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Research Paper

# Analysis of disparity in broiler meat production of Karnataka state using principal component analysis

■ **Amaresh, R. Manjula and V. Manjunath**

See end of the paper for authors' affiliations

Correspondence to :
**Amaresh**
Department of Agricultural Statistics, Applied Mathematics and Computer Sciences, University of Agricultural Sciences, **Bengaluru (Karnataka) India**
Email : amaresh.as13@gmail.com

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**ABSTRACT :** The study aims to examine inter-district disparities in broiler meat production of Karnataka state. Composite indices of broiler meat production have been constructed for each districts based on optimum combination of indicator variables grouped under agriculture and infrastructure sectors. These indices were developed separately for agriculture and infrastructure sectorsat four study points of time *i.e.*, 2003-04, 2007-08, 2011-12 and 2014-15. The technique of principal component analysis (PCA) has been used to construct the composite index. Using the PCA scores all the districts were ranked separately for agriculture and infrastructure sectors for the four study years.The analysis reveals that there was a wide disparity in broiler meat production among the districts of Karnataka state during the study years. Based on the quartiles, districts were classified as high, high medium, low medium and low broiler meat producing districts. The agriculture and infrastructure sectors were found to be highly correlated and have a positive influence on the broiler meat production of the state. Based on the eigen values of PCA for each districts revealed that area under irrigated land, area under maize and area under pulses in agriculture sector, whereas number of veterinary institutions and road length in the infrastructure sector were found to be the main causes for the disparity in broiler production among the districts of Karnataka State.

**KEY WORDS :** Principal component analysis, Disparity, Indicators, Broiler meatproduction, Quartiles

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## INTRODUCTION :

Poultry farming in India has transformed into a techno-commercial industry from the status of backyard farming and has recorded a huge success in the last decade. Poultry meat is an important source of high quality animal proteins, minerals and vitamins to balance the human diet. Specially developed meat type (broiler) that have ability for faster growth and high feed conversion efficiency are available. Depending on the farm size, broiler farming is the main source of family income or can provide subsidiary income and gainful employment to farmers throughout the year. Broilers are reared for meat and marketed at an age of around 42 days. Broiler production is a short-cycle enterprise. Therefore, a number of batches can be raised within a year, or it could be a part-time job. A number of strains exist in various regions of the country for broiler production, which have

a genetic potential to achieve 2 kg live weight at the age of 42 days.

The major component in poultry output is the meat. It accounts for two-thirds of the value of output, while eggs account for the remaining one-third. Although broiler meat was not acceptable to the consumers initially due to its tender nature, people slowly realized that it has low fat, low calorie with high protein, and as cheapest meat hence accepted. Now broiler meat finds ready acceptance not only in urban areas but also in rural areas. Poultry meat and meat products are exported to foreign markets also.

Karnataka has made considerable progress in broiler production in the last three years (2011-12 to 2014-15) with an annual growth rate of about 11 per cent taking total production of chicken meat to 82,615 tonnes (2014-15) from 9,928 tonnes (1996-97). The state produces 415 million kg of Chicken meat every year and place 11$^{th}$ rank in meat production in India. Agriculture sector plays very important role in enhancing the level of living of people in the state. The normal net cultivated area in the state is about 97, 93,060 Hectares, which accounts for 51.41 per cent of the total geographical area. The major crops grown are Cereals, Pulses, Oilseeds, Ragi, Paddy, Jowar, Maize and Bajra. These crops byproducts are important for the betterment of broiler production in the state.For the proper development of the poultry farming, not only the availability of agricultural byproducts the infrastructure facilities also plays an important role. There are 334 veterinary hospitals, 2140 veterinary dispensary, 1106 primary veterinary center, 172 mobile veterinary centers in the state. The road facilities are crucial for transportation of raw materials, feed and produce. About 4688 km length of National Highway connected through the major districts in the state. The trained manpower and consumers are also play an important role in poultry production. Of the total workers about 25.7 per cent are agricultural laborers in Karnataka state.

