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Dynamics of Farming Systems: A Study on income Maximization in Visakhapatnam district of Andhra Pradesh

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ABSTRACT: As most of the farmers expressed their displeasure in farming due to the continuous negative net returns, it was proposed to identify profitable farming systems in Visakhapatnam. A total of 10 farming systems were observed from existing 8 farming situations in Visakhapatnam district of Andhra Pradesh. This study was conducted by collecting data from 160 farmers i.e., 20 farmers from each situation. Farming System with dairy and goat & sheep as allied activities (FS-VI) was most profitable with a benefit cost ratio of 1.31. DEA (Data Envelopment Analysis) revealed that 37 percentage of farms in all five major significant farming systems were operated at sub-optimal region of production followed by optimal region (34.48%). The R^2 value lied in between 0.61 (FS-I) to 0.75 (FS-VI). The input feed was most significant and positively influencing determinant of RUE (Resource Use Efficiency). The Simpson's diversification index of farming systems ranged between 0.67 (FS-III) to 0.87 (FS-I& II) which indicating high diversification in Visakhapatnam district. The MDR (Market Dependency Ratio) value was lowest in FS-VI (0.60), which reflecting the less dependency on market for inputs by effectively using the inputs produced within the system. Response Priority Index (RPI) revealed that 'Non remunerative price for product' was the major marketing constraint followed by 'price fluctuations' and 'high transport cost' in major farming systems. Though paddy and sugarcane were major crops, the returns from them were negative due to their labour intensiveness. Hence, farm mechanization would help to bring high net returns. Adopting improved technologies and HYV's, selling the produce at MSP (Minimum Support Price), diversification towards high value crops and processing of raw products would maximize the income of the farmers.

Keywords: DEA, Farming systems, Market interlinkages, RPI, RUE, SID.

INTRODUCTION

Agriculture research has focused on component and commodities-based research throughout the past five decades. Through the creation of new crop types, animal breeds, machinery for agriculture and other production &protection technologies, farmers were able to improve their yields. However, natural resources like land and water are also being aggressively exploited at the same time. This has led to declining factor productivity, inefficient resource consumption and eventually reduced profitability. Furthermore, the income from cropping alone is hardly sufficient enough to meet the needs of small and marginal farmers who are dominant in Indian agriculture (Chand *et al.*, 2011 & Sachinkumar *et al.*, 2012). In this scenario, the Farming Systems Approach (FSA), which has been extensively acknowledged and accepted, is one of the methods for ensuring the efficient use of inputs while enhancing the sustainability and profitability of production systems. It protects farmers from the probable risks and uncertainties associated with farming.

Crops, livestock, and related activities comprise the complex interrelated set of components which collectively make up a farming system. These components interact with one another. Crops, cattle, poultry, fish, sericulture, apiculture, vermicomposting, sheep & goat rearing and other elements constitute a farming system. When carefully selected, organized and carried out, a combination of one or more enterprises along with cropping can yield larger returns than a single enterprise, especially for small and marginal farmers (Tanveer, 2006 & Torane, 2009). The term "farming system" refers to the complex interaction of several interdependent components. Primarily, the various components of the farming system are connected in such a way that materials could move from one component to another. The concept of minimizing resource competition and maximizing complementarity of returns among the enterprises must be considered as the basis for appropriate selection of crops and animal enterprises. In a farming system, an enterprise's output may be used as an input by another component (Rao *et al.*, 2017). Visakhapatnam district of the Andhra Pradesh state was deliberately selected for the study, due to its considerable coastal corridor, high altitude zone, varying climatic conditions and location-specific farming situations. This study aids farmers in locating profitable farming systems for raising yields, thereby income. Therefore, the following objectives were pursued in the study entitled "Dynamics of Farming Systems: A Study on Income Maximization in Visakhapatnam District of Andhra Pradesh"

1. To determine existing and major profitable farming systems.
2. To examine efficiency in resource use and its determinants associated with major farming systems.
3. To assess the extent of diversity in farming systems.
4. To study the inter-linkages of farming systems with markets for income enhancement.
5. To observe the marketing constraints in major farming systems
6. To suggest appropriate policy measures for creating enabling environment to implement profitable farming systems.

METHODOLOGY

The primary data was collected for the year 2019 from the farmers of Visakhapatnam district. Visakhapatnam has eight farming situations, which are classified based on soil types and irrigation facilities by DAATT centre. The mandal with the largest area was chosen among all the listed mandals from each farming situation. Then, two villages with the most arable land were chosen from each mandal. A sample of 10 farmers from every listed village were randomly identified. Thus, a total of 160 farmers were interviewed from 16 villages for identification of existing and profitable farming systems. The data was further analysed with CACP methodology for calculating its cost return structure.

A. Data Envelopment Analysis (DEA)

There are several ways to calculate economic efficiency and they can be divided into parametric and non-parametric methods. Charnes *et al.* (1978) first established the non-parametric method known as Data Envelopment Analysis (DEA). DEA provides a number of advantages including the ability to handle multiple outputs and inputs, the lack of a predetermined functional form for the production frontier, the lack of distributional assumptions for the inefficiency term and the ability to determine the optimum practice for each farm.

The DEA technique is a frontier method that can account for scale-related problems without requiring the specification of a functional or distributional form. Boles (1966); Afriat (1972) followed Farrell (1957) in using this strategy as a piecewise linear convex hull approach to frontier estimation. Until the publication of the work by Charnes *et al.* (1978), who first used the term "data envelope analysis," this method did not garner much attention. The DEA method has been expanded upon and utilized in numerous studies in the western world. There haven't been many research in India that have measured resource use efficiency using this method, particularly in agriculture or horticulture. The drawback of the DEA approach is that data noise effects are not expressly taken into account. In 1978, Charnes, Cooper, and Rhodes published a model that was input-oriented and made the assumption that Constant Returns to Scale (CRS) applied. Later, Banker *et al.* (1984) proposed the Variable Returns to Scale (VRS) model in their later articles. As most of the variables in farming systems were taken into account in this instance, data noise was less of a limitation. Additionally, the DEA technique was used because it could quickly produce complete data on technical efficiency, scale efficiency and peers.

Both the conventional models of CRS (Constant Returns to Scale) and VRS (Variable Returns to Scale) with input orientation, where one seeks input minimization to achieve a specific product level were used to apply the DEA. The linear programming model for evaluating the effectiveness of farming systems is based on the assumption of Constant Returns to Scale is (Coelli *et al.*, 1998):

$\text{Min}\ \theta, \lambda\ \theta$

Subject to $-y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$\lambda \geq 0$ (1)

where,

y_i is a vector ($m \times 1$) of gross output of the i^{th} farm,

x_i is a vector ($k \times 1$) of inputs of the i^{th} farm unit,

Y is a gross output matrix ($n \times m$) for n farms,

X is a farm input matrix ($n \times k$) for n farms,

The efficiency score is a scalar whose value will serve as the i^{th} farm's efficiency indicator. Farm will be effective if $\theta = 1$; else, it will be in effective, and λ is a vector ($n \times 1$) whose values are determined to produce the optimum outcome. The λ weights are applied in the linear combination of other, efficient farms for an inefficient farm will determine how the inefficient farm is projected on the estimated frontier.

