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Trends in Area, Production, Productivity and Economics of Onion in Haveri District of Karnataka

YASHAVANTAGOUDA S. PATIL[1], M. K. ARAVINDA KUMAR[2] AND G. M. GADDI[3]

[1&3]Department of Agricultural Economics, College of Agriculture, UAS, GKVK, Bengaluru - 560 065

[2]Department of Agricultural Economics, College of Agriculture, Hassan - 573 225

e-Mail : yashavantaspatil123@gmail.com

AUTHORS CONTRIBUTION

YASHAVANTAGOUDA S. PATIL : Conceptualization, data collection, analysis and preparation manuscript;

M. K. ARAVINDA KUMAR : Conceptualization, monitoring and editing;

G. M. GADDI : Suggestions for methodology

Corresponding Author :

YASHAVANTAGOUDA S. PATIL

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ABSTRACT

The present study examined the growth rate, instability and cost of cultivation of onion in Haveri district of Karnataka using both primary and secondary data. The data was analyzed using CAGR, instability and tabular analysis. The results revealed that the onion area and production showed a positive trend, whereas productivity showed a negative trend in the study area. The area under onion cultivation experienced medium instability (15-30 %), while production and productivity recorded higher instability (>30 %). The average yield per acre was 41.69 quintals, each quintal fetching a price of Rs.1833.00, resulting in gross returns of 76409. The cost of cultivation of onion was Rs.49,283.87 per acre of which the variable cost constituted 87.34 per cent and fixed cost constituted 12.66 per cent. Returns per rupee of expenditure from onion cultivation was found Rs.1.55. To improve growth rate and to overcome instability there is a need for developing and supplying disease-resistant and high-yielding variety seeds which are suitable to adverse climatic conditions.

Keywords : Growth rate, Instability, Cuddy-della valle index, Cost and returns

INDIAN agriculture with its solid forward linkages has significantly contributed to the country's overall growth and development besides ensuring food security to the nation. The Indian agricultural GDP has been growing at an average annual growth rate of 4.6 per cent during the last six years. It grew by 3.0 per cent in 2021-22 compared to 3.3 per cent in 2020-21(Anonymous, 2023).

Onion is a seasonal crop with a harvesting period of *rabi* (March - June), *kharif* (October - December), and late *kharif* (January - March). The major varieties grown in India are Agri Dark Red, Agri found Light Red, NHRDF Red, Agri found White, Agri found Rose (Agri found Red), Pusa Ratnar, Pusa Red and Pusa White Round. The major onion-producing states are Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Telangana. Maharashtra ranks first in onion production with a 28.32 per cent share (Nivetha *et al.,* 2020).

India holds the second position globally in terms of onion area and production during 2021-22 with an extensive area of 16.24 lakh ha and a production of 26 lakh qtls. The country accounted for 24 per cent of the global onion-producing area and contributed to 20 per cent of the total global onion production during 2021-22. Karnataka secures the second position in terms of onion area and the third position in production. Covering a substantial area of 2,32,000 ha and yielding a production of 27 lakh tonnes, Karnataka accounted for 12.11 per cent of the nation's area under onion cultivation and 8.89 per cent of its production during the period of 2021-22 (Anonymous, 2022).

Compound annual growth rate of area, production and productivity of onion in Chhattisgarh from 2006-07 to 2020-21 was 10.43 per cent, 11.08 per cent and 0.58 per cent, respectively whereas in Rajnandgaon district it was found to be 4.66 per cent, 7.48 per cent and 2.69 per cent, respectively. Instability index in Chhattisgarh with respect to area, production and productivity was found to be 17.89 per cent, 16.18 per cent and 5.62 per cent, respectively and in Rajnandgaon, the study found that the per hectare cost of cultivation varied by farm size, with costs of Rs.54,567.81, Rs.58,707.80, Rs.61,079.30 and Rs.65,499.10 for marginal, small, medium and large farmers, in turn. The cost of production per quintal of onion was Rs.340.51, Rs.360.72, Rs.354.24 and Rs.359.58, respectively. The net profit per hectare for onion cultivation was Rs.1,35,328.40, Rs.1,34,151, Rs.1,43,238 and Rs.1,50,349 in turn. The benefit-cost ratio for onion cultivation was found to be 2.48:1, 2.29:1, 2.35:1 and 2.30:1 for every rupee invested. (Chandravanshi *et al*., 2022). Average cost of cultivation of onion in Dhanwar block was Rs.57,687.95 per acreage which was higher than 50,374.3 in the case of Birni. The total variable cost per acre in Dhanwar was Rs.45,325.16 and in Birni it was Rs.41,691.40. The output per acre in Dhanwar was 65.52 quintal and in Birni it was 46.00 quintal per acre. The return per rupee investment was around 1.71 and 1.34 over variable and total cost, respectively in the case of Dhanwar block. In the Birni block it was 1.65 over variable cost and 1.37 over fixed cost (Agarwal and Kumar, 2018). This necessitates the requisite of growth rate and cost returns analysis.

