Journal of AgriSearch 5(4):282-286
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.5.4.12

Impact Analysis of Krishi Vigyan Kendras on Zero Tillage Maize, a Resource Conservation Technology in Srikakulam District of Andhra Pradesh

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ARTICLE INFO

Received on	:	05.11.2018
Accepted on	:	09.12.2018
Published online	:	15.12.2018

ABSTRACT

Frontline demonstrations resulted in a yield of 80.83 q ha^{-1} with 14.01 per cent increase over farmer's practice of 70.90 q ha^{-1}which was much more than the district average yield of 47.33 q ha^{-1}and increased net returns of Rs. 18,106 per hectare (53.16 %) over farmers practice. During the study period extension gap of 9.93 q ha^{-1} was found to be more than technology gap of 6.17 q ha^{-1} which emphasized the need to educate the farmers through various means for the adoption of this resource conservation technology for improved maize production with reduced cost of cultivation. Technology index of 18.51 per cent, indices of realized potential yield of 81.49 per cent and potential farm yield of 87.71 per cent had shown the feasibility of the demonstrated technology at the farmers' fields.

Keywords: Conservation agriculture, KVK, Maize, Zero tillage

INTRODUCTION

Maize (*Zea mays* L.) is one of the most versatile emerging crops showing wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals (Singh *et al.*, 2017). It is cultivated on nearly 190 m ha in about 165 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 39 % in the global grain production (Ahmad *et al.*, 2017). Maize is the third most important cereal crop in India after rice and wheat, grown throughout the year under very diverse ecology in our country.

It accounts for around 10 per cent of total food grain production in the country (Anonymous, 2017). In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc.

Maize is predominantly a *kharif* crop with 85 per cent of the area under cultivation in the season (Anonymous, 2017).The productivity of more than 4 t/ha in *rabi*season is catching up with global average productivity of maize. India is now major maize producer after USA, China, Brazil and Argentina. This is largely due to adoption of improved technologies by Indian farmers.India has exported 7,05,513.8 MT of maize to the world for the worth of Rs. 1228.5 crores/ 190.3 USD Millions and the major export destinations are Nepal, Bangladesh, Philippines, Myanmar, and Sri Lanka in 2017-18. The demand of specialty maize like sweet corn, pop corn, oil corn and waxy corn is on the increase. Now, more rigorous efforts are being made to fulfill this demand.

More than three-fourth of maize cultivation is under rainfed conditions which puts a limit on productivity of the crop(Anonymous, 2017). Even though there are tremendous opportunities to further enhance maize production in the country as it has strategic and geographical advantage over other countries towards supply of maize to international market. This include round-the-year production of maize in our country, low freight charges, well-established seed production and marketing network and availability of sea-port. Adoption of improved cultivation practices needs to be up-scaled. Institute, in partnership with other stake holders in maize value chain, is constantly striving for excellence in maize research and development to deliver better technologies to farmers and to have a productive, profitable, sustainable and climate resilient maize-based cropping systems.

The increase in production should preferably come from increase in the productivity rather than the area. One of the most critical factors to realize this would be development and fine-tuning of resource conservation techniques (Laik *et al.*, 2014), and to bring down cost of cultivation by enhancing resource use efficiency in maize. Maize is the second major crop grown in Srikakulam district after paddy, occupying 33,095ha area and plays a major role in the income levels of farmers (Anonymous, 2018 and Rama, 2011). In *rabi* season farmers usually grow green gram and black gram in rice fallows and in some of the years pulses yields were low because of YMV disease, low temperatures and fog during crop growth. Due to this situation cultivation of rice fallow crops became less remunerative and farmers started keeping the lands fallow after harvesting paddy crop(Laik *et al.*, 2014).

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But the farmers were interested in cultivation of maize because maize is a remunerative crop and marketing is also easy. In conventional method of maize cultivation, yields are being reduced as the crop is subjected to terminal moisture stress due to erratic distribution of rain fall as the crop is sown behind the plough after 2-3 ploughings. Frontline demonstration is an efficient technology transfer system and conducting this demonstration on farmer fields was proved as an effective means for creating awareness and acceptance of improved technologies. To tackle these situations KVK, Amadalavalasaintroduced zero tillage maize to utilize residual soil moisture available after paddy harvestings. KVK promoted zero tillage maize in the district to reduce cost of cultivation and to conserve water resources without compromising the productivity.

MATERIALS AND METHODS

KVK, Amadalavalasaorganized series of training programmes, skill demonstrations and conducted frontline demonstrations in farmer's fields on zero tillage cultivation of maize by supplying critical inputs like seed, herbicides, plant protection chemicals etc, to the farmers to improve the productivity of maize crop. Field days were organised, season wise field visits were made and the farmers were motivated towards the technology by supplying maize shellers on subsidy. KVK developed literature in local language and distributed to the farmers and extension functionaries. KVK even adopted villages for promoting zero tillage maize in the district.