When the enterprises operate at their optimum scale, only the specification of constant returns is suitable. Otherwise, scale efficiency, which takes into account all possible forms of returns to production, including increasing, constant and decreasing could be mistaken for the technical efficiency measures. So, a convexity constraint was applied in order to redesign the CRS model. Since it is free of scale effects, the measure of technical efficiency achieved in the model with variable returns is sometimes known as "pure technical efficiency." It was computed using the following linear programming model:

$\text{Min}\ \theta, \lambda\ \theta$

Subject to $-yi + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$N_1\ \lambda = 1$

$\lambda \geq 0$ (2)

where N_1 is a vector of ones ($n \times 1$). Scale inefficiency is confirmed when there are discrepancies in the efficiency score values between the CRS and VRS models, showing that the return to scale is erratic and can either be increasing or decreasing (Färe and Grosskopf 1994). The ratio between the scores for technical efficiency with constant and variable returns can be used to determine the scale efficiency values for each evaluated unit as follows:

$\theta_s = \theta_{CRS}(X_K, Y_K)/\theta_{VRS}(X_K, Y_K)$ (3)

where,

$\theta_{CRS}(X_K, Y_K)$ = Technical efficiency for the model with constant returns,

$\theta_{VRS}(X_K, Y_K)$ = Technical efficiency for the model with variable returns, and

θ_s = Scale efficiency.

According to Coelli *et al.* (1998), model (2) fails to distinguish between farms operating in the range of increasing or decreasing returns. The only information available is that the farm will be functioning with constant returns to scale if the result of calculating scale efficiency in Equation (3) equals one. However, increasing or decreasing returns are possible when 's' is less than one. As a result, in order to comprehend the nature of scale inefficiency, it is important to take into account a different linear programming problem where the convexity constraint of model (2), $N_1\lambda = 1$, is changed to either $N_1\lambda \leq 1$ or $N_1\lambda \geq 1$ depending on whether the model has non-increasing returns or non-decreasing returns respectively. As a result, in this work, efficiency was also measured using the following models, Non-increasing returns:

$\text{Min}_{\theta, \lambda}\ \theta$

Subject to $-y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$N_1\lambda \leq 1$

$\lambda \geq 0$ (4)

Non-decreasing returns:

$\text{Min}_{\theta, \lambda}\ \theta$

Subject to $- y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$N_1\lambda \geq 1$

$\lambda \geq 0$ (5)

It should be noted that each of the aforementioned models should be solved 'n' times *i.e.*, the model is solved for every farm in the sample.

Gross farm income (Rs.) was utilized as the output (Y) in this scenario, whereas the total inputs (X) for cropping alone were total human labour (man-days), total machine labour (hr), seed (kg), farm yard manure (t), total fertilizers (kg), and plant protection chemicals (l). Additional inputs like fodder (q), feed (kg), and veterinary medications (Rs) were also included in farming systems with dairy, poultry, sheep & goat rearing components. To determine the efficiency levels, the models were solved using DEAP version 2.1 while adopting an input orientation.

B. Determinants of technical efficiency

Traditional DEA was utilized by Ray (1991); Worthington and Dollery (1999) in the first stage to estimate technical efficiency, and an econometric approach was employed in the second stage to estimate the determinants of technical efficiency from the components contributing to this technical efficiency. The technical efficiency values from the DEA model, which took into account the input-oriented CRS model, were employed in the current study to examine the relationship between technical efficiency and factors affecting it. Given its excellent accuracy in differentiating efficiency when compared to variable returns to scale, the technical efficiency score from the CRS model was selected as the dependent variable (Gonclaves *et al.*, 2008). The aforementioned inputs are regarded as explanatory factors. For this, the conventional regression approach was utilized, and the regression equation was estimated using OLS analysis. The following equation specifies the regression model used in the current study:

$Y = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3}\, X_4^{b4} X_5^{b5}\, X_6^{b6}\, X_7^{b7}\, X_8^{b8} X_9^{b9} \mu$

where,

Y = Technical efficiency scores (CRS),

X_1 - Human labour (MD)

X_2 - Machine labour (hr)

X_3 - Seed (kg)

X_4 - FYM (t)

X_5 - Fertilizer quantity (kg)

X_6 - Plant protection chemicals (l)

X_7 -Fodder (q) (In case of dairy and sheep & goat)

X_8- Feed (kg) (In case of dairy, poultry and sheep & goat)

X_9 - Veterinary expenses (Rs.) (In case of dairy, poultry and sheep & goat)

'a' and 'b_i' are the constant and the coefficients respectively, which were estimated through the OLS analysis.

C. Simpsons Index of Diversification (SID)

To identify the extent of diversification in cropping activities and farming systems, the most widely used method is Simpsons Index of Diversification.

Diversification index for farming systems. Mathematically SID is formulated as

$$D_i = 1 - \sum \left(\frac{S_i}{S}\right)^2$$

Where D_i = Simpsons Diversification Index for diversification

S_i = Proportion of i^{th} enterprise's net income to the total farm income

S = whole farm total income

Between 0 and 1 is the range for the Simpson's index value. Whenever the index value is 0, there exists complete specialization and if it is 1, there exists complete diversification. The movement of index value from 0 to 1 indicates diversification and *vice-versa*.

Pearson's correlation coefficient is used to find the relation between diversification index and profitability of the farming systems.

The Pearson's correlation coefficient is a very important statistical tool which measures the strength between two variables. This is often referred as the Pearson R test.

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{\left[N\sum x^2 - (\sum x^2)\right]\left[N\sum y^2 - (\sum y^2)\right]}}$$

Where

N = Number of pairs of scores

$\sum xy$ = sum of the products of paired scores

$\sum x$ = sum of the x scores

$\sum y$ = sum of the y scores

$\sum x^2$ = sum of the squared x scores
$\sum y^2$ = sum of the squared y scores

D. Market inter-linkages in farming systems

Market Dependency Ratio (MDR) is the most effective measure for determining the degree of market interlinkage among farming systems (Rao *et al.,* 2017). It is a significant indicator which determines the dependency on markets to generate consistent income. In farming systems, one component's output could serve as the input for another. Therefore, MDR aids in locating the connections between various farming system components.

$$\text{MDR for inputs} = \frac{\text{Value of purchased inputs}}{\text{Value of total inputs used in the system}}$$

A greater MDR ratio suggests both a higher dependence on the market for inputs and an ineffective use of inputs produced within the system. While the lower MDR ratio denotes a higher level of system sustainability as well as less market dependence of inputs.