In this regard, the present study attempted to estimate the compound annual growth rate, instability, cost and returns analysis in the Haveri district of Karnataka.

Study Area and Selection of Farmers

The onion crop is purposively selected as its per cent contribution to the area is higher among all vegetable crops in the Haveri district. Further, two leading taluks of Haveri district were selected based on the area dominance with respect to onion, *viz.,* Haveri and Ranebennur. A multistage random sampling technique was adopted to select villages and sample respondents in the study area. Fifty farmers each from both taluks were contacted using a random sampling procedure to collect data on the production of onion.

METHODOLOGY

Compound Annual Growth Rate (CAGR) Analysis

The growth rates can be specified as the percentage change of a particular variable within a given period. Compound annual growth rates (CAGRs) of area and production of onion crop in the study area were estimated using the following growth model:

Growth model here is,

$Y_t = \alpha\beta^t$.....(1)

Where,

Y_t = Area/ production of onion for the year t

t = Time variable (1, 2….. n) for each period.

α = Constant

β = Growth coefficient

Log transformation of (1)

$\ln Yt = \ln \alpha + t (\ln \beta)$ ……..….. (2)

Where,

$\ln \beta = \ln (1+ t)$ and……..….. (3)

t = [antilog ($\ln \beta$) – 1]

CAGR= [antilog ($\ln \beta$)-1] *100……. (4)

Instability Index

Variability in the area, production and yield of the onion crop has been measured in relative terms using the Cuddy-Della Valle Index used in recent years as a measure of variability in time series data (Weber & Sievers, 1985 and Singh & Byerlee, 1990). The Cuddy-Della Valle index attempts to detrend the CV by using a coefficient of determination (R^2). Thus, it is a better measure to capture instability in agricultural production. A low value of this index indicates low instability in price level and vice-versa. The Cuddy-Della Valle index is given as :

$$CDVI = CV * \sqrt{1-R^2} \text{.....(5)}$$

Where :

CDVI is the Cuddy-Della Valle Index,

CV is coefficient of variation

R^2 is the coefficient of determination obtained from time trend regression adjusted to degrees of freedom.

Costs and Returns Analysis

The total costs were divided into two broad categories:

1. Variable costs; 2. Fixed costs.

1. *Variable costs* : are the costs incurred on variable inputs such as cost of seedlings, farm yard manure (FYM), fertilizers, pesticides, hired human labour and interest on working capital. The computations of different terms of variable cost components are as follows:

Seeds : The cost incurred for purchasing seeds was based on the actual amount paid by the farmers.

Farm yard manure : The existing price per tractor load was used to impute the value of farm yard manure produced on the farm.

Fertilizers and plant protection chemicals : The cost of fertilizers and plant protection chemicals was based on the actual prices paid by the farmers.

Labour : The cost of hired labour was calculated at the prevailing wage rates paid per day (8 hours) in the study area for men, women and machine labour during the study period.

Interest on working capital : The working capital consists of the expenditure on human labour, machinery labour, seeds, farmyard manure, fertilizers and plant protection chemicals. Interest on working capital was calculated at the rate of seven per cent per annum it is the rate at which commercial banks advance short-term loans.

2. *Fixed costs* : These include depreciation on farm implements and machinery, rental value of land, land revenue and managerial cost.