## MATERIALS AND METHODS :

The study is based on secondary data collected from the published sources of Directorate of Economics and Statistics, Bengaluru and Department of Animal Husbandry and Veterinary Services, Bengaluru, Govt. of Karnataka for the period of twelve years from 2003-04 to 2014-15. The district wise broiler meat production data of Karnataka state were obtained from the Department of Animal Husbandry and Veterinary Services, Bengaluru and the data pertaining to important broiler meat production indicators selected for the study were collected from Directorate of Economics and Statistics, Bengaluru, Govt. of Karnataka. For the construction of principal component analysis scores which are taken as indices for broiler meat productionthe data is taken at four points of time as Year I (2003-04), Year II (2007-08), Year III (2011-12) and Year IV (2014-15). These scores were obtained in order to ascertain disparities between districts and to know the shift in broiler meat production.

**Selection of indicators:**

For better growth and development of poultry in any region depends on many factors.Its impact cannot be evaluated fully by any single factor, a number of indicators when analysed individually do not provide an integrated and easily comprehensible picture of reality. In order to known the comprehensive development of broiler production in the state, major factors or indicators causes for the production were consider. The broiler meat production indicators common to all the districts in a state have been included in the study. It is essential that agriculture and infrastructure must flourish together because agricultural produce provides principal raw materials and infrastructure provides essential facilities for the production of the broilers. Therefore, for the analysis all the common indicators were classified into two major sectors *viz.*, Agricultural sector and Infrastructure sector.

**Agriculture sector:**

The development in agricultural sector is very important since this sector plays a crucial role in the broiler production as 80 per cent of the cost of raring poultry is incurred for feed. The indicators taken for agricultural sector are as follows:

– Net area sown (ha)
– Uncultivable land (ha)
– Net irrigated land (ha)
– Unirrigated land (ha)
– Area under cereals (other than maize) (ha)
– Area under pulses (ha)
– Area under maize (ha)
– Area under groundnut (ha).

**Infrastructure sector:**

Broiler meat production depends on the infrastructural facilities, provision for health institutions, transportations facilities and population in each districts. Therefore, the indicators considered under infrastructure sector are as follows:

– Number of veterinary Institutions
– Road length (km)
– Total number of population
– Number of agriculture workers
– Number of non-agriculture workers.

As above mentioned indicators for both agricultural sector and infrastructure sector are dependent on the area of the districts. Hence, these values were scaled per unit area per broiler production in order to give same weightage of corresponding indicators for all the districts.

**Principal component analysis (PCA):**

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. These new variables are linear combinations of original variables and are derived in decreasing order of importance so that the first principal component accounts for as much as possible of the variation in the original data.

The selected agriculture and infrastructure indicator variables measure many facets of the performance of broiler meat production of Karnataka state. Principal component analysis was employed, with a view to aggregate the performance indicators into a few groups of factors. This technique was used by many researchers for grouping the factors and is the oldest and the best known technique of multivariate analysis.

Let $x_1, x_2, x_3 ..., x_p$ are variables under study, then first principal component may be defined as:

$$z_1 = a_{11}x_1 + a_{12}x_2 + ..... + a_{1p}x_p$$

Such that variance of $z_1$ is as large as possible subject to the condition that:

$$a_{11}^2 + a_{12}^2 + .... + a_{1p}^2 = 1$$

This constraint is introduced because if this is not done, then Var ($z_1$) can be increased simply by multiplying any $\alpha_1 j$ 's by a constant factor. The second principal component is defined as:

$$z_2 = a_{21}x_1 + a_{22}x_2 + ..... + a_{2p}x_p$$

Such that Var ($z_2$) is as large as possible next to Var ($z_1$) subject to the constraint that:

$a_{21}^2 + a_{22}^2 + ..... + a_{2p}^2 = 1$ and cov ($z_1$, $z_2$) = 0 and so on.

It is quite likely that first few principal components account for most of the variability in the original data. If so, these few principal components can then replace the initial p variables in subsequent analysis, thus, reducing the effective dimensionality of the problem.

## RESULTS AND DATA ANALYSIS :

The principal component analysis (PCA) scores have been calculated for each districts with respect to 13 indicators regarding agriculture and infrastructure sectors for the study period. The PCA scores at four points of time *i.e.,* 2003-04, 2007-08, 2011-12 and 2014-15 are considered to know the disparity among the districts in broiler production. The districts have been ranked on the basis of PCA scores separately for agriculture and infrastructure sectors. The PCA scores along with the ranks of each districts based on agriculture and infrastructure sectors are presented in Table 1 and 2, respectively.

