**MANUSCRIPT TYPE: ORIGINAL RESEARCH ARTICLE**

**Assessment of Organic and Integrated Crop Management Practices in Rice Cultivation in SPSR Nellore District of Andhra Pradesh**

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**ABSTRACT**

**On-Farm Trials** were conducted during the rabi seasons of 2023–24 and 2024–25 at six canal-irrigated locations in SPSR Nellore district, Andhra Pradesh, to evaluate the performance of three rice crop management practices: **Organic Package, Integrated Crop Management (ICM)**, and the prevailing **Farmer’s Practice**, using improved rice varieties RNR-15048 and KNM-1638. The results consistently demonstrated that ICM outperformed both the organic package and farmer’s practice in terms of key growth and yield parameters, including plant height, panicle density (panicles/m²), grains/panicle, test weight and grain yield. ICM recorded the highest mean grain yield (7118 kg/ha), net returns (₹87,907/ha) and benefit-cost ratio (2.05), primarily due to **balanced nutrient management, efficient weed control and effective pest and disease management**. These factors collectively enhanced crop vigour and reduced yield losses, contributing to superior performance. While the organic package resulted in comparatively lower grain yield (5141 kg/ha), it generated economically competitive returns (₹85,581/ha) due to significantly reduced input costs and potential organic market premiums. Importantly, the organic package exhibited a steady increase in yield and profitability over the two-year period, indicating its potential for long-term sustainability. These findings highlight the agronomic and economic superiority of integrated crop management, while also recognizing the emerging viability of organic rice cultivation.

**INTRODUCTION:**

Rice (*Oryza sativa* L.) is a staple food crop for more than half of the global population and plays a pivotal role in ensuring food security in India. In India, it is grown in an area of 46.28 million hectares with a production of 129.47 million tonnes and productivity of 2798 kg/ha. In Andhra Pradesh, it is grown in an area of 2.23 million hectares with a production of 7.76 million tonnes and productivity of 3392 kg/ha ([www.indiastat.com](http://www.indiastat.com), 2022-23). In the state, rice is cultivated extensively under both irrigated and rainfed conditions, contributing significantly to the agrarian economy. However, in recent years, rice productivity in several regions of the state, including SPSR Nellore district, has been constrained by a range of agronomic and environmental challenges. Among these, the excessive application of nitrogen (N) and phosphorus (P) fertilizers, combined with the minimal or non-application of potassium (K) due to its escalating cost, has resulted in widespread nutrient imbalance. Such imbalanced fertilization has not only led to deficiencies of essential micronutrients, particularly zinc, but has also degraded soil health over time. The resulting poor plant nutrition and weakened crop resilience have been associated with increased susceptibility to pests and diseases, thereby contributing to higher pesticide usage and escalating production costs (Peñuelas *et al*., 2023). These issues have raised concerns about the sustainability and profitability of conventional rice farming systems. The traditional farming practices commonly followed by farmers in the region are characterized by deep transplanting, overcrowding of seedlings, unbalanced fertilizer use (notably high nitrogen and phosphorus with limited potassium) and indiscriminate pesticide applications. Such practices not only compromise yield potential but also deteriorate the agro-ecosystem by enhancing susceptibility to biotic stresses, particularly stem borer and brown planthopper (BPH) and inducing micronutrient deficiencies like zinc due to phosphorus antagonism. In this context, alternative crop management strategies such as organic farming and integrated crop management (ICM) are gaining attention. Organic farming emphasizes ecological sustainability through the use of farmyard manure (FYM), vermicompost, biofertilizers and biopesticides, while avoiding synthetic inputs. ICM, on the other hand, offers a balanced approach by integrating organic and inorganic inputs, pest and disease management and improved agronomic practices to optimize productivity and resource use efficiency (Choudhary *et al*., 2020). To assess the comparative effectiveness of these crop management practices, an On-Farm Trial (OFT) was conducted during the *rabi* seasons of 2023-24 and 2024-25 by Krishi Vigyan Kendra, Nellore. The trial aimed to evaluate the impact of an Organic Package, ICM approach and prevailing farmer’s practice on the growth, yield and economics of rice cultivation under canal irrigated conditions across six locations in SPSR Nellore district. This study also aimed to generate location-specific recommendations that promote sustainable intensification and improve livelihood security for rice growing farmers in the region.