Total cost = Variable cost + Fixed cost

Depreciation charges: Depreciation on each capital equipment and machinery owned by the farmers were calculated separately, based on the purchase value using the straight-line method. Thus, the

$$\text{Annual Depreciation} = \frac{\text{(Purchase value - Junk value)}}{\text{Useful life of the asset}}$$

The average life of an asset as indicated by each farmer was used in the computation of the depreciation. The average value of an asset after its useful life (economic life) was considered based on the value furnished by the respondents. The deprecation cost of each equipment was apportioned to the crop, based on its percentage use.

Land revenue : Land revenue was charged at the rates levied by the Government.

Rental value of land : Is taken based on a yearly basis and crop sown.

Cost of cultivation : It is the sum of variable costs and fixed costs and expressed on per-acre basis.

Total cost (TC) : Total cost is the sum of total variable cost (TVC) and total fixed cost (TFC).

$TC = TVC + TFC$.....(6)

Gross returns (GR): Per acre gross returns were calculated by using the below formula:

Gross Returns (GR) = Yield x Price

Net returns over variable costs: It is the gross returns minus variable costs.

Net returns over variable costs = GR - TVC.....(7)

Net returns over cost of cultivation: It is the gross returns minus variable costs plus fixed costs.

Net returns over cost of cultivation = GR - TC.....(8)

Returns per rupee of investment: Worked out by taking the ratio of gross return and total cost.

Results and Discussion

Growth Rate and Instability Analysis

Growth Rate Analysis

Growth performance of onion in major onion growing districts was carried out and presented in Table 1. Results revealed that Bagalkote and Ballari districts recorded significant increase with respect to area, production and productivity. In Vijayapura district, production of onion showed significant growth of 11.57 per cent annual which was mainly attributable to productivity growth even with decreasing area under onion in the district. Both area and production experienced a decreasing trend in Chitradurga while productivity showed positive growth (8.90 % per annum). Area under onion found to be increased significantly at a compound annual growth rate of 7.54 per cent per annum in Haveri district. It can also be found that the increase in production was comparatively less than the increase in area. Hence, the growth in yield was found to be negative. Area, production and productivity of onion in Gadag were found to be positive but non-significant. The trends in area, production and productivity of onion in major districts are also presented graphically in Fig. 1 to Fig. 3. The results are in line with the study conducted by Chandravanshi *et al.* (2022) who reported that the growth rate in area, production and productivity of onions in the Rajnandgaon district of Rajasthan were significantly positive.

Table 1

Growth rate in area, production and productivity of major onion-growing districts from 2010-11 to 2019-20

District	Area	Production	Productivity
Vijayapura	-2.12	11.57 *	14.00 **
Bagalkote	9.95 **	16.70 **	6.13 **
Chitradurga	-9.51	-1.45	8.90 ***
Gadag	1.44	5.78	4.28
Ballari	16.96 ***	27.34 ***	8.87 **
Haveri	7.54 **	3.30	-3.96

Note: ***, ** & * indicate significance at 1, 5 and 10 per cent, respectively

Instability Analysis

Instability in area, production and productivity of major onion-growing districts was analyzed and presented in Table 2. Results revealed that major onion-growing districts namely, Vijayapura, Bagalkote, Chitradurga, Gadag and Ballari have recorded high instability (>30 %) whereas, Haveri district experienced medium instability (15-30 %) in area. In terms of production, all districts have recorded higher instability (>30 %).