For the year 2003-04, the PCA scores of broiler meat production varied from 0.1541 to 34.4635 in agricultural sector and from 0.0013 to 0.1781 in infrastructural sector. The Bengaluru Urban, Bengaluru Rural and Tumakuru districts were placed on top three broiler meat producing districts with PCA scores of 0.1541, 0.1770 and 0.3707, respectively and Gadag is the last district in the broiler production with 34.4635 PCA score based on agricultural sector indicators. In the case of infrastructural sector the district of Bengaluru Rural occupied the first position and Kalaburagi on the last place. The Chikkaballapura and Kolar districts are in second and third position with PCA score of 0.0045 and 0.0052, respectively.

In the year 2007-08, the PCA scores varied from 0.0679 to 24.2758 in agricultural sector and from 0.0036 to 0.2447 in infrastructural sector. The Bengaluru Urban, Dakshina Kannada and Mandya districts were found to be top three districts in broiler production with PCA scores of 0.0679, 0.2777 and 0.3044, respectively based on agriculture sector indicators. Whereas based on infrastructure sector indicators top two districts in broiler production are same as in agriculture sector with PCA score of 0.0036 and 0.0043 and the Hassan district has

third place with 0.0050 score. Bagalkot district occupied the last rank with 24.2758 and 0.2447 scores based on both agricultural and infrastructural sectors indicators, respectively.

For the year 2011-12, the PCA scores varied from 0.0455 to 5.5924 in agricultural sector and from 0.0007 to 0.0419 in infrastructural sector. The Bengaluru Urban, Bengaluru Rural and Udupi districts are the top three broiler producing districts with scores of 0.0455, 0.1197 and 0.2120, respectively based on the agriculture sector indicators. Whereas, based on infrastructure sector indicators, Bengaluru Rural, Kodagu and Udupi districts were found to be top three broiler producing districts with score values of 0.0007, 0.0020 and 0.0022, respectively. Yadgir and Kalaburagi districts are in the last rank with score of 5.5924 and 0.0378 based on agriculture and infrastructure sector indicators, respectively. Yadgir and Kalaburagi districts were in the last place based on agriculture and infrastructure sectors, respectively.

For 2014-15, the PCA scores varied from 0.0456 to 12.8821 in agricultural sector and from 0.0002 to 0.0592 in infrastructural sector. The Bengaluru Rural, Haver and Chikkamagaluru districts are placed in the top three broiler producing districts with PCA scores of 0.0456, 0.0568

