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Effect of E-Commerce Platform on Price and Revenue of Chilli Cultivators in Guntur District, Andhra Pradesh: A Propensity Matching Estimator Technique

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ABSTRACT

The study investigates the impact of e-commerce participation on price and revenue of chilli cultivators in Guntur district of Andhra Pradesh. The significance of chilli as a spice and vegetable made both public and private sectors contribute to the improvement in production and marketing of chilli in the district. Guntur chilli market yard is considered as heart of chilli marketing in Andhra Pradesh. Also, there are many private players involved in marketing of chilli in the district. They include corporate companies, processing companies and e-commerce platforms. The study examined how an e-commerce platform impacted the price received by chilli farmer and income of the farmer using a propensity score matching method. The estimated results provided evidence that the farmers adopting digital e-commerce platform for marketing received 4.98 to 7.41 per cent more price and 10.28 to 14.13 per cent more income than the farmers practicing traditional marketing practices. However, the results showed that, e-commerce platform has differential impact depending on age, experience, training programs attended and android mobile usage etc. The study found that promoting digital marketing can boost income and prices in rural areas.

Keywords: Chilli, e-commerce platform, Guntur, Andhra Pradesh

JEL codes: Q12, Q13, Q18, O33, C21

I

INTRODUCTION

Guntur is the largest producer of chilli in Andhra Pradesh (GoI, 2022-23). It has high area of 0.78 lakh hectares under the cultivation of chilli in Andhra Pradesh (GoI, 2021-22). Due to the importance of chilli as both spice as well as vegetable, it is exported to different countries such as Sri Lanka, Bangladesh, and Middle East. Considering its importance as a commercial crop, the government has established Guntur Agriculture Market Committee (AMC), which is known as the Guntur chilli market yard. With the introduction of e-NAM by government, many corporate sectors had also entered into the market to promote digital marketing and provide better opportunities to farmers in marketing. The digital marketing mostly succeeded in eliminating the market intermediaries between farmers and consumers, who take most of the profit share of the cultivatorss. Following the implementation of e-NAM, the Indian government is working hard to further digitalise the process of agri-marketing by establishing an e-commerce portal, kisankart.online, to connect farmers and agrientrepreneurs with customers and sell their products directly (the hindubusinessline.com 2024).

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The e-Commerce sector has seen rapid growth in 2014 due increase in use of devices such as smartphones and tablets, and access to internet through broadband, 3G, etc. which led to an increase in online consumer base. The three e-Business markets most commonly discussed are – Business-to-Business (B2B), Business-to-Consumer (B2C), and Consumer-to-Consumer (C2C) (Balakrishnan et al., 2018). While e-NAM follows B2B market, most of the popular e-commerce platforms like Amazon, Flipkart and Snapdeal follow B2C market.

While the most popular e-commerce platforms such as Amazon, Flipkart focussed on other goods along with agricultural commodities, there are a few indigenous e-commerce platforms such as Big Basket, Godrej Natures Basket and Grofers which focus only on agricultural commodities. Along with them there are e-commerce platforms such as AndhraGreens, Kalgudi, Andhra Pradesh Farmers E-Vikraya Corporation Limited etc., to link the farmers of Andhra Pradesh online to the traders. These e-commerce platforms operate exclusively in Andhra Pradesh. The major objective of the study is to investigate the impact of the e-commerce platform named Kalgudi on price and income of chilli farmers in Guntur district.

The research questions addressed in this paper were:

(i) What are the factors that influence farmers in adopting e-commerce for marketing chilli?

(ii) Is there any difference in price and income among the farmers adopting of e-commerce platform for marketing chilli? If yes, how much gain in price and income does the adopters received than the non-adopters of e-commerce platform.

Kalgudi e-commerce platform was selected to study the marketing aspects of chilli in selected district of Andhra Pradesh.

1.1 Background Information: Kalgudi e-commerce platform

The Kalgudi e-commerce platform, was established in 2019 with the help of ICRISAT's Digital Agriculture Interventions known as iHub that facilitates incubation of Agri-Tech start-up companies and nurtures innovations in technology to improve farming practices. Kalgudi works both as Business to Business (B2B) and Business to Consumer (B2C) market ways, in which it deals with transactions of farmer to trader as well as farmer to consumer. It works based on Marketplace model, where the seller and buyer were connected through the e-commerce platform. The seller often partners with the leading e-commerce platform to set up their products in the platform's website. Kalgudi is an online e-commerce platform which acts as a linkedin for farmers, FPOs, traders, input companies and consumers. It mainly comprises three core service units: input store, output store and consumer store. Input store links the input-dealers and farmer, output store links farmers and trades/consumers and the consumer store link directly the SHGs (farmers, local manufacturers and food processors) and the consumers. By doing so it involves in

both B2B and B2C trade. The output store of the Kalgudi links the farmers and the traders. It mostly deals with the farmers of chilli, mango, turmeric and other horticultural crops which have high demand in local and global markets. Apart from the stores, the technical team of Kalgudi keeps regular contact with the farmers through telephone or official website and tries to clarify their production related queries. It provides most of its services free of cost to the farmer.