E. Response Priority Index (RPI)

There was debate over whether to place greater weight on the number of responses to a specific priority or the largest number of responses to a constraint in first priority when quantifying the constraints stated by the respondents. But both have distinct outcomes. In order to address this, the Responses Priority Index (RPI), a combination of the Priority Estimate (PE) and Proportion of Responses (PR), was adopted. The PR for the i^{th} constraint will provide the following information *i.e.*, the percentage of responses for a specific constraint to all responses and it is given below (Rao, 2012):

$$\textbf{(RPI)}_{\mathbf{i}} = \frac{\sum_{j=1}^{k} \mathbf{f}_{ij} \cdot \mathbf{X}_{[(k+1)-j]}}{\sum_{i=1}^{I}\sum_{j=1}^{k} \mathbf{f}_{ij}}$$

Where,

$\textbf{(RPI)}_{\mathbf{I}}$ = Response Priority Index for i^{th} constraint.

$\sum_{j=1}^{k} \mathbf{f}_{ij}$ = Total number of responses for the i^{th} constraint.

$\mathbf{f}_{ij}$ = Number of responses for the j^{th} priority of i^{th}constraint(i=1,2,3…...I; j= 1,2,3 …..k).

k = Number of priorities.

$\mathbf{X}_{[(k+1)-j]}$ = Scores for j^{th} priority.

$\sum_{i=1}^{I}\sum_{j=1}^{k} f_{ij}$ = Total number of responses to all constraints.

Here, higher the RPI, importance for that particular constraint was more.

RESULTS AND DISCUSSION

Table 1 shows that a total of ten farming systems, including FS-I: crops alone (28.13%), FS-II: crops + dairy (25.63%), FS-III: crops + poultry (11.25%), FS-IV: crops + sheep and goat (3.75%), FS-V: crops + dairy + poultry (16.25%), FS-VI: crops + dairy + sheep and goat (9.38%), FS-VII: crops + poultry + sheep and goat (1.88%), FS-VIII: Crops + Dairy + Poultry + Sheep & goat (1.88%), FS-IX: Crops + Mushroom (0.67%) and FS-X: Crops + Floriculture (1.25%). For further analysis, a sample of ten or more respondents who were practicing any of the ten farming systems was regarded as a major farming system. Crops alone (FS-I: 45) was the most common farming system in the Visakhapatnam district, followed by Crops + Dairy (FS-II: 41), Crops + Dairy + Poultry (FS-V: 26), Crops + Poultry (FS-III: 18), and Crop + Dairy + Sheep & Goat (FS-VI: 15).

A. Cropping pattern under major farming systems identified in Visakhapatnam district

Results from the Table 2 confirmed that among the seasonal crops, paddy was major crop in all farming systems but occupied only 40 per cent of net cropped area. Under annual crops, sugarcane was major crop with highest share in FS-V (31.67%) followed by FS-III (31.49%). Due to availability of sugar factories and regulated jaggery market in Anakapalle, the area under sugarcane was more in Visakhapatnam district. Other annual crop found in all farming systems except FS-VI was betel leaf. Due to the high-altitude zone in the district, coffee was another perennial crop observed in FS-II, FS-III and FS-V along with coconut, cashew nut, mango, teak *etc*. The Cropping Intensity (CI) was highest in FS-VI (226%) followed by FS-V (224%), FS-III (219%), FS-II (216%) and FS-I (213%).

Paddy was the main crop in all of the farming systems in the Visakhapatnam district, according to Table 3. Both FS-II and FS-III reported that 0.77 hectares of average area under paddy crop. Among millet crops, maize crop was found in all farming systems with an average area ranging from 0.25 ha (FS-III) to 0.10 ha (FS-V). Other millet crops grown in the Visakhapatnam were *ragi*, *sama* and bajra. Minor millets were mostly raised by tribal people of high-altitude region. Sunflower crop was noticed in FS-II (0.07 ha), FS-III (0.12 ha) and FS-V (0.07 ha) along with groundnut and sesame. In addition to sugarcane and banana, betel leaf was another annual crop noticed in all farming systems except FS-VI. The average area under sugarcane was highest in FS-III with an area of 0.70 ha followed by FS-V (0.55 ha) and FS-II (0.43 ha). Coffee plantations were particularly observed in Visakhapatnam in FS-II (0.10 ha), FS-III (0.12 ha) and FS-V (0.05 ha). However, in Visakhapatnam district, dairy activity was observed in FS-II, FS-V and FS-VI because of presence of Visakha Dairy Unit and their procurement units at Village level. Poultry component was seen in FS-III and FS-V. Sheep and goat rearing were observed in FS-VI along with crops and dairy.

B. Cost return structure of major farming systems in Visakhapatnam district

(i) Farming System-I (Crops alone). The major share in total cultivated land in FS-I was occupied by paddy and sugarcane, but recorded negative net returns of Rs. -10190 and Rs. -10140 with BCRs of 0.83 and 0.87 respectively (Table 4). The main reason for negative net returns were increased human labour wage coupled with their labour intensiveness. Maize, betel leaf and teak were the most profitable crops with BCRs of 1.49, 1.50 and 5.61 in seasonal, annual and perennial crop categories respectively. Majority of farmers grew maize under zero tillage method where cost of production was less due to lack of initial land preparation. For the entire farming system, the net returns over the total cost of cultivation were Rs. 32337.5 and the BCR was 1.12.

(ii) Farming System-II (Crop + Dairy). From the Table 4, it was clear that *bajra*, betel leaf and teak were the remunerative crops with BCRs of 1.41, 1.54 and 5.62 respectively. The demand for betel leaves was high eventhough betel leaf cost of cultivation was high. Along with crops, dairy was other activity found in the FS-II of Visakhapatnam district with an average number of 1.66 animals per farm. The total cost of maintenance for dairy animals was Rs. 61217 with an annual return of Rs. 67789 per farm. Minor millet crops *viz., ragi* and *sama* were non profitable as they gave negative net returns of Rs. -282 and Rs. -361 respectively. The reason behind negative returns were lack of proper supervision after sowing. Farmers leave the crops to rain for irrigation. The farming system as a whole received an income of Rs. 369542 with total cost of Rs. 337749 and BCR of 1.09.

(iii) Farming System-III (Crop + Poultry). Poultry was the non-crop enterprise observed in this farming system along with crops. The number of birds per farm was 2016 with maintenance cost of Rs. 317028 and gave gross income of Rs. 425330 with a return of Rs. 1.12 per each rupee investment. Among the perennial crops, coconut was profitable with net returns of Rs. 13243 over total cost of Rs. 13246. For perennial crops, there is less cost of production after initial gestation period. The net returns from betel leaf were Rs. 18035 with Benefit Cost Ratio of 1.47. Both paddy and sugarcane were non profitable crops with a BCR of 0.86 and 0.85 respectively. Crop and poultry net returns were Rs. 15760 and Rs. 124062, respectively. The BCR for the entire farming system was 1.19.