**MATERIALS AND METHODS:**

An On-Farm Trial (OFT) was conducted by Krishi Vigyan Kendra, Nellore during the *rabi* seasons of 2023-24 and 2024-25 across six farmer fields in SPSR Nellore district, Andhra Pradesh. The objective was to evaluate the performance of three crop management practices in rice cultivation namely, an organic package, Integrated Crop Management (ICM) and the farmer’s practice. The trials were implemented under canal-irrigated conditions on soils ranging from sandy clay loam to clay loam. Soil analysis of the experimental fields revealed low available nitrogen, high phosphorus and medium potassium levels. The selected sites included Ramannapalem and Basavayapalem villages in Kodavaluru mandal, Penuballi village in Buchireddypalem mandal, Edagali village in Venkatachalam mandal and Mallikarjunapuram village in Thotapalligudur mandal. Details of seasonal rainfall during the study period are presented in Table 1 and the specific technological interventions demonstrated under each treatment are provided in Table 2. The crop was transplanted during the second fortnight of December. Observations were recorded on key agronomic parameters including plant height (cm), number of hills/m2, number of panicle/m2, number of grains/panicle and test weight (g). At physiological maturity, a net plot area of 5 × 5 m was harvested and the produce was threshed. The grains were cleaned and dried to appropriate moisture levels before weighing and the yield was computed and expressed in kilograms/hectare (kg/ha). A comprehensive economic analysis was conducted to evaluate the profitability of each treatment implemented under the On-Farm Trial. Detailed records were maintained at all the trial locations regarding field operations, including labour employed, power usage and the type and quantity of inputs utilized such as seeds, fertilizers, organic amendments and plant protection materials. The total cost of cultivation was computed by dividing the expenses into fixed and variable components. Fixed costs included expenditures that were common across all treatments, such as seeds, land preparation (including ploughing and levelling), irrigation and general field maintenance. In contrast, variable costs were treatment-specific and varied depending on the nature and quantity of inputs used. For instance, the organic package incurred additional expenses for farmyard manure, vermicompost, biofertilizers and organic pest control measures, while the integrated crop management approach involved the use of chemical fertilizers, pesticides and micronutrients. Labour costs associated with input application and harvesting were also included under variable costs. The total cost of cultivation for each treatment was obtained by adding the treatment-specific variable costs to the fixed costs. Gross returns were calculated based on the actual grain yield and the prevailing market price received by the farmers. Net returns were determined by subtracting the total cost of cultivation from the gross returns. The return per rupee invested, or benefit-cost ratio, was calculated by dividing the gross return by the total cost of cultivation, providing an index of economic efficiency for each treatment.

**RESULTS AND DISCUSSION**

### ****Growth and Yield Attributes****

The effect of different crop management practices on growth and yield parameters of rice is summarized in Table 1. Significant variation in plant height was recorded across treatments, with the highest average height observed under Integrated Crop Management (96.1 cm), followed by farmer’s practice (92.9 cm) and the lowest in the organic package (89.2 cm). The reduced height under organic package may be attributed to the slow release and limited availability of nutrients from organic sources compared to chemical fertilizers used in ICM and farmer’s practice. Despite these differences, the number of hills per square meter remained uniform (17 hills/m²), owing to consistent transplanting techniques and uniform seedling age (25 days). Notably, panicle density varied significantly across treatments. ICM recorded the highest panicle number (457 panicles/m²), followed by farmer’s practice (436 panicles/m²), while organic package registered the lowest (330 panicles/m²). A similar trend was observed in the number of grains/panicle, with ICM achieving the maximum (181), followed by farmer’s practice (168) and organic package (141). Test weight was marginally higher under ICM (13.87 g) compared to farmer’s practice (13.79 g) and organic package (13.61 g). These results highlight the advantage of ICM in ensuring timely and balanced nutrient availability and effective plant protection, thereby enhancing reproductive efficiency and yield components (Khatun *et al*., 2018). Although organic package yielded lower values for most yield attributes, the consistent improvement over two years suggests it’s potential to enhance crop productivity under continuous adoption.

### ****Grain Yield and Economic Performance****

The yield and economic data presented in Table 2 reflect the agronomic performance trends. ICM achieved the highest mean grain yield (7118 kg/ha), followed by farmer’s practice (6651 kg/ha) and organic package (5141 kg/ha). The superior performance under ICM is attributable to its integrated approach, which included balanced fertilization (120-60-40 NPK kg/ha), optimal transplanting (2-3 cm depth with 2-3 seedlings/hill) and combined chemical and biological pest management. This comprehensive strategy likely contributed to higher nutrient-use efficiency and reduced biotic stress (Wang *et al*., 2017). In terms of economics, ICM recorded the highest net returns (₹87,907/ha) and benefit-cost ratio (2.05). Interestingly, organic package achieved net returns of ₹85,581/ha and a B:C ratio of 1.79, nearly comparable to FP (₹71,096/ha and 1.80). Furthermore, organic package showed a marked improvement from 2023-24 to 2024-25, with net returns increasing from ₹63,408/ha to ₹1,07,754/ha and B:C ratio from 1.61 to 1.97. These results underscore the potential economic viability of organic cultivation through reduced input costs, premium market pricing and improved system productivity over time.