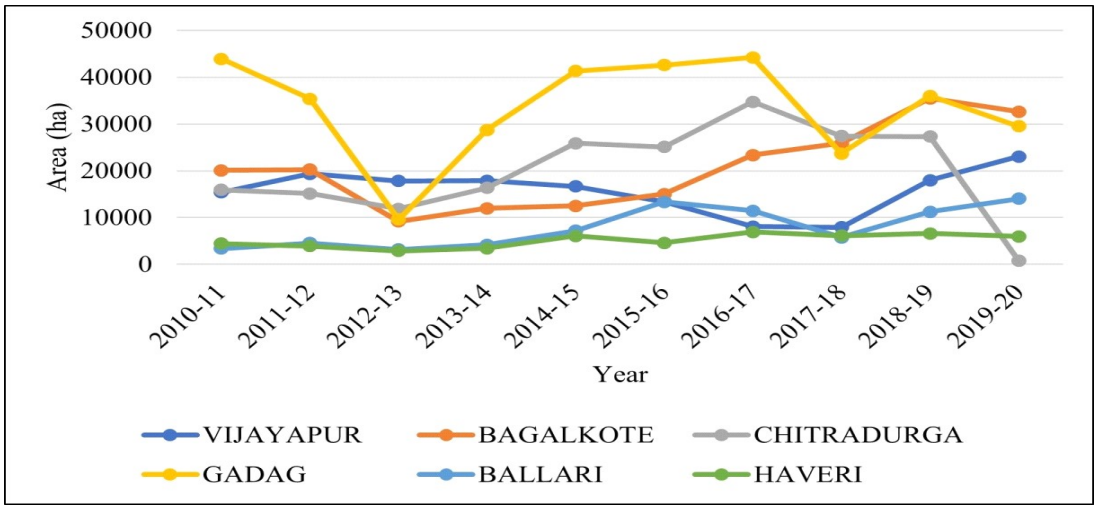

Fig. 1 : Trend in the area of major onion-growing districts

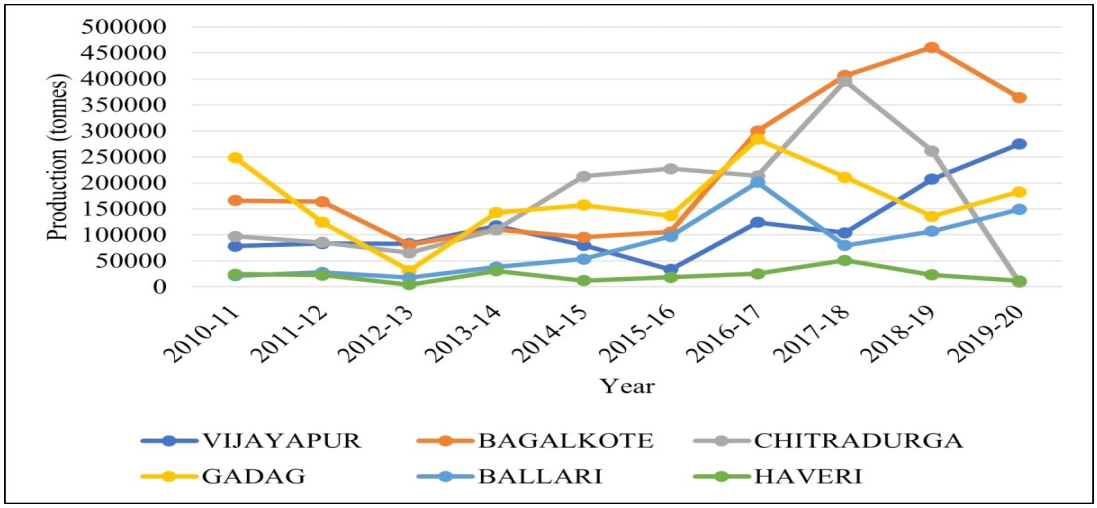

Fig. 2 : Trend in the production of major onion-growing districts

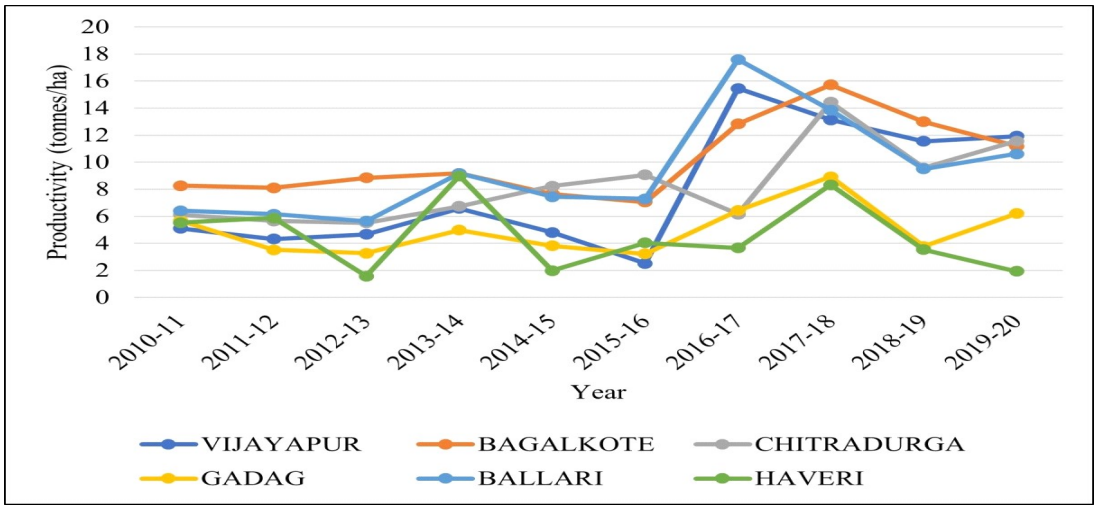

Fig. 3: Trend in the productivity of major onion-growing districts

TABLE 2

Instability (%) in area, production and productivity of major onion-growing districts from 2010-11 to 2019-20

District	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
Vijayapura	44.50	67.45	52.41
Bagalkote	34.80	47.41	22.02
Chitradurga	50.11	72.67	22.93
Gadag	34.60	43.63	36.49
Ballari	33.19	38.87	30.82
Haveri	20.28	59.79	59.72

All major onion growing districts recorded high instability (>30%) except Bagalkote and Chitradurga in terms of productivity during the study period.

Growth Rate and Instability Analysis in Area, Production and Productivity of Onion in Karnataka From 2010-11 to 2019-20

Growth and instability in area, production and productivity of onion in Karnataka have been analyzed and presented in Table 3. Results revealed that Karnataka experienced an increasing trend in area (0.19), production (0.74) and productivity (0.51) of onion and recorded lower instability (<15).

Table 3

Growth rate and instability analysis in area, production and productivity of onion in Karnataka from 2010-11 to 2019-20

District	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
CAGR (%)	0.19	0.74	0.51
CDI (%)	13.62	14.55	7.60

Costs and Returns of Onion Cultivation

To assess the economic aspects of onion cultivation in Haveri district, the cost of cultivation was computed on a per-acre basis.

Input Use Pattern in Onion Cultivation

