***Original Research Article***

**Impact of On-Farm Trials and Front-Line Demonstrations on Zero Tillage Maize in Peddapalli District, Telangana**

**ABSTRACT**

During ***Rabi* season**, a large portion of the Peddapalli district adopted rice fallow or cotton fallow maize cultivation with conventional method, which involves plow row sowing after two to three ploughings and is very expensive and time-consuming. Due to the late sowing, crop encounters to terminal moisture stress and needs extra irrigations, which decreases its yields and lowers its price in the district. The innovative idea of zero-tillage maize arose in 2012–13 as a countermeasure. Krishi Vigyan Kendra Ramagirikhilla carried out on farm trails and front-line demonstrations in various locations of Peddapalli district from 2012–13 to 2018–19. Total 52 farmers from various villages were chosen to demonstrate zero-tillage maize for seven years in a row. The results revealed that the maize yield (73.30 q ha-1) increased by 10.83 percent when compared to the **farmers’** practice (66.26 q ha-1) with a technology index of 13.76%, an extension gap of 7.04 q ha-1, a technology gap of 11.70 q t ha-1 and recorded higher benefit-cost ratio (2.50) with additional income Rs. 16,460.37/- than farmers' practices (2.11). Compared to the **farmers’** practice, zero tillage maize proved to be an effective technology for improving **farmers’** income with lower cultivation costs due to its utilization of residual moisture, minimizes the number of irrigations and prevents the crop from terminal moisture stress. During the study the adoption of Zero tillage technology increased from negligible to 283.33% with overall adoption level 144.58% and horizontal spread from 0 ha up to 892 ha during 2018-19.

**KEYWORDS:** Zero Tillage, Maize, On Farm Trials, Front Line Demonstration, Extension gap, Technology gap, Technology index, Adoption level and Horizontal spread

**INTRODUCTION:**

Maize (*Zea mays* L.) is the most significant cereal crop in the world, and it is more adaptable to a larger range of agroclimatic conditions. Due to its high genetic production potential, maize is referred to as the "queen of cereals" throughout the world. It is the most adaptable crop and is grown from sea level to 3000 meters above sea level in more than 166 nations worldwide, covering tropical, subtropical, and temperate areas. It is cultivated on approximately 197 hectares of land, yielding 1148 metric tons and 5823.8 kg/ha of productivity worldwide, with wide diversity of soil, climate, biodiversity, and management techniques. It accounts for 37% of the world's grain production (FAO, 2019). After rice and wheat, maize is the third most important cereal crop in India. It can be produced in a variety of climates, from extremely semi-arid to sub-humid and humid areas, and it takes up 82% of the land under cultivation during the ***Kharif*** season. It contributes around 10% of the nation's total food grain production. Maize serves as a basic raw component for thousands of industrial goods, including those in the food, beverage, pharmaceutical, cosmetic, film, textile, gum, packaging, and paper industries, as well as a staple diet for humans and high-quality animal feed. Additionally, it holds great promise for ensuring food security, feed security, and nutritional security as well as increased revenue for maize farmers. Maize is one crop that has the potential to double the farmer's income. Maize yields more per hectare and require less water. Compared to paddy, farmers may save 70% of power and 90% of water by cultivating maize.

India is having wide range of diversified climate zones and soil conditions. The production of maize is fluctuating due to unpredictable rainfall and insufficient irrigation, the high cost of inputs like fertilizers and improved seeds, a lack of laborers, pest and disease outbreaks, poor post-harvest storage facilities, antiquated farming methods, and restricted access to extension services are all contributing factors to the fluctuating production of maize. These factors can have a substantial impact on yield and total production.

Maize production in India was 24.4 **million metric tons** (MMT) in 2014–15, 22.6 MMT in 2015–16, 26.00 MMT in 2016–17, 25.00 MMT in 2017–18, 22.72 MMT in 2018–19, and 25.38 MMT in 2019–20. In India, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Bihar, Uttar Pradesh, Telangana, Gujarat, and Tamil Nadu cultivate more than three-fourths of the country's maize (Maize Outlook, 2020).

It is essential to develop and scale up new adaption mechanisms in order to maintain production and guarantee food security. In Telangana, maize is grown under rice fallow, cotton fallow, and pulses fallow systems and it takes one month for preparation of field for maize cultivation results in delayed sowing and the crop was subjected to hot weather at grain filling stage that needs more irrigations. Under no-till conditions, maize can be produced successfully without primary tillage, resulting in lower cultivation costs, increased farm profitability, and more effective use of resources. No tillage, or zero tillage, conserve water and soil and minimizes the need for costly machinery for intercultural operations and land preparation. Above all, zero tillage has the potential to increase maize yields. Additionally, this approach saves approximately 18% of water, or 81,500 **Litre acre-1**.