(iv) Farming System-V (Crop + Dairy + Poultry). According to the statistics shown in Table 4, paddy and sugarcane both witnessed Benefit Cost Ratios of 0.85 and net returns of Rs. -7952 and Rs. -17685, respectively. Labour intensiveness, lower yields and small holdings which not let mechanization were the major problems for these negative returns. Coconut was profitable among perennial crops identified with a net return of Rs. 6949. The BCR of betel leaf was 1.51 which gave an income of Rs. 19471. The number of dairy animals and poultry birds per farm were 1.73 and 990 with a BCR of 1.09 and 1.41 respectively.

(v) Farming System-VI (Crop + Dairy + Sheep & goat). This system consisted of dairy and sheep & goat rearing along with crops as non-crop enterprises. The total cost of crops, dairy and sheep & goat rearing were Rs. 162942, Rs. 55535 and Rs.67114 respectively (Table 4). The BCRs from crops, dairy and sheep & goat components were 1.17, 1.09 and 1.86. Sheep and goat were mostly raised by grazing public lands which hardly costs anything to the owner. The total costs and returns for whole farming system were Rs. 285591 and Rs. 373609 with return per rupee investment of 1.31.

In Visakhapatnam district, FS-VI was the most profitable farming system where dairy and sheep & goat components were practiced along with crops. My results were in accordance with results of Nedunchezhian and Thirunavukkarasu (2009), who also got BCR of 2.25 for the farming system consisted of crops, dairy and sheep & goat. Similar outcomes were obtained by Sachinkumar *et al.* (2012) in rural Belgaum, Karnataka. The farming systems with poultry as allied activity (FS-III and FS-V) were the next best farming systems in Visakhapatnam district. The FS-II (Crops + Dairy) was least profitable farming system with BCR of 1.09 as the cost maintenance of dairy became costly. Ponnusamy and Devi (2017) also reported lower BCR in farming system with crops and dairy components.

C. Resource use efficiency in major farming systems of Visakhapatnam district

Table 6 lists the efficiency measures (CRS and VRS) and descriptive information for each farming system. According to Ferriera (2005), "efficient farms" were defined as those that operated at 0.90 or higher ratings.

(i) Farming system-I (Crops alone). Only 26.67% of farms subject to the CRS assumption were run at an efficiency level of 0.90 or above, as can be shown from Table 6. Technical efficiency ratings ranged from 0.314 to 1. The remaining 73.33 percent of farms, which did not function at maximum efficiency, might lower their input usage by 27.92 percent to achieve maximum efficiency, as reached by 26.67 percent of farms, because the average efficiency score was 0.731. The mean technical efficiency score climbed to 0.893 by increasing the percentage of efficient farms to 73.33 when VRS was determined by relaxing the idea of constant returns. In terms of scale efficiency, a mean technical efficiency of 0.828 was achieved on roughly 44.44% of farms, which corresponds to an optimal level of efficiency (ϴ ≥0.90).

(ii) Farming system-II (Crops + Dairy). According to CRS assumption, 22 out of 41 farms in FS-II were run efficiently, accounting for 53.66 percent of all farms with scores of 0.90 or higher. Since the technical efficiency score was on average 0.845, there was opportunity to cut the input level by 15.46%. The average efficiency score for VRS increased to 0.907, and approximately 27 farms operated at their highest level of efficiency (65.85%). Regarding scale efficiency, 30 out of 41 farms (73.17%), were run at maximum efficiency, with a mean technical efficiency score of 0.932.

(iii) Farming system-III (Crops + Poultry). According to Table 6, 60% of farms operating under the CRS assumption had an efficiency level of 0.90 or higher. The average technical efficiency for FS-III was 0.767, indicating an excessive use of inputs. 11 out of 18 farms *i.e.,* 61.11% of all farms, were operating at maximum efficiency when the VRS assumption was introduced, with an average technical efficiency score of 0.866. 9 out of 18 farms (50%) had efficiency levels of 0.90 or higher according to the scale efficiency assumption.

(iv) Farming system-V (Crops + Dairy + Poultry). There was potential to decrease the input level by 13.79%, as indicated by the mean technical efficiency value (0.862) under CRS. In comparison to 65.38 percent of farms operating efficiently under VRS, over 57.69 percent of farms in FS-V doing so. The lowest and highest technical efficiency scores under VRS were 0.446 and 1, respectively. The average increase in technical value was 0.926. In terms of scale efficiency, 76.92% of farms were run at the maximum level of efficiency *i.e.,* Θ ≥0.90.

(v) Farming system-VI (Crops + Dairy + Sheep & goat). According to the CRS, 60% of farms were inefficient since there was a 16.24% excess in input utilization, as evidenced by the mean technical efficiency score of 0.838. According to the VRS hypothesis, there were 53.33 percent more efficient farms, raising the mean technical efficiency value to 0.896. Approximately 66.67% of farms were scale-efficient, with a mean technical efficiency of 0.933.

According to the analysis, FS-V of the Visakhapatnam district had the highest percentage of farms operating at their highest levels of efficiency under CRS, followed by FS-II, FS-III, FS-VI, and FS-I. When cropping was coupled with related activities like dairy, poultry, and sheep and goat, farms were more technically efficient. FS-I has the most productive farms under VRS, followed by FS-II, FS-V, FS-III, and FS-VI. FS-V was more effective in terms of scale efficiency.

D. Regions of operation in the production frontier

The distribution of farms on the three zones of the production frontier, or the number of farms with decreasing, increasing, and constant returns to scale, is crucial to understand after determining the technical efficiency of farms, the degree of inefficiency, and the optimal scale of operation. These are computed using the LP convexity constraint methodology specified.

A sub-optimal region of production was being operated by 36.55 percent of farms across all significant farming systems in the Visakhapatnam district (Table 7). Nearly 34.48 per cent were operating in optimal scale of production. In FS-I, the number of farms operating at DRS and IRS were 19 each. The percentage of farms operating at constant returns were high (58.33%) in FS-V.

E. Determinants of resource use efficiency in major farming systems

The factors of RUE of the major farming systems in the Visakhapatnam district of Andhra Pradesh were examined using a log linear regression model. The inputs taken into account for DEA analysis were again used as deciding elements for CRS obtained for major farming systems. Table 8 displayed the regression's results.