1.2 Process Flow

Process flow refers to a series of sequential tasks that are performed to achieve a certain goal. The series of activities that take place in transacting chilli through the Kalgudi e-commerce platform were listed and represented in Figure 1.

A farmer needs to be a member of a registered FPO that is actively co-ordinating with the stated e-commerce platform (Kalgudi) to transact his chilli produce. Farmer can also get his produce transacted through the stated e-commerce platform without the aid of any FPO, but he needs to register separately in the e-commerce website. The registered members of FPO will be registered in the e-commerce website also. The registered farmers of the e-commerce platform would derive an additional benefit of obtaining information of the crop calendars, digital extension services, advisory services, indents on specific products and the product demos. The registered farmer may update his profile according to his will which enable the extension team to provide necessary suggestions to him/her. Farmers as well as the traders have to register themselves with Kalgudi website without any nominal charge and become its member, to involve themselves with the daily transactions. This enables the Kalgudi management to have a chain of consistent suppliers and buyers to plan for their future demand.

The registered farmer gets a unique login ID and password after registration. The farmer has to clean and grade his produce before transacting it. The farmer can choose to have the lot analysed by an assaying lab within the FPO or another FPO (assaying is not required at FPOs) or display it directly in the SKU (stock keeping unit). A sample of 100 grams should be given to any registered testing laboratory available at APMC or at any FPO which have the equipment for testing of the colour, hotness, foreign particles and aflatoxins in the sample of chilli. After the assaying certificate with a specified grade to the produce is issued, both the certificate and the lot number of the produce are displayed by the farmer himself on his SKU. If the farmer had not conducted any scientific grading, he can update his SKU without the certificate and with just lot number and image.

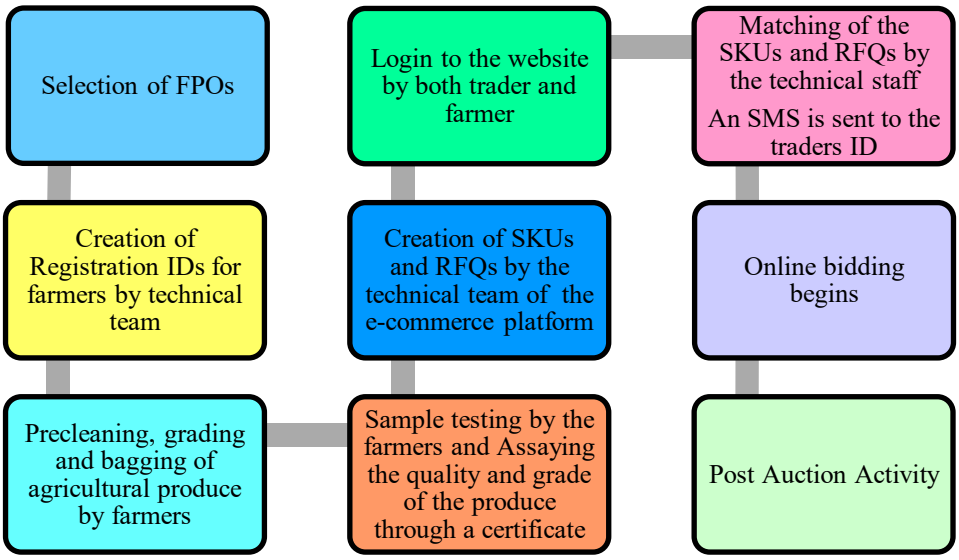

FIGURE 1. PROCESS FLOW OF TRANSACTING CHILLI THROUGH KALGUDI

The Technical team of the e-commerce platform have generated SKU (Stock Keeping Unit) to the farmers and RFQ (Request for Quote) to the trader. The SKUs defines the product description present with the farmer and RFQ describes the product the trader wants. These may include the variety, grade and quality of the produce. The farmer uploads his SKU and the trader uploads his RFQ. The matching of the required RFQ of the trader and present SKU of the farmer is done by the technical team of Kalgudi. The trader and farmer can interact verbally in the platform by signing through their registration IDs. After their verbal interaction, they may interact physically based on the price and quality of the produce. Buyers can bid on prices and interact via their laptops, on-premises computers, or via mobile apps. The farmer has the option of rejecting the bid price. Reddy and Mehjabeen (2019) studied process flow of e-NAM market which is similar to the process flow of Kalgudi as both are digital markets.