KVK, Amadalavalasa conducted 65 frontline demonstrations with plot size of 0.4 ha covering an area of 26 ha during 2014-15 to 2016-17. In zero tillage technology, maize is cultivated without any preparatory tillage under no tillage situation and seed is sown immediately harvesting of paddy with available residual soil moisture by dibbling in rows or with the help of peg marker or vijaya marker with spacing of 60cm x 20 cm. Seed rate was8 kg/acre and seed was treated with Mannose @ 3gm/kg seed. Atrazine @ 1 kg/acre and paraquat @ 1 liter /acre were applied with in the 48 hours of sowing for weed management. As per the field condition 3 to 4 irrigations are required in this technology and 2to three irrigations will be saved compared to normal method of maize cultivation.

For the present study30 beneficiary farmers (FLD farmers of KVK) who are adopters of zero tillage cultivation and 30 non - beneficiary farmers who are cultivating maize under traditional method were selected randomly. The secondary data was collected fromtheKVK, Agricultural Technology Application Research Institute (ATARI, Zone-10, Hyderabad), Research stations, Agriculture offices, Statistical departments publications, websites, etc., Data regarding crop specific issues, frontline demonstrations, beneficiary farmers was collected from the KVK. Primary data on general profile of respondents, yields and returns from selected crops were collected by personalinterviewof sample respondents through pre tested schedules.

For the quantitative assessment of the data to achieve the objectives of the present study, the following analytical tools, techniques and statistical methods were employed.

Yield Gap Analysis

The impact of frontline demonstrations was studied through yield gap analysis. Tabular analysis was used to estimate the magnitude of yield gaps. The percentage and the appropriate indices relating to yield gaps were computed and compared. For the present study, the methodology formulated by the International Rice Research Institute (IRRI) i.e. Yield Gap-I and Yield Gap-II was adopted.

Total Yield Gap (GT)

$GT=Y_p - Y_a$....................(1)

$GT = (Y_p - Y_d) + (Y_d - Y_a)$ ....(2)

Yield Gap-I (Technology gap)

$YG\text{-}I = Y_p - Y_d$....................(3)

Yield Gap - II (Extension gap)

$YG\text{-}II = Y_d - Y_a$....................(4)

Index of Yield Gap (I_y) (Technology Index)

$I_y = \{(Y_p - Y_a)/ Y_p\}*100$ ....(5)

Index of Realized Potential Yield (I_p)

$I_p= (Y_a/ Y_p)*100$ ....(6)

Index of Realized Demonstration Yield (I_d)

$I_f= (Y_a/ Y_d)*100$ ....(7)

Where,

Y_p = Potential yield as obtained in the research station

Ya = Actual farm yield taken as the average of the yield of the farms

Y_d = Average yield obtained in the demonstration plots

Per cent yield increase over farmers Practice = ((Average demonstration plot yield - Average farmers plot yield)/ Average farmers plot yield)*100....................(8)

Production Function Analysis

Cobb-Douglas type of production function in log-linear form was fitted to study the important factors affecting the productivity of maize in both zero tillage and traditional methods of cultivation.

$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} e_u$....................(9)

where,

- Y = Output of main produce (quintal per ha)
- a = Intercept
- X_1 = Human labour (human-days per ha) or Machine labour (machine hours per ha)
- X_2 = Quantity of seed (kg per ha)
- X_3 = Quantity of nitrogen (kg per ha)
- X_4 = Quantity of phosphorus (kg per ha)
- X_5 = Quantity of potash (kg per ha)
- X_6 = Number of irrigations for the entire crop period
- e_u = Error component

The regression coefficients (b_i : i =1....... 6) were tested for their significance using "t" test at chosen significant level, which is given below

$t = b_i / \text{SE of } b_i$....................(10)

Where,

b_i is the regression coefficient of i^{th} input

SE of b_i is the standard error of b_i

Decomposition Analysis

To decompose the total productivity difference between improved technology and farmers practice into its constituent sources, Bisaliah's (1977) output decomposition model was used. The model requires the production function to be specified on unit area basis. Therefore, the Cobb-Douglas production functions on per hectare basis, for the improved technology and traditional cultivation as specified below in log-linear form was estimated:

$$\ln Y_2 = \ln b_o + b_1 \ln H_2 + b_2 \ln M_2 + b_3 \ln S_2 + b_4 \ln N_2 + b_5 \ln P_2 + b_6 \ln K_2 + b_7 \ln I_2 + U_2 \text{ .... (11)}$$

$$\ln Y_1 = \ln a_o + a_1 \ln H_1 + a_2 \ln M_1 + a_3 \ln S_1 + a_4 \ln N_1 + a_5 \ln P_1 + a_6 \ln K_1 + a_7 \ln I_1 + U_1 \text{ .... (12)}$$