### ****Technological Interventions and Adoption Considerations****

The organic package emphasized agroecological sustainability by incorporating practices such as green manuring with Sesbania aculeata, FYM, vermicompost, neem cake and biofertilizers (Azospirillum, phosphate solubilizing bacteria (PSB) and potassium-releasing bacteria (KRB). Weed suppression was achieved through Azolla mulching and manual weeding, while pest and disease management relied exclusively on biocontrol agents (Pseudomonas fluorescens, Beauveria bassiana and Metarhizium anisopliae), promoting soil health and biodiversity. ICM integrated FYM, chemical fertilizers, seed treatment with fungicides and a judicious blend of biological and chemical crop protection methods, offering a balance between productivity and sustainability (Ferdous *et al*., 2018). Prior studies affirm that integrating biofertilizers with chemical fertilizers and green manures enhances nutrient availability and crop productivity (Gautam *et al*., 2008; Ghosh *et al*., 2013; Mondal *et al*., 2015; Kumar & Yadav, 2008; Sarwar *et al*., 2017). Moreover, combined application of FYM and green manures significantly improved available NPK status in soils (Kejiya *et al*., 2024), while zinc application as foliar spray or soil amendment also contributed positively to yield components (Suman & Sheeja, 2018; Singson, 2024). In contrast, the farmer's practice involved unscientific agronomic approaches, including deep transplanting (>8 cm), excessive seedling density (4-6 seedlings/ hill), and imbalanced nutrient management characterized by the application of high doses of nitrogen (160 kg/ha) and phosphorus (73 kg/ha), primarily through complex fertilizers, with suboptimal potassium input (28 kg/ha). The excessive phosphorus application is known to induce zinc deficiency by precipitating zinc in the soil and thereby reducing its availability to plants. Furthermore, the nutrient imbalance and dense canopy conditions favored higher incidence of insect pests and diseases, particularly Scirpophaga incertulas (yellow stem borer) and Nilaparvata lugens (brown planthopper).

**CONCLUSION:**

Integrated Crop Management (ICM) demonstrated superior performance in terms of grain yield and economic returns, attributable to its comprehensive approach involving balanced nutrient management, timely pest and weed control and optimized agronomic practices. Although the organic package resulted in comparatively lower yields, it exhibited a consistent upward trend in productivity and profitability, indicating its potential under sustainable production systems. In contrast, the farmer’s practice, characterized by imbalanced fertilization and suboptimal crop establishment, led to reduced yield performance and increased pest incidence. The findings highlight the importance of promoting resource-efficient and ecologically sound crop management strategies. ICM may be recommended for wider adoption to enhance productivity and farm income, while organic practices warrant gradual promotion through institutional support to strengthen long-term sustainability in rice cultivation systems.

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**Table 1: Rainfall Particulars of SPSR Nellore District in 2023-24 and 2024-25**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Normal Rainfall** | **2023-24** | | **2024-25** | |
| **Actual** | **Deviation** | **Actual** | **Deviation** |
| June | 51.9 | 19.2 | -63 | 71.1 | 37 |
| July | 81.5 | 81.5 | 0 | 125.9 | 54 |
| August | 83.5 | 34.1 | -59 | 44.4 | -47 |
| September | 103.5 | 83.3 | -20 | 74.9 | -28 |
| October | 249.1 | 20.6 | -92 | 347.9 | 40 |
| November | 297.7 | 258.1 | -13 | 193.2 | -35.1 |
| December | 99.1 | 297.4 | 200 | 202.6 | 104.4 |
| January | 12.5 | 0.3 | -97 | 2.9 | 40 |
| February | 5.4 | 0.0 | -100 | 0.0 | -35.1 |
| **Total** | **993.8** | **794.4** | **-19** | **1066.5** | **7.3** |