(i) Determinants of resource use efficiency in major farming systems of Visakhapatnam district. In FS-II, FS-VI and FS-V of the Visakhapatnam district, the variable feed was the most significant and positively impacting determinant of RUE. In FS-II and FS-VI, fertilizer was negatively significant at the 1% level, and in FS-III, at the 5% level. Majority of farmers use more fertilizer than the recommended. The investigations by Saikumar (2005) and Bidari (2014) confirmed that fertilizers had a negative effect on gross revenue. The seed variable was negatively significant at 5% and 1% levels in FS-I and FS-III, respectively. The result of negative significance of seed variable was in accordance with Bidari (2014). PPCs had significant positive influence on RUE in FS-V (1%), FS-III and FS-II (5%). The major annual crop sugarcane was grown with least plant protection measures in Visakhapatnam district. Human labour and fodder were positive and significant in FS-VI at 1 and 5 per cent levels respectively. Biradar (2007) in his study identified human labour had positive impact on gross income. The R^2 value ranged from 0.61 (FS-I) to 0.75 (FS-VI) in major farming systems of Visakhapatnam district.

F. Diversification in major farming systems of Visakhapatnam district

The SID values indicated more diversification in Visakhapatnam district (Table 9). Except FS-III, all other major farming systems were highly diversified. In FS-III, poultry was major enterprise and farmers focus more on it. Hence, diversification was comparatively low in FS-III. The diversification index of farming system ranged from 0.67 (FS-III) to 0.87 (FS-I & II). The major income contribution from poultry component reduced the SID value in FS-III. The Pearson's correlation coefficient was negative (-0.92) when found the relationship between diversification index values of farming systems and corresponding profitability. The results were not in lines with Basantaray and Nancharaiah, (2017) work on crop diversification and income. The main reason for it was the contribution of allied activities in gross income was more when compared to crops all together.

G. Inter-linkages in major farming systems of Visakhapatnam district

The results from Table 10 again proved that the farming system with sheep & goat was less dependent on markets for inputs. The MDR was lowest 0.60 with in FS-VI against the highest MDR of 0.88 recorded in FS-III. For sheep and goat rearing, farmers use to nurture them by grazing public lands and hills. Whereas, poultry component was completely depending on market for its feed and medicine. FS-II was the next best farming system in utilizing the inputs efficiently after FS-VI. Dairy component uses by-products of crops as feed which helped the FS-II to depend less on markets. Similar results were expressed by Khadese (2002) from his study.

H. Marketing constraints in the major farming systems of Visakhapatnam district

'Non remunerative price of product, appeared to be top most marketing constraint identified in all the major farming systems of Visakhapatnam district (Table 11). It is not possible to meet all the expenses incurred as the cost of production increasing year by year without much improvement in yields. This problem existing for both crop and non-crop components. Except in FS-III, 'price fluctuations' and 'high transportation costs' were next major problems noticed in all other major farming systems of Visakhapatnam. Due to less marketable surplus and increased transportation cost, farmers were forced to sell their product in the village itself at price offered by local merchant. 'Lack of marketing information' was next major problem in FS-II, FS-V and FS-VI of Visakhapatnam district. Due of their illiteracy, the majority of farmers were unaware of market prices. 'Lack of storage facilities' also one of the prime reasons to sell the produce to local merchant. Exploitation by middlemen, lack of regulated markets and mal practices in weighment were other minor marketing problems found in the study area.

Suggested policy implications to implement profitable farming systems and to enhance farmer's income:

The price received by the farmer while marketing the produce was less than the MSP in every farming system. Selling the produce at Government procuring agencies will help the farmers to get support price which is higher than the price paid by middlemen for income enhancement.

Processing of the raw product can fetch higher price in any crop as is proved in case of oil seed crops. Infrastructural facilities for value addition may be made available in the village and the farmers are to encouraged in growing these crops on large scale and practice value addition for final marketing rather than raw form.

Diversification towards high value crops is another measure to increase margin of farmer's income and also as a measure to mitigate risk and uncertainty in Agriculture.

Cost minimization by optimum resource use and high level of farm mechanization will further add income at farm level, besides reducing pressure on human labour availability.

Government should focus on establishment of community storage facilities at panchayat level to hinder the forced sales by the farmers.

Selling of the less marketable surplus of individual farmers through FPOs will increase the bargaining power, thereby increases the profits.

The regulated markets should be enriched with basic infrastructural facilities like cold storage, godown, market information dissemination boards, scientific grading and weighing technologies *etc*. to lessen marketing costs and increase marketing efficiency.

Among non-crop enterprises, sheep & goat rearing was most profitable. However, because of the negative social stigma associated with it, only small farmers have gotten into raising sheep and goats. The cost of maintenance was low when compared with poultry and dairy enterprises. Rao and Prasad (2011) were also opined same from their study.

The outreach of ACABS (Agri-Clinics and Agri-Business Centres) should be increased to grab the attention of more farmers for utilizing the services rendered by them and also to attract rural youth in farming activities.

A major observation across all the farming systems was yield gaps at various levels. Bridging the yield gaps by adopting recommended packages of practices, suitable varieties and improved technologies will enhance the farmer's income.

The high dosages of fertilizer and pesticides application can be tackled with low-cost bio-fertilizers and bio-pesticides.

Establishment of custom hiring service centres at mandal level will provide better access to farmers towards mechanization. Custom hiring service centres are effective to introduce capital intensive, high quality and efficient farm machinery to the small and marginal farmers.

Millet crops with less cost of production may be encouraged to have increased farm income and also as an alternative crops to labour intensive and less profitable traditional corps.

Inter-cropping to have diversified farm income and extensive farming can be increased.

Dairying as a complementary component of all farming systems can be encouraged through different initiatives taken up by Department of Animal Husbandry. The same suggestion was given by Radha *et al.*, (2002) from their study on livestock based farming systems.

Establishment of agro-based industries in the village itself not only helps the farmers to go for processing and value addition activities, but also provides additional employment opportunities to the rural poor.

The identified profitable farming systems in the district needs to be promoted by arranging necessary inputs and marketing facilities

Extension activities and institutional support like credit, market intelligence and infrastructural facilities could be strengthened.

Table 1: Farming systems practiced by the sample respondents in the study area.

Sr. No.	Farming systems (FS)	Visakhapatnam (N=160)	
		No.	% to total
I	C	**45**	**28.13**
II	C+D	**41**	**25.63**
III	C+P	**18**	**11.25**
IV	C+S&G	6	3.75
V	C+D+P	**26**	**16.25**
VI	C+D+S&G	**15**	**9.38**
VII	C+P+S&G	3	1.88
VIII	C+D+P+S&G	3	1.88
IX	C+Mu	1	0.67
X	C+F	2	1.25
	Total	160	100

Note: C= Crops, D= Dairy, P= Poultry, S&G= Sheep & Goat, Mu= Mushroom unit, F=Floriculture

Table 2: Cropping pattern of major farming systems of Visakhapatnam district.

