Maize Journal (October 2025) 14(2): 184-190

RESEARCH PAPER

Dynamics of crop diversification, area allocation behaviuor and determinants of output growth in north Gujarat

Sujit Mohalkar[1] • Kalpesh Thakar[2] • Ganesh Dhonde[3]

Abstract The agricultural sector in North Gujarat has shown significant development, contributing substantially to India's production of food grains, oilseeds, and spices. This study aims to assess the compound growth rates and instability indices of area, production, and productivity of major crops in North Gujarat from 1982–83 to 2017–18. Further, it evaluates crop diversification using the Herfindahl Index (HI) and Modified Entropy Index (MEI), analyzes changes in cropping pattern through Markov Chain Analysis, and identifies determinants of output growth via the decomposition method of Minhas and Vaidyanathan (1965). Data were collected from the Directorate of Agriculture, Government of Gujarat. Results revealed moderate specialization across food grains, cereals, pulses, oilseeds, and commercial crops, with the Herfindahl Index ranging from 0.583 to 0.676 and MEI values close to 1, indicating a gradual trend towards specialization. Markov analysis showed high crop stability in pearl millet (79.60%), wheat (74.00%), followed by maize (39.60%) and cotton (74.30%), whereas crops like rice and gram exhibited low retention. Decomposition analysis indicated that yield effect was the major contributor to output growth (48.61%), followed by area effect (14.27%) and interaction between area, yield, and crop pattern (13.17%). The findings emphasize the need for further diversification and technology-driven productivity enhancements to ensure long-term sustainability and stability in the agricultural sector of North Gujarat.

✉ Sujit Mohalkar: sujitmohalkar2014@gmail.com

[1,2]Department of Agricultural Economics, MPKV, Rahuri, Maharashtra, India

[3]Department of Agricultural Economics, SDAU, Dantiwada Gujarat, India

Received: 24 May 2025/ Accepted: 07 September 2025

Keywords: Crop diversification • Behavioural changes • Determinant of output growth • North Gujarat

Introduction

Agricultural growth and its inherent instability have long been central to the discourse of agricultural economics in India. The trajectory of agricultural development, though marked by substantial gains in output and productivity, continues to be marred by volatility in production levels, leading to multidimensional implications for farmers, consumers, and policymakers alike. While growth in agricultural production is vital for ensuring food security, income stability, and rural development, the concurrent increase in production instability undermines the sustainability and inclusiveness of this growth (Chand and Raju, 2009). The Indian experience with the Green Revolution underscores this paradox–while yield improvements in cereals such as wheat and paddy catalyzed food self-sufficiency, the skewed nature of this technological transformation led to regional and crop-wise disparities, exacerbating instability in rainfed and less-favored regions (Birthal *et al.,* 2006). Despite the expansion of irrigation potential and input-intensive agriculture, many parts of the country–particularly semi-arid zones–continue to experience unstable production, necessitating a closer examination at sub-regional levels.

Gujarat, one of the most agro-ecologically diverse states in India, represents an important case for investigating the dynamics of crop diversification and output growth. The state comprises eight agro-climatic zones, each with distinctive soil types, rainfall patterns, and irrigation access (GoG, 2020). Particularly in North Gujarat, the preponderance of rainfed agriculture, limited irrigation infrastructure, and climatic variability have resulted in significant fluctuations in crop productivity and income levels (Ghosh and Pal, 2010). Crop diversification has emerged as a potential risk-mitigation strategy to address production instability and income uncertainty. By shifting from mono-cropping to a more diversified crop portfolio, farmers can spread risks and take advantage of emerging market opportunities (Joshi *et al.,* 2004). Area allocation behaviour, influenced by factors such as market prices, agro-climatic suitability, input availability, and institutional support, plays a crucial role in determining the degree of diversification and, consequently, the growth dynamics of the sector.

In this context, the present study seeks to analyze the dynamics of crop diversification, area allocation behaviour and determinants of output growth in North Gujarat. It aims to quantify the extent of diversification, examine the underlying drivers of area shifts among crops, and evaluate the role of yield, area, and input use in influencing output growth. This analysis is critical for formulating region-specific agricultural policies, promoting sustainable growth, and safeguarding farmer livelihoods in the face of increasing climatic and market uncertainties.