**Table 2: Comparative Details of Demonstrated Technologies in OFTs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **Particulars** | **T1: Organic Package** | **T2: ICM** | **T3: Farmer Practice** |
| 1 | Variety | RNR-15048 (2023-24),  KNM-1638 (2024-25) | RNR-15048 (2023-24),  KNM-1638 (2024-25) | RNR-15048 (2023-24),  KNM-1638 (2024-25) |
| 2 | Seed rate | 62.5 kgs/ha | 62.5 kgs/ha | 62.5 kgs/ha |
| 3 | Green manuring | Dhaincha @ 25 kgs/ha | Dhaincha @ 25 kgs/ha | Not adopted |
| 4 | Farm yard manure | 10 t/ha FYM | 2.5 t/ha FYM | Not adopted |
| 5 | Zinc sulphate application | Not adopted | Zinc Sulphate - 25 kg/ha  (Basal application) | Zinc Oxide 39.5% SC @ 625 ml/Acre (Foliar application) |
| 6 | Seed treatment | Pseudomonas fluorescens @ 10 ml/kg of seed | Mancozeb 50% + Carbendazim 25% WP @ 2g/l | Not adopted |
| 7 | Biofertilizers | Azospirullum @ 1250 ml/ha , PSB @ 1250 ml/ha, KRB @ 1250 ml/ha | Azospirullum @ 1250 ml/ha , PSB @ 1250 ml/ha, KRB @ 1250 ml/ha | Not adopted |
| 8 | Seedlings age for transplantation | 25 days | 25 days | 25 days |
| 9 | Transplanting depth | Shallow (2-3 cm) | Shallow (2-3 cm) | Deep (> 8 cm) |
| 10 | Spacing | 25 × 25 cm | 25 × 25 cm | 25 × 25 cm |
| 11 | No. of seedlings/hill | 2-3 | 2-3 | 4-6 |
| 12 | Fertilizer application | Vermicompost @ 2.5 t/ha,  Neem cake @ 500 kg/ha | 120-60-40 kg NPK/ha | 160-73-28 kg NPK/ha |
| 13 | Weed management | Azolla mulch along with hand weeding twice at 25 and 50 DAT | Pyrazosulfuron ethyl 10% WP @ 0.5 g/l (Pre),  Bispyribac Sodium 10% SC - 0.5 ml/l (Post) | Pretilachlor 37% EW @ 3 ml/l (Pre),  Triafamone 20% + Ethoxysulfuron 10% WG @ 0.45 g/l (post) |
| 13 | Blast management | Pseudomonas fluorescens @ 4 ml/l | Tricyclazole @ 0.6 g/l | Tricyclazole @ 0.6 g/l |
| 14 | Leaf folder management | Neem oil (1500 ppm) - 3 ml/l, Baeuveria Bassiana - 5 g/l | Chlorpyripos 20% EC - 2.5 ml/l | Chlorantraniliprole 20% SC - 0.3 ml/litre |
| 15 | Stem borer management | Neem oil (1500 ppm) - 3 ml/l, Baeuveria Bassiana - 5 g/l, Pheromone Traps - 10 No./ha | Chlorantraniliprole 20% SC - 0.3 ml/l, Pheromone Traps - 10 No./ha | Tetraniliprole 200 g/L @ 0.5 ml/l |
| 16 | BPH Management | Metarhizum Anisopliae @ 5 g/litre | Pymetrozine 50% WG - 0.6 g/l | Triflumezopyrim 10% SC @ 0.47 ml/l |
| 17 | Stem rot management | Pseudomonas fluorescens @ 4 ml/litre | Hexaconazole 5% SC - 2 ml/l | Azoxystrobin 18.2% + Difenoconazole 11.4% SC @ 1 ml/l |

**Table 3: Assessment of Organic Package on Yield of Rice**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Particulars** | **Plant height (cm)** | | | **No. of hills/m2** | | | **No. of panicles/m2** | | | **No of grains/panicle** | | | **Test weight (g)** | | |
| **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** |
| **T1: Organic Package** | 94.6 | 83.7 | 89.2 | 18 | 16 | 17 | 312 | 348 | 330 | 126 | 155 | 141 | 12.69 | 14.53 | 13.61 |
| **T2: ICM** | 101.9 | 90.20 | 96.1 | 18 | 16 | 17 | 345 | 569 | 457 | 154 | 208 | 181 | 13.03 | 14.70 | 13.87 |
| **T3: Farmer Practice** | 98.5 | 87.20 | 92.9 | 18 | 16 | 17 | 336 | 536 | 436 | 146 | 189 | 168 | 12.98 | 14.60 | 13.79 |

**Table 4: Grain Yield and Economics Analysis of Organic Package in Rice**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Particulars** | **Grain yield (kg/ha)** | | | **Cost of cultivation (Rs/ha)** | | | **Gross returns (Rs/ha)** | | | **Net returns (Rs/ha)** | | | **B:C ratio** | | |
| **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** | **2023-24** | **2024-25** | **Average** |
| **T1: Organic Package** | 4806 | 5476 | 5141 | 104225 | 111286 | 107756 | 167633 | 219040 | 193337 | 63408 | 107754 | 85581 | 1.61 | 1.97 | 1.79 |
| **T2: ICM** | 6693 | 7542 | 7118 | 75227 | 92123 | 171582 | 179007 | 164157 | 171582 | 103780 | 72034 | 87907 | 2.38 | 1.78 | 2.05 |
| **T3: Farmer Practice** | 6306 | 6995 | 6651 | 86894 | 91800 | 160443 | 168649 | 152237 | 160443 | 81755 | 60438 | 71096 | 1.94 | 1.66 | 1.80 |

**Fig 1: Economics Analysis of Organic Package and Integrated Crop Management in Rice**