Sr. No.	Season/year	Crop wise area under farming systems				
		FS-I	FS-II	FS-III	FS-V	FS-VI
1.	***Kharif* crops**					
	Paddy	32.64 (40.38)	31.48 (40.95)	13.94 (34.64)	15.68 (34.85)	9.21 (48.78)
	Maize	3.58 (4.43)	3.66 (4.76)	1.86 (4.62)		
	Cotton	2.64 (3.27)				
	Ragi	2.62 (3.24)	1.95 (2.54)	1.64 (4.08)	1.32 (2.93)	
	Bajra	1.60 (1.98)	1.42 (1.85)			
	Sama	1.34 (1.66)	1.35 (1.76)			
	Total *kharif*	**44.42 (54.95)**	**39.86 (51.85)**	**17.44 (43.34)**	**17.00 (37.79)**	**9.21 (48.78)**
2.	***Rabi* crops**					
	Blackgram	8.60 (10.64)	7.56 (9.83)	2.35 (5.84)	4.37 (9.71)	2.12 (11.23)
	Greengram	7.24 (8.96)	7.82 (10.17)	1.96 (4.87)	3.18 (7.07)	1.83 (9.69)
	Groundnut	4.18 (5.17)	3.66 (4.76)		2.35 (5.22)	
	Sunflower	4.85 (6.00)	2.75 (3.58)	2.15 (5.34)	1.79 (3.98)	
	Sesame	6.22 (7.70)	5.88 (7.65)	4.33 (10.76)	2.14 (4.76)	2.75 (14.57)
	Maize	5.40 (6.68)	6.36 (8.27)	2.73 (6.78)	2.62 (5.82)	2.00 (10.59)
	Ragi	4.14 (5.12)	3.34 (4.34)	3.16 (7.85)		
	Total *rabi*	**40.63 (50.27)**	**37.37 (48.61)**	**16.68 (41.45)**	**16.45 (36.56)**	**8.70 (46.08)**
3.	**Annual crops**					
	Sugarcane	16.62 (20.56)	17.44 (22.69)	12.67 (31.49)	14.25 (31.67)	4.28 (22.67)
	Banana	1.68 (2.08)	2.26 (2.94)	-	-	
	Betel leaf	3.75 (4.64)	2.65 (3.45)	1.65 (4.10)	2.58 (5.73)	
	Total	**22.05 (27.28)**	**22.35 (29.08)**	**14.32 (35.59)**	**16.83 (37.41)**	**4.28 (22.67)**
4.	**Perennial crops**					
	Coconut	3.22 (3.98)	3.88 (5.05)	2.78 (6.91)	2.13 (4.73)	1.25 (6.62)
	Cashew nut	3.02 (3.74)	2.72 (3.54)	1.86 (4.62)	2.00 (4.44)	
	Mango	3.20 (3.96)	2.60 (3.38)	1.60 (3.98)	3.80 (8.45)	
	Teak	1.20 (1.48)	2.56 (3.33)			2.00 (10.59)
	Casuarina	2.00 (2.47)			1.75 (3.89)	
	Eucalyptus	1.75 (2.17)				1.68 (8.90)
	Coffee		4.22 (5.49)	2.24 (5.57)	1.48 (3.29)	
	Total	**14.39 (17.80)**	**14.66 (19.07)**	**8.48 (21.07)**	**11.16 (24.81)**	**5.39 (28.55)**
5.	**Dairy (No.)**		68		45	21
	a. Cows		45		30	13
	b. Buffaloes		23		15	8
6.	**Poultry (No.)**			66297	25752	
7.	**Sheep & Goat (No)**					565
	NCA	80.83 (100)	76.87 (100)	40.24 (100)	44.99 (100)	18.88 (100)
	GCA	172.32	165.91	88.20	100.59	42.64
	CI (%)	213	216	219	224	226

Note: Figures in parentheses indicate percentage to the respective net cultivated area
NCA=Net Cropped Area, GCA=Gross Cropped Area and CI=Cropping Intensity

Table 3: Components of major farming systems (per farm) in the Visakhapatnam district.

District	Farming systems	No. of respondents	Components
Visakhapatnam	FS-I (C)	45	Seasonal crops: Paddy (0.72), Maize (0.2), *ragi* (0.15), *bajra* (0.03), blackgram (0.19), greengram (0.16), *sama* (0.03), groundnut (0.09), sunflower (0.11), sesame (0.14), cotton (0.06) Annual crops: sugarcane (0.37), banana (0.03), beetle leaf (0.08) Perennial crops: coconut (15.07), cashewnut (7.55), mango (7.33), teak (0.03), eucalyptus (0.04), casuarina (0.04)
	FS-II (C+D)	41	Seasonal crops: Paddy (0.77), Maize (0.24), *ragi* (0.13), *bajra* (0.03), blackgram (0.18), greengram (0.19), groundnut (0.09), sunflower (0.07), sesame (0.14), *sama* (0.03) Annual crops: sugarcane (0.43), banana (0.05), beetle leaf (0.06) Perennial crops: coconut (18.54), cashewnut (7.68), mango (6.71), coffee (0.10), teak (0.06) Dairy: Milch cattle- 1.66 (Cows: 45, Buffaloes: 23)
	FS-III (C+Po)	18	Seasonal crops: Paddy (0.77), Maize (0.25), *ragi* (0.27), blackgram (0.13), greengram (0.11), sunflower (0.12), sesame (0.24), Annual crops: sugarcane (0.70), betel leaf (0.09) Perennial crops: coconut (26.39), cashewnut (11.39), mango (10.28), coffee (0.12)

			Poultry: 2016
	FS-V (C+D+Po)	26	Seasonal crops: Paddy (0.60), Maize (0.10), *ragi* (0.05), blackgram (0.17), greengram (0.12), groundnut (0.09), sunflower (0.07), sesame (0.08), Annual crops: sugarcane (0.55), betel leaf (0.10) Perennial crops: coconut (14.23), cashewnut (8.46), mango (15.96), casuarinas (0.06), coffee (0.05) Dairy: Milch cattle-1.73 (Cows: 30, Buffaloes: 15) Poultry: 990
	FS-VI (C+D+S&G)	15	Seasonal crops: Paddy (0.61), Maize (0.13), blackgram (0.14), greengram (0.12), sesame (0.18), Annual crops: sugarcane (0.28), Perennial crops: coconut (15.33), teak (0.13), eucalyptus (0.11) Dairy: Milch cattle-1.40 (Cows: 13, Buffaloes: 8) Sheep & Goat: 37.66 (Sheep=446 & Goat=119)

Note: Figures in the parentheses indicate area in ha. for seasonal, annual crops and forest plantations (teak, eucalyptus, casuarinas, coffee) and numbers for perennial crops (coconut, cashewnut, mango), cattle, sheep & goat and poultry birds.