Among fallow systems for rice, cotton, and legumes, rice fallow fields are more challenging and require a month to properly prepare the land for planting. As a result, the crop was exposed to hot weather during the grain filling stage, which is unacceptable, and the sowings were postponed until the first two weeks of January. During hot weather, more irrigation is required. During ***Rabi* season**, there was not enough water in the village tank to plant maize in rice fallows. Farmers are being forced to adjust to new management techniques due to low rainfall and inadequate irrigation water. Under these conditions Krishi Vigyan Kendra, located in Ramagirikhilla, Peddapalli district, brought the technology to implement in farmers’ fields. Due to inexperience about the technology and a lack of awareness and backup support, farmers had difficulties during deployment of technology which unable to reach farmers in the area. Maize is an extremely demanding crop that draws more nutrients from the soil and needs a lot of fertilizer. The KVK scientists proposed zero tillage as one of the potential answers while investigating various technologies that could assist farmers in enhancing soil fertility, conserving water, and increasing production. However, farmers did not, have confidence to implement it widely. After discussing the technology with a few progressive farmers of Haripuram, Peddapalli, Gundaram, Perapalli, Nagaram, Mutharam and taking their opinion on adopting it, KVK scientific team conducted digital video presentations, Awareness cum training programmes and pamphlet distribution, etc. on zero tillage technology in a few select villages which cultivate maize later started **on-farm trials** in 2012-13 to 2014-15 and **front-line demonstrations** in 2015-16 to 2018-19.

**MATERIALS AND METHODS**

In order to investigate the impact and adaptation of zero tillage maize on yield and economics in comparison to traditional maize cultivation, a total of 12 on-farm trials **(OFT)** and 40 front-line demonstrations (FLDs) were carried out on farmers' fields in Haripuram, Peddapalli, Gundaram, Perapalli, Nagaram, Mutharam villages of Telangana during the ***Rabi*** season, from 2012–2013 to 2018–2019. Selected farmer's fields had medium to coarse-textured soils that were neutral to slightly saline in nature, low in organic carbon and available nitrogen, high in available phosphorus, and medium in available potassium. Each demonstration was conducted on an area of 0.4 ha and adjacent fields to the demonstration plot was kept as farmers practices.

To implement zero-tillage maize “Peg markers” are used for demonstrations and were made from wood that is readily available in the area. It is a small equipment which makes six holes at a time, spaced 20 cm apart, to help dibble the maize seed and apply basal fertilizer in the holes to minimize fertilizer loss. It is a manually operated tool, and the land does not need to be ploughed. NPK are applied in the form of Urea, DAP, respectively as recommended by the PJTSAU. Phosphorus applied as basal dose, Nitrogen applied as four splits at basal, 25, 45, and 60 **days after sowing** and Potassium as two splits at 45 and 60 DAS. The crop was maintained by adopting the recommended package of practices PJTSAU.

After each fertilizer application, a total of three light irrigations were given. On the second day after maize is sown, a pre-emergence weedicide atrazine @5 g l-1 is sprayed to control the weeds that are sprouting and prevent paddy stubbles from growing back. During the crop growing period, need-based plant protection measures were implemented. The average yield and cost of cultivation, gross and net returns cost were calculated for both the zero tillage and conventional methods. A comparative study of the cost-benefit ratio per hectare was determined, and the percentage yield improvement above the standard approach was computed and displayed.

Regular monitoring was conducted on the exhibited trials, and all relevant data pertaining to the required qualities were gathered. **The parameters** i.e., technology gap, extension gap and technology index were calculated by using formula suggested by Samui *et al.,* (2000).

**Extension gap (t ha-1) = Demonstration yield – Farmers’ yield**

**Technology gap (q ha-1) = Potential yield – Demo yield**

However, data about adoption and horizontal spread of technologies were collected from the farmers with the help interview schedule. The following formulae (Singh *et al.,* 2018) were used to assess the impact on different parameters of drum seeding method of paddy cultivation.

**RESULTS AND DISCUSSIONS:**

The **on-farm trials** and **front-line demonstrations** on Zero tillage method is conducted in 52 locations across the selected villages of Peddapalli District in ***Rabi* seasons of**, 2012-13 to 2018-19 in innovative farmer fields and yield, economics, **extension attributes like technology gap, extension gap** and adoption of zero tillage maize are depicted in table.