II

METHODOLOGY

2.1 Data Collection

The empirical analysis was implemented using primary data collected from a sample of 210 farmers randomly selected from six FPOs in Guntur district of Andhra Pradesh. Guntur district is selected as it is the largest producer of chilli in AP. Multistage stratified sampling technique was used for the study. Andhra Pradesh state was purposively selected as it is the highest chilli producer with 7.01 lakh tonnes (TE

2020-21) in India. The Guntur district having the highest area of 0.78 lakh ha, with production of 4.1 lakh tonnes (Directorate of Economics and Statistics, 2021) and 13489 farmers selling their produce through selected e-commerce was purposively selected for the study. Since the Kalgudi e-commerce platform has dealt with the FPOs to connect with farmers, 6 FPOs were selected from the Guntur district. The list of FPOs and respondents selected from each FPO were listed in the below Table 1:

TABLE 1. LIST OF FARMERS, ADOPTERS AND NON-ADOPTERS IN EACH FPO.

FPO	Total Farmers	No. of Adopters	No. of Adopters Selected	No. of Non-Adopters	No. of Non-Adopters Selected
Amaravathi	1885	256	13	1629	19
Bollapalli	1975	149	8	1826	21
Durgi	2453	238	12	2215	26
Macharla	3143	306	15	2837	33
Peddanandipadu	2031	223	11	1808	21
Veldurthy	2002	215	11	1787	20
Total	13489	1387	70	12102	140

Farmers that buy inputs from e-commerce and sell their output through e-commerce are classified as adopters. The remainder were non-adopters. A detailed questionnaire was distributed to chilli growers from the six FPOs listed above in Guntur district to obtain primary data. Chilli farmers were interviewed about socioeconomic variables such as input prices and quantities, production, and income.

2.2 Empirical Background of the Study

Quantifying the effect of a treatment on the treated is the main parameter of interest in investigating the impact of a social program (Heckman et al., 1997, 1998). The average treatment effect on the treated (ATT) compares the means of outcome variables of interest in the treatment group (y1) and control group (y0) based on treatment. If we observe the outcome variable of interest for everyone, the individual's gain from participating in the program (π) is:

$$\pi = y_1 - y_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq (1)}$$

The Propensity Score Matching (PSM) technique introduced by Rosenbaum and Rubin (1983). The basic idea behind the PSM method is to find control observations (i.e., non-e-commerce farmers) having observable characteristics as similar as possible to the treatment group (e-commerce farmers), to serve as valid surrogates for the missing counterfactuals.

The PSM can be expressed as,

$$P(z) = Pr\{T = 1/Z\} = E\{1/Z\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Eq (2)}$$

where T = {0,1}is the indicator for adoption and Z is the vector of pre-adoption characteristics. The conditional distribution of Z, given p (Z) is similar in both groups of adopters and non-adopters.

A parametric binary response model (in our case, probit model) will be used for single binary treatment to estimate the propensity score for each observer in the treatment (e-commerce adopters) and control (non-e-commerce adopters) groups.

After estimating propensity scores using probit model, with dependent variable 1 for adopters and 0 for non-adopters, kernel matching method, radius matching method and stratified matching method were used to compute ATT (Average Treatment effect on Treated) using the following equation:

$$\text{ATT} = \frac{1}{K}\sum_{j=1}^{k}(Y1 - Y0)$$

Where, k is number of matched pairs.

2.3 Probit Model (Single Binary Treatment)

A probit model was used to identify the factors that influence the probability of adoption of e-commerce among farmers.

The probability of adoption of the new technology can be represented as

$$\Pr(I_i = 1) = \Pr(Ii^* > 0) = \Pr(\mu_i, > -\beta Z_i) = 1 - F(-\beta Z_i) \quad \text{..... Eq (3)}$$

where F is the cumulative distribution function for I_i. where Ii is a binary indicator variable that equals 1 for farmer i in case of adoption and 0 otherwise, β is a vector of parameters to be estimated, Zi is a vector of farmer and plot-level characteristics and μi is an error term assumed to be normally distributed. Ii* is the net benefit to the i^{th} observer of adopting e-commerce platform over non-adoption.