The average input use pattern for onion cultivation across a one-acre area has been estimated and presented in Table 4. The input use pattern for onion cultivation illustrates the quantities of various resources employed in the process. An average of 6.45 kilograms of seeds were used, along side 35.4 man-days of human labour, one pair-day of bullock labour and two hours of machine labour. For soil enrichment, 5.25 metric tons of (FYM) were utilized. Additionally, chemical fertilizers consist of 92.65 kilograms of urea, 52.88 kilograms of DAP and 50.28 kilograms of MOP. PPC incur an expense of Rs.2,349 and the amount spent on irrigation water was Rs.887.36.

Table 4

Input use pattern in onion cultivation (per acre)

Inputs	Units	Quantity/Value
Seeds	kg	6.45
Human labour	Man-days	35.40
Bullock labour	Pair day	0.92
Machine labour	hrs.	2.00
FYM	tonnes	5.25
Urea	Kg	92.65
DAP	Kg	52.88
MOP	Kg	50.28
PPC	Rs.	2,349
Irrigation water	Rs.	887

Operation-Wise Labour use Pattern in Onion Cultivation

The average labour use pattern across various stages of onion cultivation in the Haveri district has been estimated and presented in Table 5. For land preparation, an average of 3.9 man-days of labourers are involved. Broadcasting and sowing require 1 man-day and 1 bullock labour day, respectively, while FYM application necessitates 4.4 man-days. Chemical fertilizer application and PPC application each require 1.4 and 4 man-days, respectively. Weeding demands 7.01 man-days and irrigation requires 2.55 man-days. The most labour-intensive operation is harvesting, which consumes 11.07 man-days. For each acre of onion cultivation, a total of 35.4 man-days, 1 bullock labour day and 2 machine labour days are needed to complete these essential agricultural tasks.