**Maize yield (q ha-1):**

The results of yield performance between demonstration fields and **farmers’** practices are given in Table 1. Throughout the seven years of the study, the demonstration maize yield ranged from 65.50 to 80.30 q ha-1 and farmers' yields ranged from 57.20 to 74.40 q ha-1, with a cumulative average yield of 73.30 and 66.26 q ha-1, respectively. In comparison to farmers' practices, the demonstration of **zero-tillage** in the maize crop resulted in a 10.83% increase in maize yields. The result revealed the positive effects of OFT and FLD over the existing practices as it enhanced **the yield**. **The results** are consistent with those of Srinivas Rao *et al.,* (2016), who found that the **zero-tillage** method (6600 kg ha-1) enhanced grain output by 7.72% compared to the conventional farming method (6166 kg ha-1). When compared to conventional maize farming, the **zero-tillage** method produced a higher grain yield; this could be because of the uniform plant population and good grain filling. **According to Venkata Rao *et al.,* (2022) FLDs on the adoption of zero tillage maize in rice fallows increased yield by 9.35%, 5.6%, 2.03% and 13.33% in 2017–18, 2018–19, 2019–20 and 2020–21, respectively. This method have decreased the cost of cultivation, saved two irrigations, prevented terminal moisture stress in the crop, and additionally, saves time by allowing the crop to mature five to eight days earlier.**

The discrepancy in productivity between **farmers’** practice and demonstration may be explained by the extension gap. The average extension gap (Table 1) between demonstration and **farmers’** practice was recorded 7.04 q ha-1 with a range of 8.30 to 5.90 q ha-1 which emphasizes the need to educate the farmers through various means for the adoption of Zero tillage in maize crop to reverse the trend of wide extension gap. Throughout the seven-year study period, the extension gap decreased as a result of the district's adoption and acceptance of the technology. On-farm trials and front-line demonstrations in farmers’ fields are helping to reduce the extension gap. Singh *et al.,* (2018) revealed similar results, showing that **front-line demonstration** in tomatoes decreased the extension gap from 136.08 q ha-1 to 78.78 q ha-1. The findings also support those of Teggelli *et al.,* (2015), who claimed that the alarming trend of the accelerating extension gap will be reversed by the gradual adoption of enhanced crop production technology with high-yielding varieties.

The trend of technology gap (Table 1) ranging between 19.50 to 4.70 q ha-1 with mean of 11.70 q ha-1 reflected the farmer’s cooperation in carrying out such demonstration with encouraging results in subsequent years. The technology gap observed may be attributed to the dissimilarity in soil fertility status and weather condition of the area and management practices implemented by the farmers. Hence, more location specific recommendations and precise use of technology in the fields are necessary to bridge the technology gap as supported by Singh *et al.,* (2018) as the technology gap declined from 424.71 q ha-1 to 394.58 q ha-1 due to front line demonstration.

The viability of the advanced technology in the farmer's field was demonstrated by the technology index (Table 1). The more feasible the technology, the lower the technology index rating. Therefore, the technology index decreased from 22.94% in 2012–13 to 5.53% in 2018–19, demonstrating the viability of the technology that was demonstrated in this area. The district's adoption and adjustment to the technology is reflected in the decline in the technology index. Singh *et al.,* (2018) observed similar results, showing that the frontline demonstrations decreased the technology index from 56.62% to 52.61%. According to Kiran Pilli *et al.,* (2025) Cluster front line demonstrations reduced the extension gap, technology gap, and technology index.

**Economics:**

The effect of front line demonstration on farm income (Table 2) indicates that the average cost of cultivation involved in demonstration was Rs. 54,297.14 ha-1, which is lower than the **farmers’** practice (Rs. 58,375.71 ha-1). The data concluded that the higher gross monetary returns (Rs. 1,38,122.59 ha-1) as well as net monetary returns (Rs. 84,254.01 ha-1) were obtained with the adoption of zero-tillage over **farmers’** practice (gross monetary returns Rs. 1,26,169.36 ha-1) and net monetary returns (Rs. 67,793.65 ha-1)) during the course of trial. A mean benefit cost ratio of 2.50 was recorded in demonstrations with an increase **net returns of** Rs. 16,460.37 **ha-1**and with 36.07% increase of net returns than **farmers’** practices (2.11). The benefit-cost ratio increased from least 1.70 in 2012-13 to 3.46 in 2018-19, reflecting the positive impact of FLD on both **grain** yield and profitability. Reduced land preparation costs, soil moisture conservation, improved soil health through organic matter accumulation, and decreased erosion may all contribute to the demonstration's increased yields and economic benefits. This would increase crop productivity while using fewer inputs, such as fertilizer and water, and ultimately increase farmers' profitability compared to the framers' methods. Improved technology, non-monetary elements, timely crop cultivation activities, and scientific monitoring may all contribute to the higher incremental returns and benefit cost ratio that were produced under demonstration. According to Srinivas Rao *et al.,* (2016), farmers who adopted the zero-tillage approach with a benefit cost ratio of 3.33 had an increase in net income of Rs. 18,400.00/ha compared to those who followed the practice (2.41). It was mostly brought about by lower irrigation and sowing operating costs. Similarly, Singh *et al.,* (2018) reported that these front-line demonstrations contributed to an increase in the tomato crop yield, gross returns, net returns, and benefit-cost ratio.

