, rejuvenation / replanting under the NHM scheme (Jadhav *et al.,* 2016).

Overall study reveals significant positive growth in area, production and productivity of horticultural crop groups after implementation of NHM. However, the country's underlying horticulture potential has yet to be fulfilled, and it will need more effort to attain its pinnacle through NHM interventions.

In recent years, the horticultural sector has received much attention since it is seen as a potential source of growth, employment, and foreign exchange benefits. The above results highlighted that growth of area, production and productivity for major horticultural crop groups in India was positive and statistically significant. Among horticultural crops, NHM has created the highest production growth on flowers (12.30%), followed by fruits (7.85%), spices (7.46%), vegetables (5.55%) and plantation crops (4.27%). This indicates higher growth performance among the country in all the crop groups. Hence, the horticulture sector focuses on research and development, technical advancements, and supporting institutional reforms. With the growth of this industry, the government may play a big role in making rules that encourage horticulture development and ensuring that basic infrastructure is in place for horticulture marketing and transportation. Diversification into horticulture must use an agro-climatic strategy, finding possible crops that thrive in specific climates to boost productivity and profitability with the support of NHM.

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