Table 5

Operation-wise labour use pattern in onion cultivation (per acre)

Operation	Haveri (n=100)		
	M	BL	ML
Land preparation	3.9	0	2
Broadcasting	1	0	0
Sowing	0	1	0
FYM application	4.4	0	0
Chemical fertilizer application	1.4	0	0
PPC application	4	0	0
Weeding	7.01	0	0
Irrigation	2.55	0	0
Harvesting	11.07	0	0
Total	35.4	1	2

Note: M= Man days (hrs.), BL= Bullock Labour (Pair Day), ML=Machine Labour (hrs.)

Cost of Cultivation of Onion in Haveri District

Analysis of cultivation expenses for onions in the Haveri district has been meticulously detailed and organized in Table 6. The breakdown encompasses key cost components, encompassing both variable and

Table 6

Cost of cultivation of *kharif* onion (Rs./Per acre)

Variable cost	Cost	% Share
Seeds	7,648	15.52
Human labour	14,154	28.72
Bullock labour	1,061	2.15
Machine labour	2,300	4.67
Plant protection chemicals	2,349	4.77
Manure	8,394	17.03
Fertilizers	2,942	5.97
Irrigation charges	887	1.80
Miscellaneous expenses	496	1.01
Interest on working capital @ 7%	2,816	5.71
Total variable cost	43,047	87.34
Fixed cost		
Depreciation	870	1.77
Land revenue	50	0.10
Rental value of owned land	5,231	10.61
Interest on fixed capital@12%	88.57	0.18
Total fixed cost	6,239.34	12.66
Total cost	49,286.27	100.00

fixed expenditures associated with onion cultivation. This presentation offers a comprehensive overview of the financial aspects tied to cultivating onion in this study area.

Variable Costs

The variable costs of onion cultivation encompass several essential components which are shown in Table 6. These include the expenditure on seeds, which accounted for 15.32 per cent (Rs.7648) of the total cost and human labour constituted the largest share at 28.34 per cent (Rs.14,154). Additionally, bullock labour contributes 2.12 per cent (Rs.1,061), while machine labour accounted for 4.61 per cent (Rs.2,300) of the total cost. Plant protection chemicals expenditure (Rs.2,349) constitute 4.70 per cent while manure cost accounted for 16.81 per cent (Rs.8,394) of the total cost of cultivation, highlighting the resources allocated for maintaining crop health. Fertilizers and irrigation charges collectively make up 7.67 per cent with 5.89 per cent (Rs.2,942) and 1.78 per cent (Rs.887), respectively. Furthermore, miscellaneous expenses and interest on working capital at a rate of 7 per cent contribute to about one per cent (Rs.496) and six per cent (Rs.2816), respectively. The accumulation of these variable costs resulted in a total variable cost of 86.20 per cent of the overall expenditure.

Fixed Costs

The fixed costs associated with onion cultivation comprise various elements is shown in Table 6. Depreciation changes for various machinery and equipment used in onion cultivation accounted for 1.74 per cent (Rs.870) of the total cost, indicating the impact of asset wear and tear. Land revenue and the rental value of owned land, together constituted for 10.57 per cent (Rs.5281), reflect the expenses related to land utilization. Interest on fixed capital at a rate of 12 per cent accounted for 1.48 per cent (Rs.738) of the costs. The combination of these fixed-cost components resulted in a total fixed cost of Rs.6,889 and accounted for 13.80 per cent of the total cost of cultivation.

Total Cost

Upon summing up both the variable and fixed costs, the total cost of onion cultivation was calculated to be Rs.49,936. This comprehensive breakdown provides valuable insights into the allocation of resources and expenses involved in the process, shedding light on the financial aspects of onion cultivation.

Returns Structure of Onion Cultivation

The presented information in Table 7 outlines the yield and returns obtained from onion crop cultivation in the Haveri district. The average yield per hectare was 41.69 quintals with each quintal fetching a price of Rs.1833, which resulted in gross returns of 76,409. After accounting for the total cultivation cost of Rs.49,284, the net returns from onion cultivation were 27,125 per acre. The cost of production was estimated at Rs.1182 per quintal. Notably, for every rupee spent on production, there was a return of Rs.1.55, underscoring the profitability of the cultivation

TABLE 7

Yield and returns structure of onion cultivation (Per acre)

Particulars	Unit	Value
Average Yield (q)	qtls	41.69
Price per quintal	Rs.	1,833
Gross returns	Rs.	76,409
Total cost	Rs.	49,284
Net Returns	Rs.	27,125.
Cost of Production	Rs.	1,182
Return per rupee of expenditure	Rs.	1.55

process and the favourable ratio of returns to expenditures.