**Extension:**

The objective of the current study was to investigate how OFT and FLD affected the adaptation and horizontal spread of zero tillage in the maize crop (Table 3). It was discovered that farmers' adoption of zero tillage in maize crops was minimal prior to the demonstration in 2012–13, but it increased by 283.33% after the demonstration in 2018–19. The study finds that OFTs and FLDs conducted by KVK, Ramagirikhilla had a substantial impact on the horizontal spread of this technology since the area increased significantly from 0 ha to 892.00 ha with a horizontal spread of 157.48% over the seven years of the study. Therefore, a targeted awareness and training campaign on zero tillage in maize crops, frequent field visits, field days, and mass media communications increased growers' knowledge and skill levels, which in turn encouraged the farmers to adopt the technology in Peddapalli district. According to Singh *et al.,* (2018), frontline demonstrations of tomato cultivation using an enhanced package of practices boosted the technology's adaptability and horizontal spread. Similar results have also been reported by Mahale *et al.,* (2016) for the mustard crop and Chapke (2012) for the jute crop.

**CONCLUSION:**

On Farm Trials and Frontline demonstrations on Zero-tillage in maize crop during 2012- 13 to 2018-19 resulted that average yield of 73.30 q ha-1 with an increment of 10.83% yield higher than the **farmers’** practice (66.26 q ha-1) which created greater awareness and motivated the fellow farmers for adoption the Zero tillage in maize crop. The yield difference between farmers' practices and demonstrations thus made the financial returns very evident. Zero-tillage maize has been proven to be a successful technology for increasing farmers' income since it uses residual moisture to minimize irrigations, prevents terminal moisture stress in rice fallows, and lowers the cost of cultivation on land preparation when compared to the farmer’s practice of field preparation after rice cultivation. Therefore, the extension system may promote this kind of cost-effective technology to close the wide extension gap and reduce cultivation costs while increasing maize yields in the region. Farmers normally prepare their land after paddy cultivation, which is a laborious process that also exposes crops to terminal moisture stress, increasing cost of cultivation and reducing yields. For this reason, the extension agency may choose to take a comprehensive approach to promote the use of this technology.

**CONFLICT OF INTEREST:**

The authors declare that there is no conflict of interest exist (both financial and non-financial).

Disclaimer (Artificial intelligence)

Option 1: Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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**AUTHOR CONTRIBUTIONS:**

**Conceptualization:** Venkanna Yana, B. Bhaskar Rao and Amanaganti Srinivas

**Investigation:** Kiran Pilli,Venkanna Yana, B. Bhaskar Rao

**Data Curation and Analysis**: Kiran Pilli and Venkanna Yana

**Writing**: Kiran Pilli and Venkanna Yana

**Writing-review & editing**: Kiran Pilli, B. Bhaskar Rao, Venkanna Yana, T. V Kumar, Bairineni Navya, Bandari Naresh and Kannoju Archana

**Supervision:** D. Vijaya

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**Table 1:** **Yield, Extension gap, Technology Gap, Technology Index (%) and Percent increase (%) in yield over farmers’ practice of Maize cultivation as influenced by Zero-Tillage Maize in Peddapalli District.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Year** | **Area (ha)** | **No. of Demonstrations** | **Potential Yield (q/ha)** | **Demo Yield (q/ha)** | **FP Yield (q/ha)** | **Extension gap (q/ha)** | **% increase in Yield** | **Technology gap (q/ha)** | **Technology Index (%)** |
| **OFT** | **2012-13** | 1.60 | 4 | 85.00 | 65.50 | 57.20 | 8.30 | 14.51 | 19.50 | 22.94 |
| **2013-14** | 1.60 | 4 | 85.00 | 68.30 | 60.75 | 7.55 | 12.43 | 16.70 | 19.65 |
| **2014-15** | 1.60 | 4 | 85.00 | 68.80 | 60.90 | 7.90 | 12.97 | 16.20 | 19.06 |
| **FLD** | **2015-16** | 4.00 | 10 | 85.00 | 73.20 | 66.50 | 6.70 | 10.08 | 11.80 | 13.88 |
| **2016-17** | 4.00 | 10 | 85.00 | 77.50 | 71.00 | 6.50 | 9.15 | 7.50 | 8.82 |
| **2017-18** | 4.00 | 10 | 85.00 | 79.50 | 73.10 | 6.40 | 8.76 | 5.50 | 6.47 |
| **2018-19** | 4.00 | 10 | 85.00 | 80.30 | 74.40 | 5.90 | 7.93 | 4.70 | 5.53 |
| **Average** | | **20.8** | **52** | **85.00** | **73.30** | **66.26** | **7.04** | **10.83** | **11.70** | **13.76** |