**Table 1: Computed values of PCA scores based on agriculture sector for different districts of Karnataka**

| Districts | 2003-04 | | 2007-08 | | 2011-12 | | 2014-15 | |
|---|---|---|---|---|---|---|---|---|
| | PCA score | Rank | PCA score | Rank | PCA score | Rank | PCA score | Rank |
| Bagalkot | 3.1564 | 22 | 24.2758 | 30 | 3.1022 | 27 | 0.4528 | 18 |
| Ballari | 0.5249 | 7 | 1.0154 | 13 | 0.6385 | 18 | 0.4152 | 15 |
| Belagavi | 1.4007 | 17 | 5.0522 | 22 | 1.3727 | 24 | 0.4324 | 16 |
| Bengaluru Rural | 0.1770 | 2 | 0.9109 | 12 | 0.1197 | 2 | 0.0456 | 1 |
| Bengaluru Urban | 0.1541 | 1 | 0.0679 | 1 | 0.0455 | 1 | 0.0947 | 4 |
| Bidar | 19.3653 | 28 | 13.6041 | 25 | 2.0668 | 26 | 1.6258 | 25 |
| Chamarajnagar | 1.5192 | 18 | 1.8063 | 17 | 0.6088 | 16 | 2.7303 | 27 |
| Chikkaballapura | 0.4588 | 5 | 0.5593 | 7 | 0.6177 | 17 | 0.3419 | 14 |
| Chikkamagaluru | 1.6878 | 20 | 1.6119 | 16 | 0.3375 | 8 | 0.0671 | 3 |
| Chitradurga | 1.2398 | 15 | 1.3585 | 14 | 1.1425 | 22 | 0.4582 | 19 |
| Dakshina Kannada | 0.8594 | 10 | 0.2777 | 2 | 0.2871 | 5 | 0.1965 | 6 |
| Davangere | 1.0780 | 14 | 0.8138 | 9 | 0.5294 | 14 | 0.4505 | 17 |
| Dharwad | 6.3488 | 25 | 10.8707 | 24 | 0.8580 | 20 | 0.7974 | 23 |
| Gadag | 34.4635 | 30 | 21.3492 | 28 | 4.0577 | 28 | 12.8821 | 30 |
| Hassan | 0.7022 | 8 | 0.3672 | 4 | 0.2882 | 6 | 0.5440 | 20 |
| Haveri | 4.2938 | 24 | 2.7089 | 18 | 0.8567 | 19 | 0.0568 | 2 |
| Kalaburagi | 13.9142 | 27 | 16.4235 | 26 | 4.1661 | 29 | 2.2247 | 26 |
| Kodagu | 1.3811 | 16 | 0.9021 | 11 | 0.4142 | 11 | 0.3275 | 12 |
| Kolar | 0.4585 | 4 | 0.5012 | 5 | 0.4373 | 12 | 0.3044 | 11 |
| Koppal | 2.5813 | 21 | 3.0644 | 19 | 1.1840 | 23 | 0.8409 | 24 |
| Mandya | 0.5110 | 6 | 0.3044 | 3 | 0.2638 | 4 | 0.2101 | 7 |
| Mysuru | 0.9906 | 11 | 0.7805 | 8 | 0.5442 | 15 | 0.3032 | 10 |
| Raichur | 3.5942 | 23 | 4.8270 | 21 | 1.4959 | 25 | 0.7027 | 22 |
| Ramanagara | 0.8024 | 9 | 3.4937 | 20 | 0.4422 | 13 | 0.5999 | 21 |
| Shivamogga | 1.5390 | 19 | 6.4712 | 23 | 0.3238 | 7 | 0.2833 | 9 |
| Tumakuru | 0.3707 | 3 | 0.5168 | 6 | 0.3377 | 9 | 0.3331 | 13 |
| Udupi | 1.0250 | 13 | 1.3750 | 15 | 0.2120 | 3 | 0.2413 | 8 |
| Uttara Kannada | 1.0076 | 12 | 0.8586 | 10 | 0.4011 | 10 | 0.1329 | 5 |
| Vijayapura | 8.8724 | 26 | 19.3566 | 27 | 0.9760 | 21 | 4.0544 | 28 |
| Yadgir | 25.8638 | 29 | 21.5736 | 29 | 5.5924 | 30 | 6.3990 | 29 |

and 0.0671, respectively based on the agriculture sector indicators. For the infrastructure sector the Bengaluru Rural, Haveri and Chikkamagaluru districts are the top producers with scores of 0.0002, 0.0004 and 0.0005, respectively. Gadag district occupied the last rank with PCA scores of 12.8821 and 0.0592 based on both agriculture and infrastructure sectors, respectively.

The results indicates that in the first study year 2003-04, the top three broiler meat producing districts are Bengaluru Urban, Bengaluru Rural and Shivamogga based on agricultural sector indices whereas Bengaluru Rural, Chikkaballapura and Kolar are top three broiler producing districts based on infrastructure sector indices. For the last study year 2014-15, the top three broiler producing districts are Bengaluru Rural, Haveri and Chikkamagaluru based on agriculture sector as well as based on infrastructure sector indices. It is clear from the analysis that, the Haveri and Chikkamagaluru districts have improved in their broiler meat production during the last four years.