Materials and methods

Time series data on area, production, and yield of major vegetable crops in Gujarat were obtained from the Directorate of Agriculture, Government of Gujarat, Gandhinagar, covering the period from 1982-83 to 2017-18.

Crop diversification

The approach used in this study for crop diversification is to utilize a variety of measures of crop diversification, which connects the extent of dispersion and concentration of activities in a given time and space by a single quantitative indicator. Following two measures of crop diversification were used in the empirical analysis. HI and MEI formula was referred from research article of (Shinde *et al.,* 2013) for studying region wise changes in cropping pattern and levels of the crop diversification of different crops in Vidarbha region of Maharashtra.

A. Herfindahl index (HI)

Herfindahl index as given below was computed by taking sum of square of area proportion of each crop in the total cropped area.

$$\text{Herfindahl Index Hi} = \sum_{i=1}^{N} Pi^2$$

Where, $Pi = [Ai/\Sigma Ai]$

Pi = Proportion of area under i^{th} crop

Ai = Actual area under i^{th} crop

B. Modified Entropy index (MEI)

The Modified Entropy Index (MEI) is a normalized measure of crop diversification that improves upon the traditional Entropy Index (EI) by using a variable logarithmic base equal to the number of crops (N). This adjustment standardizes the index, making it bounded between 0 and 1.

$$\text{M.E.I.} = \sum_{i=1}^{N} (P_i \text{ Log N } P_i)$$

Or equivalently,

$$\text{MEI} = \frac{\text{EI}}{\text{Log N}}$$

Where, Pi = Proportion of area under the i^{th} crop

N = Total number of crops

$\log_N$ = Logarithm to the base NNN

Behavioural change in area allocation

The behaviors of change in area allocation of crops over the years were studied using Markov Chan Analysis.

A. The Markov probability model

A first-order Markov process is a stochastic model where the probability of transitioning to a future state depends solely on the current state. It is suitable for analyzing year-to-year shifts in cropping patterns, where the proportion of area under a crop in one period influences the next.

Let:

- Si = Crop state i, where i=1,2,...,ri = 1, 2, ..., r
- Wit = Proportion of area under crop i at time t

- P_{ij} = Probability of transition from crop i to crop j between two periods
- $P=(P_{ij})$ = Transition probability matrix

Properties of the Transition Matrix:

$0 \leq p_{ij} \leq I$ ... (1)

$\Sigma P_{ij} = 1$ ...(2)

Given this set of notations and definitions for a first order Markov chain the probability of a particular sequence Si on trial t and St on trial t + 1 may be represented by $P_r (S_{it}\ t\ S_{jt} + 1) = P_r$

$(S_{it})\ P_r\ (S_t\ t + 1 / S_{it}) = W_{it}\ P_{jt}$ ... (3)

and the probability of being in state j at trial t + 1 may be represented by

$$P_r\ (S_j.\ t{+}1) = \frac{\Sigma\ W_{it}\ P_{it}}{I} \quad \text{or}$$

$W_t = t + 1 = \Sigma\ W_{it}\ P_{tj}$ ... (4)

The study used data on the proportion of area under major crops, which varies annually due to factors such as weather, technology, prices, and institutional changes. These influences can be reasonably modeled as a stochastic process, where farmers' transitions between crop states differ by crop type. Under this assumption, changes in cropping patterns can be represented by a first-order transition probability matrix (P). Each element P_{ij} indicates the probability of shifting from crop *i* to crop *j* in the next period, while diagonal elements P_{ii} reflect the probability of retaining the same crop.

B. Estimation of transition probability matrix

Estimation (4) can be used as a basis for specifying the statistical model for estimating the transition probabilities. If errors were incorporated in equation (4) to account for the difference between the actual and estimated occurrence of (W_j t + 1), the sample observations may be assumed to be generated by the following Linear Statistical Model.

$W_{jt} = \Sigma W_t\, t - 1\ P_{ij} + U_j\, t$ ...(5)

Or in Matrix form it can be written as,

$Y_j = X_j\ P_j + U_j$

Where, Y_j is a (Txi) vectors of observations reflecting the proportion in cropping pattern j in time t, X_j is a (T × R) matrix of realized values of the proportion in cropping I in time t-1, Pj is a (r × 1) vector of unknown transition parameters to be estimated and U_j is a vector of random disturbances.