It is assumed that Zi is a function of the vector of farmer socio-economic characteristics (sec), farm characteristics (farm), and of institutional characteristics (inst). The latent variable can be written as follows:

$$Z_i = \propto + \nu\text{sec} + \theta\text{farm} + \gamma\text{inst} + e$$

Zi* is the expected value of the latent variable Zi*

Two sampling frames from Guntur district were collected comprising the list of farmers transacting their produce through e-commerce platform Kalgudi (treated, n=70) vis-à-vis farmers transacting their produce through non-e-commerce platforms *viz.,* market yards, commission agents *etc*. (untreated, n=140). Thus, the farmers in the study area were stratified into treated and untreated based on market place where they transacted their chilli. The treated farmers majorly purchased their inputs from Kalgudi, while the untreated farmers do not purchase their inputs from Kalgudi. The variables used for probit model are listed in Table 2.

TABLE 2. DESCRIPTION OF VARIABLES USED IN PSM AND PROBIT MODELS

Variable Type	Abbreviation	Variable Expansion	Variable Type
Outcome variable (for PSM)	Price	Price received by farmer for produce (Rs.)	Continuous
	Income	Income obtained by farmer through agriculture and other allied activities after deducting the marketing and input cost (CoC was not deducted)	Continuous
Treatment variable (dependent variable for probit)	Treatment	Farmers selling their produce (chilli) through Kalgudi e-market.	Dummy (1=Treated 0=Untreated)
Independent variables	Age	Age of the farmer (years)	Continuous
	Experience	Experience in Farming	Continuous
	Education	Number of years educated	Continuous
	Extension Network	Whether received any extension service from any government or non-government organisations	Dummy (1=Received 0=Not Received
	Training received from Kalgudi	No. of training programmes attended which were given by Kalgudi	Continuous
	Android Mobile	Using Android phone or not	Dummy (1=Using 0=not using
	Market Information	Availability of information about market prices and arrivals	Dummy (1=Yes 0=No)

III

RESULTS AND DISCUSSION

The description of variables used for matching and their descriptive statistics were presented in Table 2 and 3. The average price received by the farmer was Rs.15792.8. Non-adopters received an average price of Rs. 15303.5 while adopters received average price of Rs. 16771.4 which is higher than adopters. The average income received by the sample farmers was Rs. 622315.3. For non-adopters the average farm income was Rs. 607854.4 and for adopters it was Rs. 657788.5.

3.1 Determinants and Propensity Scores for Adoption of Kalgudi E-commerce Platform by Farmers

To compare e-commerce adopters with non-adopters, pscores were estimated using a probit model. The probit regression also estimates the determinants of adoption of e-commerce platform. The estimates from the probit regression model on determinants of adoption of e-commerce in PSM are furnished in Table 4.

TABLE 3. VARIABLE DESCRIPTION AND DESCRIPTIVE ANALYSIS OF ENTIRE SAMPLE, ADOPTERS AND NON-ADOPTERS.

Variable Type	Variable	Variable Description	Entire sample (210)		Adopters (70)		Non-adopters (140)	
			Mean	S. D	Mean	S. D	Mean	S. D
Outcome variables of PSM	Price	Price received by the farmer	15792.8	1581.5	16771.4	1443.8	15303.5	1415
	Income	Gross returns after deducting marketing expenses	622315.3	157036.9	657788.5	143119.6	607854.4	158140.3
Matching Variables	Age	Age of the farmer	43.8	5.6	43.5	6.01	44.5	7.1
	Experience	Farming Experience	17.2	7.3	17.2	7.3	18.4	5.8
	Education	No. of years educated	7.4	4.5	8.1	4.6	7.2	4.1
	Extension Network	Whether having any access to extension network (1=yes, 0=no)	0.7	0.4	0.9	0.4	0.5	0.4
	Training Programs	Number of Training Programmes received from Kalgudi	1.2	0.9	1.5	0.8	1.1	1.0
	Mobile	Whether using Android mobile or not. (1=yes, 0=no)	0.5	0.3	0.7	0.4	0.4	0.4
	Market Information	Whether having access to market information or not. (1=yes, 0=no)	0.7	0.4	0.8	0.3	0.6	0.3