Where,

Y = Quantity of output per hectare
H = Human labour (man days per hectare)
M = Machine labour (machine hours per hectare)
S = Quantity of seed (kg per hectare)
N = Quantity of nitrogen (kg per hectare)
P = Quantity of phosphorous (kg per hectare)
K = Quantity of potash (kg per hectare)
I = Number of irrigations per hectare
u = Error term

1 and 2 stand for farmers practice/ traditional variety and improved technology/ variety respectively.

$$\ln Y_2 - \ln Y_1 = [\ln b_0 - \ln a_0] + [(b_1 - a_1) \ln H_1 + (b_2 - a_2) \ln M_1 + (b_3 - a_3) \ln S_1 + (b_4 - a_4) \ln N_1 + (b_5 - a_5) \ln P_1 + (b_6 - a_6) \ln K_1 + (b_7 - a_7) \ln I_1] + [b_1 (\ln H_2 - \ln H_1) + b_2 (\ln M_2 - \ln M_1) + b_3 (\ln S_2 - \ln S_1) + b_4 (\ln N_2 - \ln N_1) + b_5 (\ln P_2 - \ln P_1) + b_6 (\ln K_2 - \ln K_1) + b_7 (\ln I_2 - \ln I_1)] + [U_2 - U_1] \text{ .... (14)}$$

Equation (14) was used for decomposing the sources of yield gap. The left hand side of the equation indicates the total difference in production expressed as percentage over farmers' practice/ traditional variety. The summation of 1st and 2nd square bracketed terms on the right hand side represents the yield gap, attributable to the difference in the technology. The 3rd term represents the yield gap attributable to the difference in the input use between improved and traditional methods. The last term represents the random disturbance.

RESULTS AND DISCUSSION

Impact of Frontline Demonstrations on Yields and Returns: KVK Amadalavalasa

The frontline demonstrations conducted by Krishi Vigyan Kendra, Amadalavalasa on zero tillage cultivation in maize (Table 1) at adopted farmers' fields resulted in a yield of 80.83 q ha^{-1} which is 14.01 per cent higherthan that of traditional cultivation of 70.90 q ha^{-1}. Zero tillage maize technology resulted in increased net returns of Rs. 18106 per hectare (53.16 %) over farmers practice. Similar results in zero tillage practice in maize were also reported by Govardhanrao and Ramana (2017) which indicated that the demonstration has given good impact in terms of yield and income thereby changing the farmer's attitude towards following this technology in future.

Table 1: Impact of frontline demonstrations on yields and returns in Maize

Technology demonstrated	Number of FLDs	Area (ha)	Average Yield (q/ha)				Net Returns (Rs./ha)			
			FLD	FP	Increase over FP	Per cent increase	FLD	FP	Increase over FP	Per cent increase
Zero tillage Maize	65	26	80.83	70.90	9.93	14.01	52167	34061	18106	53.16

Note: FLD: Frontline demonstration; FP: Farmers practice

Yield gaps

During the study period extension gap of 9.93 q ha^{-1} was found to be more than technology gap of 6.17 q ha^{-1} which emphasized the need to educate the farmers through various means for the adoption of this resource conservation technology for improved maize production with reduced cost of cultivation (Table 2). Technology index of 18.51 per cent, indices of realised potential yield of 81.49 per cent and potential farm yield of 87.71 per cent had shown the feasibility of the demonstrated technology at the farmers' fields. These results were similar with the results reported by Meena *et al.* (2015) and Rama (2011),who evaluated the performance of frontline demonstrations organised by Krishi Vigyan Kendra, to know the production and economic benefits of scientific maize production technology in Ernakulum district of Kerala on traditional farmer's field.

Table 2: Yield gaps in Maize

Technology demonstrated	Yield Gaps (q ha^{-1})			Index of Yield Gaps (%)		
	YG -I Technology Gap	YG -II Extension Gap	Total Yield Gap	Technology Index	Index of Realized Potential Yield	Index of Realized Potential Farm Yield
Zero tillage Maize	6.17	9.93	16.10	18.51	81.49	87.71

Factors affecting the productivity of Maize

The Cobb-Douglas type of production function was fitted for the estimation of coefficients of important variables contributing to the yield of maize crop under both zero tillage cultivation and farmers practice (Table 3).