C. Determinants of out-put growth (Decomposition model)

The growth in agricultural output was analyzed using the (Minhas and Vaidyanathan, 1965) decomposition model. Output growth and its components were measured as the difference between three-year averages of the base and current periods. Constant price weights, based on the three-year average farm harvest prices, were applied to individual crops. This approach allowed estimation of the contribution of area, yield, and cropping pattern to overall output growth across different periods.

Consider:

$P_o = A_0\, \Sigma_i\ Wi\ C_{io}\ Y_{io}$ ... (I)

$Pt = A_t\, \Sigma_i\ Wi\ C_{it}\ Y_{it}$ ... (II)

From the identities (I) and (II) we can write

$$\frac{P_t - P_0}{P_0} = \frac{A_t - A_0}{A_0} + \frac{\sum W_i C_{io} Y_{io}\left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{\sum W_i C_{io} Y_{io}} + \frac{\sum W_i C_{io} Y_{io}\left[\frac{C_{it} - C_{io}}{C_{io}}\right]}{\sum W_i C_{io} Y_{io}}$$
$$+\left[\frac{A_t - A_o}{A_o}\right]\frac{\sum W_i C_{io} Y_{io}\left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{\sum W_i C_{io} Y_{io}} + \left[\frac{A_t - A_o}{A_o}\right]\frac{\sum W_i C_{io} Y_{io}\left[\frac{C_{it} - C_{io}}{C_{io}}\right]}{\sum W_i C_{io} Y_{io}}$$
$$+\frac{\sum W_i C_{io} Y_{io}\left[\frac{C_{it} - C_{io}}{C_{io}}\right]\left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{\sum W_i C_{io} Y_{io}} + \left[\frac{A_t - A_o}{A_o}\right]\frac{\sum W_i C_{io} Y_{io}\left[\frac{C_{it} - C_{io}}{C_{io}}\right]\left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{\sum W_i C_{io} Y_{io}}$$

Where,

P_t = Value of agricultural output in the current year 't'

P_0 = Crop output in base year 'o'

A_t = Gross cropped area of crops in year 't'

A_o = Gross cropped area of crops in year 'o'

Y_{it} = Yield per hectare of i^{th} crop in year 't'

Y_{i0} = Yield per hectare of i^{th} crop in year 'o'

C_{it} = Proportion of area under i^{th} crop to the total cropped area in year 't'

C_{io} = Proportion of area under i^{th} crop to the total cropped area in year 'o'

W_i = Constant price weight represents to the three year average of farm harvest price

Quantitative assessment of factors influencing crop output at the regional level is essential for reorienting agricultural policies and setting development priorities. This study considers three key determinants of crop output growth: area, yield, and crop pattern, along with their interactions. The seven-factor additive decomposition model proposed (Minhas and Vaidyanathan, 1965) was employed to estimate the relative contribution of each component to changes in crop output.

Results and discussion

Crop diversification in North Gujarat

The results of the diversification indices for North Gujarat region during different time periods are presented in Table 1. It is observed from Table 1 in North Gujarat region that Herfindahl Index in food grain crops is high in period 1995-1997 (0.666) followed by period 2015-2017 (0.657) while low in period 1985-1987 (0.625). Overall three periods indicated that moderate specialization is observed. In cereals crops, Herfindahl Index is high in period 2015-2017 (0.676) followed by period 1995-1997 (0.666) while low in period 1985-1987 (0.623). Overall three periods indicated that moderate specialization is observed. In pulses crops, Herfindahl Index is high in period 1995-1997 (0.656) followed by period 2015-2017 (0.642) while low in period 1985-1987 (0.583). Overall three periods indicated that moderate specialization is observed. In oilseeds crops Herfindahl Index is high in period 2015-2017 (0.666) followed by period 1995-1997 (0.659) while low in period 1985-1987 (0.644). Overall three periods indicated that moderate specialization is observed. In commercial crops, Herfindahl Index is high in period 1995-1997 (0.665) followed by period 2015-2017 (0.654) and low in period 1985-1987 (0.620). Overall three periods indicated that moderate specialization is observed. In horticulture crops Herfindahl Index is 0.665 in period 2015-2017. It indicated that moderate specialization is observed (Joshi *et al.*, 2004; Kabebe, 2000).