TABLE 4. PROBIT REGRESSION RESULTS OF PSM

Sr No.	Variable	Marginal effect	Coefficient	S.E.
1.	Age	-0.13***	-0.43***	0.13
2.	Experience	-0.12***	-0.41***	0.13
3.	Education	0.006	0.02	0.02
4.	Extension Network	0.005	0.01	0.31
5.	Training Programmes	0.14***	0.46***	0.15
6.	Android Mobile	0.45***	1.4***	0.22
7.	Market Information	0.10	0.35	0.27
Number of Observations			210	
LR statistic			89.68	
Pseudo R^2			0.33	

****, ** and * statistically significant at 1%, 5% and 10% level*

The probit results show that age, experience, Kalgudi training programs, and Android mobile availability have a substantial impact on farmers' e-commerce adoption. The probit model regression's main aim is to estimate the propensity scores that will be used to match adopters and non-adopters; nonetheless, the probit results provide a variety of intriguing insights. Farmers with higher age and more experience have negative impact on adoption of e-commerce platforms. Older farmers usually have low awareness on new technologies like e-commerce and hence with increase in age, the probability of adoption of e-commerce decreases. Farmer who received more training programmes and have android mobile phones had high impact on adoption of e-commerce platforms. Similar results have been found in Ranjan and Grote (2017).

3.2 Propensity Scores of Adopters and Non-adopters

The number of adopters matched with non-adopters is presented in Table 5. The propensity scores ranged from 0.11 to 0.8. The highest number of respondents fell under the propensity range of 0.2, and lowest number in the range of 0.8. Finally, 70 adopters were matched with 109 non-adopters.

TABLE 5. PROPENSITY SCORES OF ADOPTERS AND NON-ADOPTERS IN THE STUDY AREA

Inferior of block of p-score	Treatment		Total
	0	1	
0.1	30	4	34
0.2	46	25	71
0.4	24	21	45
0.6	9	19	28
0.8	0	1	1
Total	109	70	179

3.3 Common Support and Propensity Score Graph (ps-graph)

The dependability of PSM results is highly reliant on the matching accuracy. The quality of matching is measured by extent to which estimated propensity scores are overlapped between the treatment (adopters) and control (non-adopters). The overlap between the propensity scores of the treatment group (adopters) and the control group (non-adopters) provides common support. A large range of common support is generally associated with a better matching quality. It is clear from the ps-graph in Figure 2, that there is a considerable range of overlap between the propensity score of the adoption group and the non-adoption group.

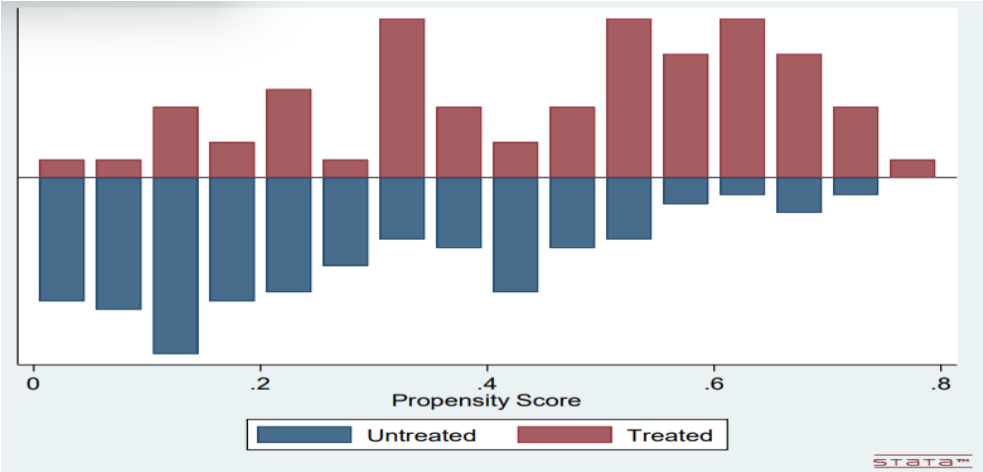

FIGURE 2. PS-GRAPH OF ADOPTERS AND NON-ADOPTERS IN THE STUDY AREA

More specifically, the common support area is [0.015, 0.6], which is associated with a loss of few observations owing to matching. In the graph, most of the adopters (red) and non-adopters (blue) were concentrated from 0.2 to 0.4.