Table 3: Factors affecting the productivity of Maize yield in Zero tillage and Farmers practice

Particulars	Method of cultivation	
	Zero tillage	Farmers practice
Intercept	3.769*** (0.527)	3.261*** (0.596)
Human labour (X1)	-0.135 (0.113)	-0.114 (0.111)
Seed (X2)	-0.060 (0.054)	0.049 (0.065)
Nitrogen (X3)	0.138*** (0.031)	0.222*** (0.061)
Phosphorous (X4)	0.050 (0.041)	0.00006 (0.029)
Potash (X5)	0.105** (0.055)	-0.008 (0.022)
Irrigation (X6)	0.112** (0.051)	-0.207*** (0.073)
R^2	0.87	0.69
F value	24.81***	8.73***
N	30	30

Note: (1) * = significant at 10%, ** = significant at 5%, ***= significant at 1% level of significance.(2) Figures in parentheses indicate standard errors of the regression coefficients.

The value of coefficient of multiple determinations (R^2) was found to be 0.87 under zero tillage cultivation and 0.69 under farmers practice. Nitrogen impacted the yields of maize in both zero tillage and farmers practice positively and significantly with coefficient values of 0.138 and 0.222 which shows the need of increasing the application of nitrogen for improving the yields.

The coefficient of this variable was higher in farmers practice than zero tillage maize, which shows more response of farmers practice for nitrogenous fertilizer in comparison with zero tillage maize cultivation. Irrigation contributed positively and significantly in zero tillage (0.112) where its contribution was negative and significant (-0.207) in farmers practice, which shows that the yields can be improved by using less number irrigations by adopting zero tillage maize cultivation which is a water conserving technology. Application of potash (0.105) also had positive and significant impact on the yields of zero tillage maize as one per cent increase in the application of potash can increase the yield of zero tillage maize by 0.105 per cent. All the other variables were found to be non significant.

Decomposition of yield gap between Zero tillage and Farmers' practice in Maize

The inputs considered for the study in zero tillage technology and farmers practice in maize were seed, human labour, nitrogen, phosphorous, potash and irrigation (Table 4). Quantity of seed used was almost same in both the technologies, where as nitrogen application was more in zero tillage farms than traditional farmer's fields. There was less use of human labour in zero tillage cultivation because this technology does not require land preparation and application of manure and fertilizer and the seed could be directly sown in rice fallows. The output obtained from improved technology was appreciably more than the traditional farmers' practice.

Table 4: Geometric mean level of inputs and output in Zero tillage and Farmers' practice in Maize

Input/ Output	Method of cultivation	
	Zero tillage	Farmers' practice
Human labour (man days)	83.51	101.13
Seed rate (kg)	22.11	22.78
Nitrogen (kg)	99.99	88.57
Phosphorous (kg)	56.87	54.57
Potash (kg)	38.47	34.35
Irrigation (No.)	4.00	7.00
Output (q)	80.83	70.99

The decomposition analysis of yield gaps showed that 23.77 per cent of the potential farm yield was left untapped under farmers practice (Table 5) of maize cultivation. Among different sources of yield gap, difference in technology (23.96 %) turned out to be the major contributor than input use (-0.19 %). In input-use, human labour (1.12 %) turned out to be a crucial factor followed by nitrogen (0.73 %), potash (0.52 %) and phosphorous (0.09 %) fertilizers. But, irrigation (-2.73 %) contributed negatively. However, contribution of inputs in the yield gap was negligible, and adoption improved technology i.e. zero tillage cultivation of maize in rice fallows can reduce the yield gap in maize by 23.96 per cent without much change in input levels in Srikakulam district, which indicated that the demonstration has given good impact in terms of yield and income thereby changing the farmer's attitude towards adopting this technology in future.

Table 5: Sources of yield gap between Zero tillage and Farmers practice in Maize

Sources of yield gap	Per cent
Difference in Technology	23.96
Difference in Input use	-0.19
a) Human Labour	1.12
b) Seed Rate	0.08
c) Nitrogen	0.73
d) Phosphorous	0.09
e) Potash	0.52
f) Irrigation	-2.73
Total	23.77

CONCLUSION

With the intervention of the KVK the area under zero tillage cultivation of maize has increased from 260 ha to 2500 ha in the district in three years from 2014-15 to 2016-17. Even though the existence of higher extension gap than the technology gap emphasized the need to educate the farmers through various means for the adoption of this resource conservation technology for improved maize production.

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Citation:

Malathi B, Rao DVS, Prasad JV, Appaji C, Naidu DC and Prasad YG.2018. Impact analysis of krishi vigyan kendras on zero tillage maize, a resource conservation technology in Srikakulam District of Andhra Pradesh. *Journal of AgriSearch* **5** (4): 282-286