**Classification of districts based on quartiles using the PCA score:**

Quartiles are a major tool in descriptive analysis and

**Table 2 : Computed values of PCA scores based on infrastructure sector for different districts of Karnataka**

| Districts | 2003-04 | | 2007-08 | | 2011-12 | | 2014-15 | |
|---|---|---|---|---|---|---|---|---|
| | PCA score | Rank | PCA score | Rank | PCA scores | Rank | PCA scores | Rank |
| Bagalkot | 0.0345 | 21 | 0.2447 | 30 | 0.0292 | 27 | 0.0033 | 10 |
| Ballari | 0.0092 | 8 | 0.0142 | 12 | 0.0090 | 20 | 0.0063 | 23 |
| Belagavi | 0.0393 | 23 | 0.1201 | 25 | 0.0342 | 28 | 0.0091 | 24 |
| Bengaluru Rural | 0.0013 | 1 | 0.0081 | 9 | 0.0007 | 1 | 0.0002 | 1 |
| Bengaluru Urban | 0.0064 | 4 | 0.0036 | 1 | 0.0030 | 4 | 0.0059 | 22 |
| Bidar | 0.1173 | 26 | 0.1125 | 24 | 0.0168 | 24 | 0.0111 | 25 |
| Chamarajnagar | 0.0235 | 17 | 0.0190 | 15 | 0.0069 | 16 | 0.0284 | 27 |
| Chikkaballapura | 0.0045 | 2 | 0.0056 | 6 | 0.0050 | 11 | 0.0022 | 5 |
| Chikkamagaluru | 0.0214 | 16 | 0.0204 | 16 | 0.0038 | 7 | 0.0005 | 3 |
| Chitradurga | 0.0176 | 15 | 0.0157 | 14 | 0.0113 | 22 | 0.0043 | 13 |
| Dakshina Kannada | 0.0103 | 10 | 0.0043 | 2 | 0.0043 | 9 | 0.0026 | 7 |
| Davangere | 0.0137 | 14 | 0.0080 | 8 | 0.0051 | 12 | 0.0038 | 11 |
| Dharwad | 0.0437 | 24 | 0.0686 | 22 | 0.0056 | 13 | 0.0048 | 15 |
| Gadag | 0.1272 | 27 | 0.1004 | 23 | 0.0189 | 25 | 0.0592 | 30 |
| Hassan | 0.0080 | 7 | 0.0050 | 3 | 0.0033 | 5 | 0.0053 | 17 |
| Haveri | 0.0390 | 22 | 0.0221 | 17 | 0.0074 | 17 | 0.0004 | 2 |
| Kalaburagi | 0.1781 | 30 | 0.1723 | 28 | 0.0419 | 30 | 0.0238 | 26 |
| Kodagu | 0.0106 | 12 | 0.0051 | 5 | 0.0020 | 2 | 0.0023 | 6 |
| Kolar | 0.0052 | 3 | 0.0077 | 7 | 0.0045 | 10 | 0.0032 | 9 |
| Koppal | 0.0254 | 19 | 0.0232 | 18 | 0.0084 | 19 | 0.0053 | 16 |
| Mandya | 0.0074 | 6 | 0.0050 | 4 | 0.0037 | 6 | 0.0028 | 8 |
| Mysuru | 0.0133 | 13 | 0.0122 | 11 | 0.0082 | 18 | 0.0038 | 12 |
| Raichur | 0.0536 | 25 | 0.0514 | 21 | 0.0163 | 23 | 0.0057 | 20 |
| Ramanagara | 0.0071 | 5 | 0.0399 | 19 | 0.0041 | 8 | 0.0044 | 14 |
| Shivamogga | 0.0250 | 18 | 0.1365 | 26 | 0.0068 | 15 | 0.0058 | 21 |
| Tumakuru | 0.0098 | 9 | 0.0112 | 10 | 0.0065 | 14 | 0.0055 | 18 |
| Udupi | 0.0106 | 11 | 0.0145 | 13 | 0.0022 | 3 | 0.0022 | 4 |
| Uttara Kannada | 0.0341 | 20 | 0.0419 | 20 | 0.0213 | 26 | 0.0057 | 19 |
| Vijayapura | 0.1377 | 28 | 0.1848 | 29 | 0.0094 | 21 | 0.0363 | 29 |
| Yadgir | 0.1674 | 29 | 0.1366 | 27 | 0.0378 | 29 | 0.0360 | 28 |

grouping of data, which divides the data into four parts each having equal size (25%) of the data.The quartiles are calculated for the study year 2003-04, 2007-08, 2011-12 and 2014-15 using the PCA scores separately for agriculture and infrastructure sectors, the results are depicted in the Table 3. Based on these quartiles, the classification of districts is carried out for the four study years separately for agriculture and infrastructure sectors as high, high medium, low medium and low broiler producing districts.

For relative comparisons among the districts with regard to the broiler meat production, the districts are classified as high if the PCA score is less than first quartile $Q_1$, high medium if scores lies between first quartile $Q_1$ and less than second quartile $Q_2$, low medium if scores lies between second quartile $Q_2$and less than third quartile $Q_3$and low if scores more than third quartile $Q_3$. Accordingly all the districts are grouped for the study years. Tables 4 and 5 presents the classification of districts lying in different levels of production and percentage share of broiler meat production covered by the districts falling under different level of classification at four different study years.

By careful examination of Tables 4 and 5, the the Bengaluru Rural, Bengaluru Urban and Mandya districts were classified under the high broiler producing class in all the four period of the study, whereas Haveri and Chikkamagaluru districts which were classified under low medium class for the study years 2003-04, 2007-08 and 2011-12, occupied high category in last period of study due to drastic increase in broiler meat production in these districts.