3.4 Impact of Kalgudi E-commerce Platform on Price and Income of chilli Farmers

It is measured from both ATE and ATT of the matching methods

3.4.1 Average Treatment Effect (ATE)

Average treatment effect is the effect of treatment (e-commerce adoption) applied on both adopters and non-adopters. The treatment is generally applied only to the treated group, but the entire population may derive some direct or indirect impact from the treatment.

TABLE 6. ATT AND ATE OF PRICE AND INCOME OF THE FARMERS BY VARIOUS MATCHING METHODS

Outcome variable	Price			Income		
Matching Method	attk	attr	atts	attk	attr	atts
No. of treated matched	70	70	69	70	70	69
No. of control matched	109	109	110	109	109	110
ATE	555.1***	555.1***	555.1***	54505.6***	54505.6***	54505.6***
Std Error	185.48	185.48	185.48	18036.3	18036.3	18036.3
ATT	822.7***	1171.3***	772.8***	67488.2***	87991.3***	63999.7**
Std Error	226.6	225.7	226.1	23344.4	19952.1	25050.5
Bias	-14.2	-50.4	14.6	965.6	-4804.6	-1491.7
T	3.6	5.1	3.4	2.8	4.4	2.6

So, the ATE is the impact of treatment on entire sample. The ATE of Kalgudi on price received by farmer was Rs. 555.1 and on income of the farmer was Rs. 54505.61.

3.4.2 Average Treatment Effect on the Treated (ATT)

ATT is the effect of treatment (e-commerce adoption) actually applied on the treated individuals (adopters). In terms of the magnitude of effects, participation in e-commerce would increase the price per quintal by between Rs. 772.8 and Rs.1171.3, and income per hectare between Rs. 63999.7and Rs. 87991.3, respectively. Similar results were reported by Luo and Niu (2019).

3.4.3 Impact of Kalgudi E-commerce Platform on Price Received by Chilli Farmers

The Kernel matching method generated ATT of 822.7 with a bias of -14.2, standard error of 226.6 and T-value of 3.6 at 1 percent LOS. The radius method generated ATT of 1171.3 with a bias of -50.4, standard error of 225.7 and T-value of 5.1 at 1% LOS. The stratified matching method generated ATT of 772.8 with a bias of 14.6, standard error of 226.1 and T-value of 3.4 at 1 percent LOS. The kernel and stratified matching methods ATTs are in close vicinity and the results clearly indicate that the treated enjoyed incremental prices from the adoption of Kalgudi e-commerce platform for marketing chilli. The above results were in contrary with the findings of Priscilla and Chauhan (2019), in their study on impact of cooperative membership on price received by dairy farmers in Manipur.

3.4.4 Impact of Kalgudi E-commerce Platform on Income of Chilli Farmers

The Kernel matching method generated ATT of 67488.2 with a bias of 965.6, standard error of 23344.4 and T-value of 2.8 at 1 percent LOS. The radius method

generated ATT of 87991.3 with a bias of -4804.6, standard error of 19952.09 and T-value of 4.4 at 1 percent LOS. The stratified matching method generated ATT of 63999.7 with a bias of 1491.7, standard error of 25050.5 and T-value of 2.6 at 1 percent LOS. The kernel and stratified matching methods ATTs are in close vicinity and the results clearly indicate that the treated enjoyed incremental income per hectare from the adoption of Kalgudi e-commerce platform for marketing chilli. Similar results were reported by Luo and Niu (2019).

IV

CONCLUSION

The study has evaluated the impact of the current technological intervention such as digital marketing and e-commerce platform on chilli farmers using a sample of 70 adopters and 140 non-adopters selected from six FPOs in Guntur district of Andhra Pradesh. The non-adopters received an average price of Rs. 15303.5/- earning farm income of Rs. 607854.4/- while adopters received an average price of Rs. 16771.4/- earning farm income of Rs. 657788.5/-. The farmers adopting digital e-commerce platform for marketing received 4.98 to 7.41 per cent more price and 10.28 to 14.13 per cent more income than the farmers practicing traditional marketing practices. Thus, adopters received better price earning more income than the non-adopters transacting through e-commerce platform. The training programmes and android mobile availability had a positive and significant impact while age and experience had a negative impact on adoption of e-commerce platforms by the chilli farmers. Thus there is a need to create awareness among the farmer groups on the price and income advantage the farmers would obtain and encourage them to transact the agricultural products through e-commerce paltforms. This increases transparency and help in eliminating the market intermediaries between farmers and consumers. Additionally, it promotes local and special products, empowers small and marginal farmers, and encourages local value addition at farm level to lower post-harvest losses.

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