Table 1. Temporal Changes in Crop Diversification Indices in North Gujarat (1985–87, 1995–97, 2015–17)

Crop group	1985-87	1995-97	2015-17
Herfindahl Index (1-HI)			
Food grains crops	0.625	0.666	0.657
Cereals	0.623	0.666	0.676
Pulses	0.583	0.656	0.642
Oilseeds	0.644	0.659	0.666
Commercial crops	0.620	0.665	0.654
Horticulture	NA	NA	0.665
Maize	0.715	1.223	0.356
*Modified Entropy Index [Pi * (Log N (1/Pi)*			
Food grains crops	0.937	0.999	0.981
Cereals	0.933	0.999	0.989
Pulses	0.861	0.989	0.965
Oilseeds	0.967	0.976	0.999
Commercial crops	0.930	0.988	0.996
Horticulture	NA	NA	0.986
Maize	0.848	0.928	0.743

NA - Data not available

During 1985-87 periods, maize exhibited a moderate level of diversification. It held a balanced position within the cropping system–neither dominant nor marginal. The relatively high MEI value reflects a fairly even distribution of maize area across different crop combinations. In 1995-97 period marked the peak of maize diversification. The unusually high 1–HI value suggests a highly fragmented or evenly spread maize share, likely due to inclusion in diverse intercropping or mixed cropping systems. The MEI of 0.928 confirms a highly uniform distribution, indicating that maize played a strong role in enhancing overall cropping diversity. In 2015-17 period maize has a significant decline in diversification is observed. Lower index values suggest maize became more concentrated or was replaced by other crops (e.g., cash crops, horticulture). This trend may reflect shifts in policy, market demand, climatic conditions, or cropping patterns, and underscores the need for renewed attention to maize-based diversification strategies in the region. (Shiyani and Patel, 2001).

Modified Entropy Index of food grains crops in North Gujarat region is high in period 1995-1997 (0.999) followed by period 2015-2017 (0.981) while low in period 1985-1987 (0.937). Overall three periods indicated that specialization is observed. Modified Entropy Index of cereals crops is high in period 1995-1997 (0.999) followed by period 2015-2017 (0.989) while low in period 1985-1987 (0.933). Overall three periods indicated that specialization is observed. Modified Entropy Index of pulses crops is high in period 1995-1997 (0.989) followed by period 2015-2017 (0.965) while low in period 1985-1987 (0.861). Overall three periods indicated that specialization is observed. Modified Entropy Index of oilseeds crops is high in period 2015-2017 (0.999) followed by period 1995-1997 (0.976) while low in period 1985-1987 (0.967). Overall three periods indicated that specialization is observed. Modified Entropy Index of commercial crops is high in period 2015-2017 (0.996) followed by period 1995-1997 (0.988) while low in period 1985-1987 (0.930). Overall three periods indicated that specialization is observed. Modified Entropy Index of horticulture crops is in period 2015-2017 (0.986). It indicated that specialization is observed. The findings were similar (Gehlot and Kaur, 2015).

Behavioral changes in area allocation in North Gujarat region

It can be observed from the Table 2 that in North Gujarat region all crops have shown stability (except gram). In case of cereals as well as other crops the maximum stability is acquired by pearl millet crop as reflected in high probability of retention is 79.60 per cent. In rice probability of retention is 18.70 per cent. In maize probability of retention is 39.60 per cent. In wheat probability of retention is 74.00 per cent.

Maize cultivation in North Gujarat exhibited low stability, with a self-retention probability of just 0.396, indicating that only 39.6 per cent of maize area remained under maize in subsequent years. The crop showed a strong substitution trend toward pearl millet, with a transition probability of 0.538 (53.8%), reflecting farmers' preference for drought-resilient, low-input alternatives in semi-arid conditions. Additionally, a minor shift to black gram (0.067 or 6.7%) suggests efforts to integrate pulses into the cropping system for diversification and soil fertility enhancement. These dynamics highlight maize's vulnerable and transitional role in the region's crop economy. (Ardeshna and Shivani, 2013).

However, in case of pulses crops black gram and probability of retention were 62.50 and 19.30 per cent, respectively. While considering oilseed crops groundnut probability of retention is 59.80 per cent. In castor probability of retention is 67.50 per cent. In case of commercial crops in cotton probability of retention is 74.30 per cent. However, in sugarcane probability of retention is 62.00 per cent. In case of spices crops in cumin probability of retention is 49.70 per cent and in fennel probability of retention is 36.70 per cent.