**Table 3 : Computed quartiles for the study periods**

| Study period | Agriculture sector | | | Infrastructure sector | | |
|---|---|---|---|---|---|---|
| | $Q_1$ | $Q_2$ | $Q_3$ | $Q_1$ | $Q_2$ | $Q_3$ |
| 2003-04 | 0.7273 | 1.3105 | 3.4848 | 0.0094 | 0.0196 | 0.0393 |
| 2007-08 | 0.7888 | 1.4935 | 6.1165 | 0.0081 | 0.0198 | 0.0925 |
| 2011-12 | 0.3376 | 0.5765 | 1.1737 | 0.0042 | 0.0069 | 0.0151 |
| 2014-15 | 0.2518 | 0.4238 | 0.7738 | 0.0029 | 0.0051 | 0.0062 |

**Table 4: Classification of districts based on agricultural sector indicators**

| Classification | 2003-04 | 2007-08 | 2011-12 | 2014-15 |
|---|---|---|---|---|
| High | Ballari, Bengaluru Rural, Bengaluru Urban, Chikkaballapura, Hassan, Kolar, Mandya and Tumakuru (63.97) | Bengaluru Urban, Chikkaballapura, Dakshina Kannada, Hassan, Kolar, Mandya, Mysuru, Tumakuru (65.88) | Bengaluru Rural, Bengaluru Urban, Dakshina Kannada, Hassan, Mandya, Shivamogga, Udupi (49.91) | Bengaluru Rural, Bengaluru Urban, Chikkamagaluru, Dakshina Kannada, Haveri, Mandya, Udupi, Uttara Kannada (65.74) |
| High medium | Chitradurga, Dakshina Kannada, Davangere, Mysuru, Ramanagara, Udupi, Uttara Kannada(20.63) | Ballari, Bengaluru Rural, Chitradurga, Davangere, Kodagu, Udupi, Uttara Kannada (23.05) | Chikkamagaluru, Davangere, Kodagu, Kolar, Mysuru, Ramanagara, Tumakuru, Uttara Kannada (25.41) | Ballari, Chikkaballapura, Kodagu, Kolar, Mysuru, Shivamogga, Tumakuru (15.66) |
| Low medium | Bagalkot, Belagavi, Chamarajnagar, Chikkamagaluru, Kodagu, Koppal, Shivamogga (11.3) | Belagavi, Chamarajnagar, Chikkamagaluru, Haveri, Koppal, Raichur, Ramanagara (9.74) | Ballari, Chamarajnagar, Chikkaballapura, Chitradurga, Dharwad, Haveri, Vijayapura (16.76) | Bagalkot, Belagavi, Chitradurga, Davangere, Hassan, Raichur, Ramanagara (13.33) |
| Low | Bidar, Dharwad, Gadag, Haveri, Kalaburagi, Raichur, Vijayapura, Yadgir (4.09) | Bagalkot, Bidar, Dharwad, Gadag, Kalaburagi, Shivamogga, Vijayapura, Yadgir (1.33) | Bagalkot, Belagavi, Bidar, Gadag, Kalaburagi, Koppal, Raichur, Yadgir (7.92) | Bidar, Chamarajnagar, Dharwad, Gadag, Kalaburagi, Koppal, Vijayapura, Yadgir (5.26) |

Figure in the parenthesis is percentage share of broiler meat production

The broiler production in Ballari is declining over the years which is clear from the analysis that, it is in high broiler producing class in the initial study year 2003-04, high medium in 2007-08, low medium in 2011-12 and it comes to low broiler producing class in the final study year 2014-15. The Belagavi districts remains in the low medium class based on agriculture sector where as it remains in the low class based on the infrastructure sector for all the four study periods. Bidar, Gadag, Kalaburagi, Vijayapura and Yadgir districts remains in the low broiler producing districts based on the both agriculture and infrastructure sectors for all the four study years.

Further, the relative share of broiler production under different level of classification shows that more than 75 per cent of the broiler production is from the districts under high and high medium classes based on indices values of both agriculture and infrastructure sectors during all the four study years. The less contribution to broiler meat production is from the districts under low medium and low classification.