Table 4: Cost return structure of the major farming systems in the study area.

Sr. No.	Components of FS	FS-I			FS-II			FS-III			FS-V			FS-VI		
		TC (Rs)	GR (Rs)	BCR	TC (Rs)	GR (Rs)	BCR	TC (Rs)	GR (Rs)	BCR	TC (Rs)	GR (Rs)	BCR	TC (Rs)	GR (Rs)	BCR
	CROPS															
1	Paddy	61644	51453	0.83	69885	57869	0.83	66243	56717	0.86	53757	45805	0.85	55810	45780	0.82
2	Maize	15143	22545	1.49	19129	26408	1.38	19079	28054	1.47	7969	10818	1.36	10316	14093	1.37
3	Ragi	6840	6617	0.97	6171	5889	0.95	13032	11982	0.92	2284	2381	1.04			
4	Bajra	782	1090	1.39	801	1128	1.41									
5	Sama	718	465	0.65	758	501	0.66									
6	Blackgram	4061	5639	1.39	3872	5032	1.30	2838	3681	1.30	3640	4748	1.30	3054	3985	1.30
7	Greengram	3317	4780	1.44	4159	5724	1.38	2414	3324	1.38	2520	3439	1.36	2611	3637	1.39
8	Groundnut	7247	8108	1.12	7224	7928	1.10				7422	8181	1.10			
9	Sunflower	5691	5140	0.90	3659	3298	0.90	6353	5605	0.88	3597	3298	0.92			
10	Sesame	5675	5980	1.05	5743	5854	1.02	10107	9619	0.95	3296	3111	0.97	8116	7360	0.91
11	Cotton	5908	5970	1.01												
12	Sugarcane	77852	67712	0.87	91566	79087	0.86	149149	126914	0.85	116809	99124	0.85	59107	49261	0.83
13	Banana	5558	6024	1.08	9391	10123	1.08									
14	Betel leaf	33935	50851	1.50	25549	39408	1.54	38375	56410	1.47	38321	57792	1.51			
15	Coconut	8143	14457	1.78	9717	17824	1.83	13246	26489	2.00	7361	14311	1.94	7939	15194	1.91
16	Cashewnut	5919	8111	1.37	6155	8251	1.34	8732	12237	1.40	6477	9089	1.40			
17	Mango	6659	9176	1.38	6078	8400	1.38	9130	12870	1.41	14520	19980	1.38			
18	Teak	1313	7370	5.61	2624	14740	5.62							6080	31936	5.25
19	Casuarina	3650	6918	1.90							5429	9842	1.81			
20	Eucalyptus	3415	7329	2.15										9909	19906	2.01
21	Coffee	1592	1663	1.04	4051	4289	1.06	4697	5258	1.12	1947	2080	1.07			
	All crops	265062	297398	1.12	276532	301753	1.09	343395	359160	1.05	275349	293999	1.07	162942	191152	1.17
22	**Dairy**				61217	67789	1.11				68067	73900	1.09	55535	57373	1.09
23	**Poultry**							317028	425330	1.34	150463	212722	1.41			
24	**Sheep & Goat**													67114	125084	1.86
	Total	265062	297398	**1.12**	337749	301753	**1.09**	660423	784490	**1.19**	493879	580621	**1.18**	285591	373609	**1.31**

*TC= Total Costs, GR= Gross Returns, BCR= Benenfit Cost Ratio, Rs.= Rupees

Table 5: Comparative economics of the major farming systems in the study area

Sr. No.	Farming systems	Total variable costs (TVC)	Total fixed costs (TFC)	Total costs (TC)	Gross returns (GR)	Net returns over TC	Net returns over TVC	BCR
1.	FS-I	195859	69230	265062	297398	32337	101539	1.12
2.	FS-II	207203	69375	337749	369542	31794	162339	1.09
3.	FS-III	563037	97435	660423	784490	124062	221453	1.19
4.	FS-V	406011	87896	493879	580621	86742	174610	1.18
5.	FS-VI	231191	54758	285591	373609	88018	142418	1.31

Table 6: Efficiency measures and descriptive statistics across major farming systems in Visakhapatnam district according to scale of operations.

Scale of operations	No. of respondents	Efficient farms (θ ≥ 90)		Efficiency measures			
		No.	%	Mean	SD	Max.	Min
FS-I							
Technical efficiency (Constant returns)	45	12	26.67	0.7308	0.2049	1	0.314
Technical efficiency (Variable returns)		33	73.33	0.8929	0.1861	1	0.317
Scale efficiency		20	44.44	0.8277	0.1732	1	0.407
FS-II							
Technical efficiency (Constant returns)	41	22	53.66	0.8454	0.1640	1	0.518
Technical efficiency (Variable returns)		27	65.85	0.9066	0.1331	1	0.586
Scale efficiency		30	73.17	0.9324	0.1087	1	0.597
FS-III							
Technical efficiency (Constant returns)	18	9	50.00	0.7674	0.2608	1	0.268
Technical efficiency (Variable returns)		11	61.11	0.8656	0.1927	1	0.394
Scale efficiency		9	50.00	0.8668	0.1612	1	0.455
FS-V							
Technical efficiency (Constant returns)	26	15	57.69	0.8621	0.1882	1	0.446
Technical efficiency (Variable returns)		17	65.38	0.9301	0.1161	1	0.577
Scale efficiency		20	76.92	0.9208	0.1356	1	0.538
FS-VI							
Technical efficiency (Constant returns)	15	6	40.00	0.8376	0.1492	1	0.556
Technical efficiency (Variable returns)		8	53.33	0.8956	0.1131	1	0.681
Scale efficiency		10	66.67	0.9330	0.0925	1	0.683

Table 7: Distribution of respondents in major farming systems of Visakhapatnam District according to type of returns among different scale of operations.

Type of returns to scale	FS-I	FS-II	FS-III	FS-V	FS-VI	Total
Increasing (IRS)	19 (42.22)	14 (34.15)	7 (38.89)	8 (30.77)	5 (41.67)	53 (36.55)
Constant (CRS)	7 (15,55)	15 (36.56)	8 (44.44)	13 (50)	7 (58.33)	50 (34.48)
Decreasing (DRS)	19 (42.22)	12 (29.27)	3 (16.67)	5 (19.23)	3 (20)	42 (28.97)
Total	45 (100)	41 (100)	18 (100)	26 (100)	15 (100)	145 (100)

Note: Figures in parenthesis indicating the percentage of farms

Table 8: Determinants of Resource Use Efficiency (CRS) in major farming systems of Visakhapatnam district.