The results of the present study are in a similar line to the study conducted by Barakade *et al.* (2011) and Kantariya *et al.* (2018), who reported that overall average gross returns per hectare of onion farms amounted to Rs.1,82,280.

Breakdown of the variable cost is presented in Fig. 4. It was observed that human labour takes the lead accounting for 33 per cent of the variable cost followed by manure and seeds making up 20 per cent and 18 per cent, respectively. Additionally, fertilizers, plant protection chemicals and machine labour accounted for seven, five and five per cent share of total variable cost, respectively. On the other hand, bullock labour and irrigation charges contribute two per cent each while miscellaneous expenses collectively account for eight per cent of the overall variable cost.

Compound annual growth rate and instability analysis indicated a poor growth rate in yield with higher instability in both production and productivity. Hence, to improve growth rate and to overcome instability, there is a need for developing and supplying disease-resistant and high-yielding variety seeds which are suitable to adverse climatic conditions through effective Transfer of Technology (ToT) with appropriate extension strategies. Also, for every rupee spent on production, the return per rupee of expenditure was Rs.1.65, indicating a favourable economic outcome hence there is a scope for increase in area under onion production.

In the nutshell following are the outcomes of the study: Bagalkote and Ballari districts recorded significant increase with respect to area, production and productivity. In Vijayapura district, production of onion showed significant growth of 11.57 per cent which was mainly attributable to productivity growth even with decreasing area under onion in the district. Both area and production experienced a decreasing

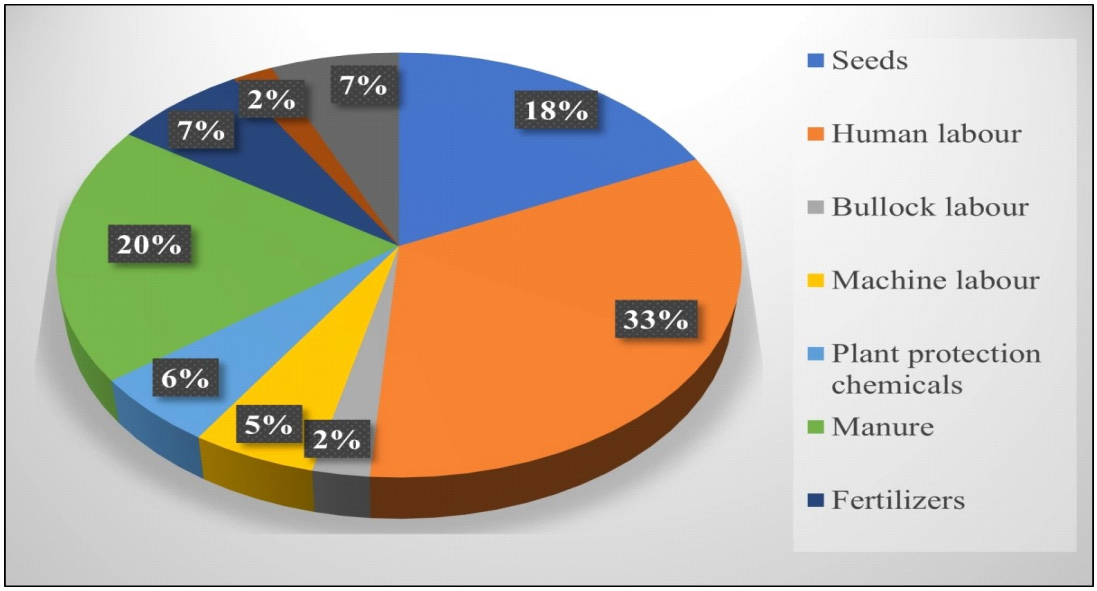

Fig. 4 : Per cent share of factors in variable cost

trend in Chitradurga while productivity shown positive growth (8.90). Area under onion found to be increased significantly at a compound annual growth rate of 7.54 per cent in Haveri district. It can also be found that the increase in production was comparatively less than the increase in area. Hence, the growth in yield found to be negative. Area, production and productivity of onion in Gadag found to be positive but non-significant.