**Inter-relationship between agriculture and infrastructure sectors :**

For proper and effective broiler meat production, it is desire that agriculture and infrastructure sector should prosper together. For examining the relationship between the agriculture and infrastructure sectors in each districts, Pearson's correlation co-efficient have been worked out on PCA scores and estimates of linear association are presented in the Table 6.

The correlation co-efficient between the agriculture and infrastructure sectors based on principal component scores for all the four study years were found to be highly correlated and they are highly significant. This clearly indicated that both the sectors flourishing together will facilitate for more production of broiler meat in the Karnataka state.

**Contribution of different indicators towards regional disparity in broiler meat production:**

In the principal component analysis the eigen values

**Table 5: Classification of districts based on infrastructural sector indicators**

| Classification | 2003-04 | 2007-08 | 2011-12 | 2014-15 |
|---|---|---|---|---|
| High | Ballari, Bengaluru Rural, Bengaluru Urban, Chikkaballapura, Hassan, Kolar, Mandya, Ramanagara (61.32) | Bengaluru Rural, Bengaluru Urban, Chikkaballapura, Dakshina Kannada, Davangere, Hassan, Kodagu, Kolar, Mandya (75.33) | Bengaluru Rural, Bengaluru Urban, Chikkamagaluru, Hassan, Kodagu, Mandya, Ramanagara, Udupi (53.16) | Bengaluru Rural, Chikkaballapura, Chikkamagaluru, Dakshina Kannada, Haveri, Kodagu, Mandya, Udupi (64.61) |
| High medium | Chitradurga, Dakshina Kannada, Davangere, Kodagu, Mysuru, Tumakuru, Udupi (23.93) | Ballari, Chamarajnagar, Chitradurga, Mysuru, Tumakuru, Udupi (14.82) | Chamarajnagar, Chikkaballapura, Dakshina Kannada, Davangere, Dharwad, Kolar, Shivamogga, Tumakuru (25.18) | Bagalkot, Chitradurga, Davangere, Dharwad, Kolar, Mysuru, Ramanagara (15.64) |
| Low medium | Bagalkot, Chamarajnagar, Chikkamagaluru, Haveri, Koppal, Shivamogga, Uttara Kannada (9.17) | Chikkamagaluru, Dharwad, Haveri, Koppal, Raichur, Ramanagara, Uttara Kannada (8.15) | Ballari, Chitradurga, Haveri, Koppal, Mysuru, Vijayapura (14.82) | Bengaluru Urban, Hassan, Koppal, Raichur, Shivamogga, Tumakuru, Uttara Kannada (13.58) |
| Low | Belagavi, Bidar, Dharwad, Gadag, Kalaburagi, Raichur, Vijayapura, Yadgir (5.58) | Bagalkot, Belagavi, Bidar, Gadag, Kalaburagi, Shivamogga, Vijayapura, Yadgir (1.69) | Bagalkot, Belagavi, Bidar, Gadag, Kalaburagi, Raichur, Uttara Kannada, Yadgir (6.84) | Ballari, Belagavi, Bidar, Chamarajnagar, Gadag, Kalaburagi, Vijayapura, Yadgir (6.17) |

Figure in the parenthesis is percentage share of broiler meat production

**Table 6: Correlation co-efficients**

| Sectors | Correlation co-efficients | | | |
|---|---|---|---|---|
| | 2003 | 2007 | 2011 | 2014 |
| Agriculture and infrastructure | 0.8444** | 0.8970** | 0.8357** | 0.9452** |

** indicate significance of value at p=0.01

of each of the variable indicates the proportion of variation explained by that variable for the particular component. Hence, in order to assess the causes for the changein broiler meat production, the contribution of each of the indicator based on the eigen values obtained in the first principal component were ranked separately for agriculture and infrastructure sectors in each of the districts. Then the frequencies of ranks pertaining to the respective indicators are consider irrespective of the districts to know the major causes for the disparity in the broiler meat production of Karnataka state.Tabular compilation is made by counting the ranks obtained by each indicator and its relative frequencies are presented in Table 7 for agriculture sector and in Table 8for infrastructure sector.

In the agriculture sector the frequently occurring indicators in rank order from highest to lowest contributing variables are area under irrigated land (ha), area under maize (ha), area under pulses (ha), area under groundnut (ha), net sown area (ha), area under cereals (ha), area under uncultivable land (ha) and area under unirrigated land (ha) in that order. Similarly in infrastructure based indicator number of veterinary institutions, road length (km), non-agriculture workers, population and agriculture workers found to occur frequently with higher ranks in this order.