At overall level the major area retainer among the major crops is pearl millet which is having a transfer probability of 0.538 from maize, 0.380 from sugarcane and 0.106 from cotton and showed highest probability of

Table 2. Transition probability matrix for crops in North Gujarat region (1982-83 to 2017-18)

Crop	Rice	Pearl millet	Maize	Wheat	Gram	Black gram	Green gram	Groundnut	Castor	Cotton	Sugarcane	Cumin	Fennel
Rice	**0.187**	0.000	0.313	0.000	0.000	0.000	0.291	0.000	0.209	0.000	0.000	0.000	0.000
Pearl millet	0.030	**0.796**	0.043	0.000	0.000	0.008	0.094	0.018	0.008	0.000	0.003	0.000	0.000
Maize	0.000	0.538	**0.396**	0.000	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wheat	0.000	0.000	0.000	**0.740**	0.026	0.000	0.000	0.074	0.061	0.099	0.000	0.000	0.000
Gram	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
Black gram	0.048	0.000	0.043	0.000	0.000	**0.625**	0.192	0.000	0.163	0.306	0.000	0.000	0.000
Green gram	0.016	0.000	0.260	0.000	0.000	0.062	**0.193**	0.000	0.162	0.307	0.000	0.000	0.000
Groundnut	0.012	0.000	0.000	0.052	0.000	0.000	0.000	**0.598**	0.320	0.005	0.000	0.000	0.013
Castor	0.007	0.000	0.000	0.116	0.000	0.006	0.000	0.078	**0.670**	0.000	0.000	0.105	0.018
Cotton	0.000	0.106	0.000	0.034	0.000	0.000	0.105	0.013	0.000	**0.743**	0.000	0.000	0.000
Sugarcane	0.000	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.620**	0.000	0.000
Cumin	0.000	0.000	0.000	0.273	0.024	0.000	0.158	0.019	0.000	0.013	0	**0.497**	0.016
Fennel	0.000	0.000	0.000	0.000	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.544	**0.367**

retention *i.e.* 79.60. On the contrary rice, wheat, black gram, green gram, groundnut, castor, cumin and fennel were having the probability of retention zero indicating that share of these crops is unstable which means it is not able to retain its share during the current year. Pearl millet is likely to lose its previous years share to maize, black gram, green gram, groundnut, castor, sugarcane by 0.043, 0.008, 0.094, 0.018, 0.008 and 0.003 per cent, respectively (Parmar, 2012).

It is enlightened from Table 3 that result of determinant analysis during study period (1982-83 to 2017-18) showed that in North Gujarat region maximum output growth is due to yield effect *i.e.* 48.61 per cent followed by area effect, interaction between area, yield and crop pattern, interaction between yield and crop pattern, crop pattern effect, interaction between area and yield, interaction between area and crop pattern which contribute about 14.27, 13.17, 8.84, 8.02, 6.07 and 1.22%, respectively.

Determinants of output growth during different time periods

This table presents the decomposition of crop output growth in the North Gujarat region over the period 1982–83 to 2017–18, using the seven-factor additive model proposed (Minhas and Vaidyanathan, 1965). The analysis quantifies the relative contribution of key components–area, yield, crop pattern, and their interactions–to overall output growth.

The results indicate that the yield effect was the dominant contributor, accounting for 48.61 per cent of the total output growth, highlighting the critical role of productivity improvements. The area effect contributed 14.27 per cent, while changes in crop pattern explained 8.02 per cent of the growth. Among the interaction effects, the three-way interaction between area, yield, and crop pattern contributed significantly (13.17%), followed by the yield–crop pattern interaction (8.84%). The area–yield and area–crop pattern interactions had smaller but notable impacts, contributing 6.07 per cent and 1.22 per cent, respectively (Singh, 2016).

Table 3. Determinants of output growth in North Gujarat region from 1982-83 to 2017-18

Determinants	Percentage
Area effect	14.27
Yield effect	48.61
Crop pattern effect	8.02
Interaction between area and yield	6.07
Interaction between area and crop pattern	1.22
Interaction between yield and crop pattern	8.84
Interaction between area, yield and crop pattern	13.17
Total	100.00

Overall, the findings suggest that both technological advancements (reflected in yield improvements) and cropping decisions played vital roles in driving agricultural output growth in the region.