\*OFT- On Farm Trials, FLD- Front Line Demonstration, Demo- Demonstration conducted, FP- Farmers Practice, q- Quintal, ha- Hectare

**Table 2:** **Cost of cultivation, Gross return, Net return and Benefit cost ratio of Maize cultivation as influenced by Zero-Tillage Maize in Peddapalli District.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Year** | **Demo** | | | **FP** | | | **% Increase in Net returns** | **Additional net Income (Rs./ha)** | **Demo** | **FP** |
| **Cost of cultivation (Rs./ha)** | **Gross returns (Rs./ha)** | **Net returns (Rs./ha)** | **Cost of cultivation (Rs./ha)** | **Gross returns (Rs./ha)** | **Net returns (Rs./ha)** | **B:C** | **B:C** |
| **OFT** | **2012-13** | 48280.00 | 81875.00 | 33595.00 | 51480.00 | 71500.00 | 20020.00 | 67.81 | 13575.00 | 1.70 | 1.39 |
| **2013-14** | 50100.00 | 89473.00 | 39373.00 | 52400.00 | 79582.50 | 27182.50 | 44.85 | 12190.50 | 1.79 | 1.52 |
| **2014-15** | 51300.00 | 93128.00 | 41828.00 | 54500.00 | 79779.00 | 25279.00 | 65.47 | 16549.00 | 1.82 | 1.46 |
| **FLD** | **2015-16** | 53700.00 | 143618.40 | 89918.40 | 57700.00 | 130473.00 | 72773.00 | 23.56 | 17145.40 | 2.67 | 2.26 |
| **2016-17** | 55050.00 | 167555.00 | 112505.00 | 59050.00 | 155880.20 | 96830.20 | 16.19 | 15674.80 | 3.04 | 2.64 |
| **2017-18** | 59500.00 | 179441.84 | 119941.84 | 64200.00 | 165899.06 | 101699.06 | 17.94 | 18242.78 | 3.02 | 2.58 |
| **2018-19** | 62150.00 | 214766.87 | 152616.87 | 69300.00 | 200071.78 | 130771.78 | 16.70 | 21845.09 | 3.46 | 2.89 |
| **Average** | | **54297.14** | **138551.16** | **84254.01** | **58375.71** | **126169.36** | **67793.65** | **36.07** | **16460.37** | **2.50** | **2.11** |

\*OFT- On Farm Trials, FLD- Front Line Demonstration, Demo- Demonstration conducted, FP- Farmers Practice, Rs.- Rupees, ha- Hectare

**Table 3:** **Impact of on-farm trails (OFT) and front-line demonstration (FLD) on adoption of Zero-Tillage Maize technology in Peddapalli District.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Year** | **No. before adoption** | **No. after adoption** | **Impact on Adoption (% change)** | **Area before (ha)** | **Area after (ha)** | **Impact on Horizontal Spread (% change)** |
| **OFT** | **2012-13** | 0 | 3 | 0.00 | 0 | 2.00 | 0.00 |
| **2013-14** | 3 | 5 | 66.67 | 2 | 4.00 | 100.00 |
| **2014-15** | 5 | 11 | 120.00 | 4 | 8.40 | 110.00 |
| **FLD** | **2015-16** | 11 | 27 | 145.45 | 8.4 | 23.80 | 183.33 |
| **2016-17** | 27 | 78 | 188.89 | 23.8 | 72.80 | 205.88 |
| **2017-18** | 78 | 240 | 207.69 | 72.8 | 232.00 | 218.68 |
| **2018-19** | 240 | 920 | 283.33 | 232 | 892 | 284.48 |
|  | **Average** | **52** | **183** | **144.58** | **49** | **176.43** | **157.48** |

\*OFT- On Farm Trials, FLD- Front Line Demonstration, ha- Hectare