Variables	FS-I	FS-II	FS-III	FS-V	FS-VI
Intercept	0.757087	0.876091	0.756047	1.36111	0.938473
Human labour (Man-days)	-0.0027 (0.009)	0.0074 (0.005)	-0.0358 (0.027)	0.1275 (0.099)	0.1372** (0.031)
Machine labour (hrs)	0.0038** (0.001)	-0.0014 (0.009)	-0.1173 (0.441)	0.0084 (0.007)	-0.1618 (0.133)
Seed (kgs)	-0.1025* (0.004)	0.2665 (0.177)	-0.7799** (0.055)	0.0574** (0.019)	-0.5573 (0.318)
FYM (t)	0.0039 (0.007)	0.0084** (0.002)	0.0354* (0.016)	0.0160 (0.012)	0.0993 (0.137)
Fertilizers (kgs)	-0.0322 (0.022)	-0.0848** (0.007)	-0.0047* (0.002)	0.1189* (0.045)	-1.6641** (0.099)
PPCs (lts)	0.0748 (0.061)	0.0514* (0.025)	0.1109* (0.051)	0.0973** (0.024)	-0.0454 (0.028)
Fodder		-0.0053 (0.066)		0.0114 (0.017)	0.0582* (0.022)
Feed		1.3375** (0.276)	0.0739 (0.018)	0.1191* (0.055)	0.6889** (0.115)
Veterinary medicine		0.0914(0.117)	-0.7429(1.192)	-0.0127(0.008)	0.1419(0.131)
R^2 value	0.61	0.72	0.68	0.67	0.75

Note: Figures in parentheses indicate standard errors of respective variables,
(*,** significance at 5 and 1 per cent levels respectively)

Table 9: Farming system diversification in major farming systems of Visakhapatnam district.

Sr. No.	Components of FS	FS-I		FS-II		FS-III		FS-V		FS-VI	
		Area (ha)	GR (Rs)	Area (ha)	GR (Rs)	Area (ha)	GR (Rs)	Area (ha)	GR (Rs)	Area (ha)	GR (Rs)
	CROPS										
1.	Paddy	0.72	51453	0.77	57869	0.77	56717	0.60	45805	0.61	45780
2.	Maize	0.20	22545	0.24	26408	0.25	28054	0.10	10818	0.13	14093
3.	Ragi	0.15	6617	0.13	5889	0.27	11982	0.05	2381		
4.	Bajra	0.03	1090	0.03	1128						
5.	Sama	0.03	465	0.03	501						
6.	Blackgram	0.19	5639	0.18	5032	0.13	3681	0.17	4748	0.14	3985
7.	Greengram	0.16	4780	0.19	5724	0.11	3324	0.12	3439	0.12	3637
8.	Groundnut	0.09	8108	0.09	7928			0.09	8181		
9.	Sunflower	0.11	5140	0.07	3298	0.12	5605	0.07	3298		
10.	Sesame	0.14	5980	0.14	5854	0.24	9619	0.08	3111	0.18	7360
11.	Cotton	0.06	5970								
12.	Sugarcane	0.37	67712	0.43	79087	0.70	126914	0.55	99124	0.28	49261
13.	Banana	0.03	6024	0.05	10123						
14.	Betel leaf	0.08	50851	0.06	39408	0.09	56410	0.09	57792		
15.	Coconut	0.07	14457	0.09	17824	0.15	26489	0.08	14311	0.08	15194
16.	Cashewnut	0.07	8111	0.07	8251	0.10	12237	0.08	9089		
17.	Mango	0.07	9176	0.06	8400	0.09	12870	0.15	19980		
18.	Teak	0.03	7370	0.06	14740					0.13	31936
19.	Casuarina	0.04	6918					0.06	9842		
20.	Eucalyptus	0.04	7329							0.11	19906
21.	Coffee	0.04	1663	0.10	4289	0.12	5258	0.05	2080		
	Gross area	2.72		2.79		3.14		2.34		1.78	
	Dairy				67789				73900		57373
	Poultry						425330		212722		
	Sheep & Goat										125084
	Total returns		297398		301753		784490		580621		373609
	SID for FS		0.87		0.87		0.67		0.80		0.82
	Pearson's Correlation Coefficient	-0.92									

Table 10: Market inter-linkages among different components of major farming systems in Visakhapatnam district.

Particulars	FS-I (C)	FS-II (C+D)	FS-III (C+P)	FS-V (C+D+P)	FS-VI (C+D+S&G)
Total value of inputs used	184884	189662	545827	212555	389779
Total value of purchased inputs	157901	144143	478928	172169	232330
MDR for inputs	0.85	0.76	0.88	0.81	0.60

Table 11: Farming system wise RPI for prioritization of marketing problems pertained to Visakhapatnam district.

Sr. No.	Marketing Constraints	Visakhapatnam				
		FS-I	FS-II	FS-III	FS-V	FS-VI
1.	Non remunerative price of product	0.996 (1)	0.992 (1)	0.966 (1)	0.996 (1)	0.989 (1)
2.	Price fluctuations	0.867 (2)	0.892 (2)	0.816 (3)	0.870 (2)	0.842 (2)
3.	High transport cost	0.722 (3)	0.717 (3)	0.844 (2)	0.740 (3)	0.715 (3)
4.	Lack of market information	0.511 (5)	0.612 (4)	0.554 (5)	0.622 (4)	0.644 (4)
5.	Lack of storage facility	0.608 (4)	0.552 (5)	0.598 (4)	0.551 (5)	0.508 (5)
6.	Exploitation of middle men	0.222 (7)	0.261 (7)	0.215 (7)	0.268 (7)	0.270 (7)
7.	Lack of regulated markets	0.322 (6)	0.350 (6)	0.318 (6)	0.344 (6)	0.317 (6)
8.	Malpractices in weighing	0.122 (8)	0.143 (8)	0.158 (8)	0.107 (8)	0.140 (8)

Note: Figures in parentheses indicate corresponding rank

CONCLUSIONS

Unlike other north coastal districts, the area under paddy was comparatively less in Visakhapatnam. Farmers would decrease cost of cultivation by increasing farm mechanization and following recommended dosage of NPK in paddy. Sowing suitable varieties and HYVs could also increase the yield in paddy.Another major crop along with paddy was sugarcane in Visakhapatnam district. The decreased yields in sugarcane were due to growing excess area under rainfed situation. Improper management of ratoon crop, poor plant protection measures and monocropping were other major reasons for lower yields.

The areas under minor millets were comparatively more in Visakhapatnam district, but the yields were very less due to lack of supervision during crop period. Betel leaf and banana were other annual crops recording good returns in the district. However, these two crops need more capital and human labour while growing. Coffee was most lucrative crop if practiced commercially. Girijan Corporations were available to farmers for selling their produce at remunerative prices.

FUTURE SCOPE

This study gave further scope to do research on individual farming systems with large samples and able to suggest optimum farm plans to the farming community for enhancing farm income

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