Conclusions

The present study analyzed the trends in crop diversification, behavioral changes in crop area allocation, and the determinants of agricultural output growth in North Gujarat over the period 1982–83 to 2017–18. The application of Herfindahl Index (HI) and Modified Entropy Index (MEI) revealed that the region exhibited moderate specialization across all major crop groups. Among them, cereals and oilseeds showed higher concentration levels, indicating a lesser degree of diversification.

The Markov chain analysis demonstrated varying levels of crop stability. Pearl millet showed the highest probability of retention (79.60%), followed by wheat (74.00%) and cotton (74.30%), indicating a relatively stable cropping preference for these crops. Conversely, crops such as gram and certain spices exhibited low or zero probability of retention, suggesting instability and shifting preferences likely influenced by market conditions, agro-climatic variability, and policy changes.

The decomposition analysis of output growth clearly identified yield improvement as the dominant contributor, accounting for 48.61 per cent of total output growth. This reflects the positive impact of high-yielding varieties, improved agronomic practices, and technological interventions. The area effect contributed 14.27 per cent, while interaction effects between area, yield, and crop pattern collectively accounted for the remaining share.

In conclusion, while North Gujarat has witnessed commendable growth in agricultural productivity, sustained efforts in enhancing yield stability, promoting balanced crop diversification, and strengthening infrastructure for high-value crops and processing are crucial. A policy focus on technology dissemination, irrigation expansion, and market integration will be essential to ensure inclusive and sustainable agricultural development in the region.

References

Ardeshna, N. J. & Shiyani, R. L. (2013). Dynamics of cropping pattern in Gujarat State: A Markov chain approach. *Agricultural Economics Research Review,* **26**(2): 211–218.

Birthal, P. S., Joshi, P. K., Roy, D., & Thorat, A. (2006). Diversification in Indian Agriculture Towards High-Value Crops: The Role of Small Farmers. *IFPRI Discussion Paper 00727*.

Chand, R. & Raju, S. S. (2009). Instability in Indian Agriculture during Different Phases of Technology and Policy. *Indian Journal of Agricultural Economics*, **64**(2): 283–288.

Gehlot, N. & Kaur, N. (2015). Crop diversification for sustainable agricultural development : A case of Haryana (India). *Indian Journal of Economics and Development,* **11**(1): 21-30.

Ghosh, S., & Pal, S. (2010). Regional Disparities in Agricultural Development of Gujarat: A District-Level Analysis. *Agricultural Situation in India*, **67**(1): 15–22.

Government of Gujarat (GoG). (2020). *Statistical Abstract of Gujarat*. Directorate of Economics and Statistics, Gandhinagar.

Joshi, P. K., Gulati, A., Birthal, P. S. & Tewari, L. (2004). Agriculture Diversification in South Asia: Patterns, Determinants, and Policy Implications. *Economic and Political Weekly*, **39**(24): 2457–2467.

Kabebe, E., Mehata, V. P. & Dixit, A. (2000). Diversification of agriculture in Haryana : An empirical analysis. *Agricultural Situation in India,* **57**(8): 459-463.

Khatkar, R. K., Singh, V. K. and Tomar, B. S. (2001). Status of diversification, wage rates and employment in agriculture in Haryana. *Indian Journal of Agricultural Economics,* **56**(3): 562.

Minhas, B. S. & Vaidyanathan, A. (1965). Growth in crop output in India. An Analysis by Component Elements. *Journal of Indian Society of Agricultural Statistics,* **17**(2): 230-52.

Mittal S. & Hariharan, V. K. (2016). Crop diversification by agro-climatic zones of India - Trends and drivers. *Indian Journal of Economics and Development*, **12**(1): 123-131.

Parmar, S. (2012). Study of growth, instability and supply response of commercial crops in Punjab: An econometric analysis. *Abhinav, National Monthly Refereed Journal of Research in Arts and Education,* **1**(5): 49-52.

Shinde, V. N., Pawar, N. N. & Patil, S. S. (2013). Changes in cropping pattern and crop diversification in Vidarbha region of Maharashtra. *Indian Journal of Agricultural Economics,* **68**(4): 530–544.

Shiyani, R. L. & Patel, K. B. (2001). Changes in cropping pattern and crop diversification in Gujarat. *Indian Journal of Agricultural Economics,* **56**(4): 532-543.

Singh, N. (2016). Agricultural diversification and contract farming in Punjab. *Agricultural Situation of India*, **72**: 22-31.