Area under irrigated land (ha) scored first rank with a relative frequency of 36.67 per cent, area under maize (ha) (33.33 %) and area under pulses (ha) (16.67 %) are the main indicator variables in agriculture sector for the development and number of veterinary institutions (80 %) and road length (km) (20 %) in infrastructure sector based indicator variables which indicates the major causes for the disparity among the districts. Simila work related to the present investigation Ajagekar and Masal (2011); Amarender Reddy (2010); Narain *et al.* (1994,1997, 2000 and 2001) and Pradhan and Kumar (2015)

## Conclusion:

The broad conclusions emerging from the study are as follows:

Districts were ranked according to the principal component scores for the four study years it revealed that there is a significant disparity among the districts in broiler meat production.

Bengaluru rural, Bengaluru urban and Mandya districts are in the high broiler producing class for all the four study years, while in last four years the Haveri and Chikkamagaluru districts production was found to be increased and they are placed in high broiler producing

**Table 7 : Relative positional frequencies of agriculture sector indicator variables and its percentage contribution**

| Positions (Rank) | Area (ha) under | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Cereals | Pulses | Groundnut | Maize | Uncultivable land | Unirrigated land | Irrigated land | Net sown area |
| 1st | 0 (0.00) | 5 (16.67) | 2 (6.67) | 10 (33.33) | 0 (0.00) | 0 (0.00) | 11 (36.67) | 2 (6.67) |
| 2nd | 1 (3.33) | 3 (10) | 2 (6.67) | 11 (36.67) | 0 (0.00) | 0 (0.00) | 10 (33.33) | 3 (10) |
| 3rd | 1 (3.33) | 6 (20) | 8 (26.67) | 5 (16.67) | 0 (0.00) | 0 (0.00) | 4 (13.33) | 6 (20) |
| 4th | 2 (6.67) | 4 (13.33) | 6 (20) | 1 (3.33) | 4 (13.33) | 6 (20) | 2 (6.67) | 5 (16.67) |
| 5th | 4 (13.33) | 6 (20) | 6 (20) | 1 (3.33) | 5 (16.67) | 3 (10) | 2 (6.67) | 3 (10) |
| 6th | 4 (13.33) | 2 (6.67) | 2 (6.67) | 1 (3.33) | 11 (36.67) | 8 (26.67) | 0 (0.00) | 2 (6.67) |
| 7th | 9 (30) | 3 (10) | 3 (10) | 0 (0.00) | 3 (10) | 5 (16.67) | 1 (3.33) | 5 (16.67) |
| 8th | 9 (30) | 1 (3.33) | 0 (0.00) | 0 (0.00) | 7 (23.33) | 8 (26.67) | 0 (0.00) | 4 (13.33) |

Figure in the parenthesis is percentage contribution

**Table 8 : Relative positional frequencies of infrastructure sector indicator variables and its percentage contribution**

| Positions (Ranks) | Agriculture workers | Non-agriculture workers | Population | Road length | Veterinary institutions |
|---|---|---|---|---|---|
| 1st | 0 (0.00) | 0 (0.00) | 0 (0.00) | 6 (20) | 24 (80) |
| 2nd | 2 (6.67) | 1 (3.33) | 0 (0.00) | 21 (70) | 6 (20) |
| 3rd | 10 (33.33) | 17 (56.67) | 2 (6.67) | 1 (3.33) | 0 (0.00) |
| 4th | 1 (3.33) | 1 (3.33) | 28 (93.33) | 0 (0.00) | 0 (0.00) |
| 5th | 17 (56.67) | 11 (36.67) | 0 (0.00) | 2 (6.67) | 0 (0.00) |

Figure in the parenthesis is percentage contribution

category.

Bidar, Gadag, Kalaburagi, Vijayapura and Yadgir districts are in the low broiler producing category for all the four study years.

The agriculture and infrastructure sectors are highly correlated and have a positive influence on the broiler production of the state.

The main causes for the disparity in broiler production are area under irrigated land, area under maize and area under pulses based on the agriculture sector indicator variables. Whereas number of veterinary institutions and road length are the main causes based on the infrastructure indicator variables.

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Authors' affiliations:
**R. Manjula and V. Manjunath,** Department of Agricultural Statistics, Applied Mathematics and Computer Sciences, University of Agricultural Sciences, **Bengaluru (Karnataka) India**

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