Vijayapura, Gadag and Ballari have been recorded high instability in area, production and productivity while other districts like Bagalkote and Chitradurga found to have medium instability in terms of productivity. Similarly, Haveri district recorded medium instability in area under onion cultivation.

Karnataka experienced the increasing trend in area (0.19), production (0.74) and productivity (0.51) of onion and recorded lower instability (<15). Among the variable costs, the major contributors were human labour (28.72%), manure (17.03%), seeds (15.52%), machine labour (4.67%) and plant protection chemicals (4.77%). These together constitute 87.34 per cent of the total variable cost. For fixed costs, the rental value of owned land (10.61%) holds the most significant share, followed by depreciation (1.77%) and interest on fixed capital (0.18%), summing up to a total fixed cost of Rs.6,239 (12.66%). The overall total cost of onion cultivation amounts to Rs.49,284 encompassing both variable and fixed costs.

The returns structure of onion cultivation was outlined through several key parameters. With an average yield of 41.69 q per acre and a price of Rs.1833 per quintal, the gross returns tally up to Rs.76,409. After accounting for the total cost of Rs.49,284, the net returns stand at Rs.27,126. The cost of production was found Rs.1,182.

Compound Annual Growth Rate and instability analysis indicated a poor growth rate in yield with higher instability. Hence, to improve growth rate and to overcome instability there is a need for developing and supplying disease-resistant and high-yielding variety seeds which are suitable to adverse climatic conditions through effective Transfer of Technology (ToT) with appropriate extension strategies.

References

Agarwal, P. K. and Kumar, M., 2018, An economic analysis of onion cultivation in Giridih district of Jharkhand. *Economic Affairs,* **63** (3) : 703 - 709.

Anonymous, 2023, Economic survey. *Annual report,* Department of Economic Affairs, Government of India, New Delhi.

Anonymous, 2022, Indiastatagri, Ministry of Agriculture and Farmers Welfare, Govt. of India, Indiastatagri, Available at: https://www.indiastatagri.com/table/agriculture/area-production-productivity-onion-india-1978-1979/14907.

Barakade, A. J., Lokhande, T. N. and Todkari, G. U., 2011, Economics of onion cultivation and it's marketing pattern in satara district of Maharashtra. *Int. J. Agric. Sci.,* **3** (3) : 110.

Chandravanshi, U., Sushila, D. D. N. and Patle, D., 2022, Compound growth rate, instability index and economic analysis of production of onion in Rajnandgaon district of Chhattisgarh. *Pharma Innov. J.,* **11** (9) : 3041 - 3047.

Kantariya, G. K., Ardeshna, N. J., Vilhekar, R. A. and Thumar, V. M., 2018, Resource use efficiency and economics of onion cultivation in Bhavnagar district of Gujarat. *J. pharmacogn. phytochem.,* **7** (5) : 1333 - 1338.

Nivetha, T. and Uma, K., 2020, Performance of fresh onions in India : An economic analysis. *J. Chem. Stud.,* **8** (4) : 465 - 469.

Prakash, K. N. and Venkataramana, M. N., 2023, Growth of maize ecosystem in India and Karnataka Vis-a-Vis associated risk in production: An economic insight. *Mysore J. Agric. Sci.,* **57** (2) : 264 - 272.

Singh, A. J. and Byerlee, D., 1990, Relative variability in wheat yields across countries and over time. *J. Agric. Econ.,* **41** (1) : 21 - 32.

Soujanya, C. K., Venkataramana, M. N. and Babu, B. P., 2023, Growth in production and export performance of Indian coffee in International Market. *Mysore J. Agric. Sci.,* **57** (2) : 395 - 402.

Weber, A. and Sievers, M., 1985, Observations on the geography of wheat production instability. *J. Int. Agric.,* **24** (3) : 201 - 211.