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To assess the technical efficiency of inputs on farmer producer organizations (FPO) and non-farmer producer organizations (non-FPO) farms in Kurnool district of Andhra Pradesh

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Abstract
Small and marginal farmers constitute the largest group of cultivators in Indian agriculture. Although the productivity of small and marginal farmers is more than that of medium and large farmers, their economic condition is worse off. A variety of approaches have emerged in response to the problems faced by the small and marginal farmers. Hence the Indian government has been promoting a new form of collectives called Farmer Producer Organizations (FPOs) to address the challenges, faced by the small and marginal farmers, particularly those to do with enhanced access to investments, technological advancements, and efficient inputs and markets (Hellin *et al*., 2009; Department of Agriculture & Cooperation 2013) [5]. Purposive-cum-random sampling technique was employed for the selection of sample. Data Envelopment Analysis (DEA) was carried out in SPSS (IBM software version 21) to examine the Technical Efficiency of selected farms. Mean technical efficiency of inputs was relatively higher on FPO farms over non-FPO farms. Particularly the mean technical efficiency was superior in onion over groundnut, but between FPO and non-FPO farms, the technical efficiency was encouraging for both the crops on FPO farms. Between FPO and non-FPO farms of onion and groundnut FPO farms were better off in respect of OTE, PTE and SE than non-FPO farms.

Keywords: Economic condition, producer organizations, technical efficiency, investments

1. Introduction
Agriculture and allied activities support livelihoods of nearly 70 per cent of India's rural population. Small and marginal farmers constitute the largest group of cultivators in Indian agriculture. About 85 per cent of operational holdings are smaller than or about two hectares and amongst these holdings, 66 per cent are less than one hectare (Singh, 2012) [9]. The small holding character of Indian agriculture is much more prominent today than even before. However, the increasing number of agricultural suicides among small and marginal farmers is an indication that these farmers' are struggling to survive.

Although the productivity of small and marginal farmers is more than that of medium and large farmers, their economic condition is worse off. According to Pingali *et al.* (2005) [8], marginal and small farmers cannot take up high-value crops as they are often perishable and are typically associated with high transaction costs.

A variety of approaches have emerged in response to the problems faced by the small and marginal farmers. At the market end of agriculture value-chain, private participation is being promoted through contract farming, particularly after the amendment of the Agricultural Produce Marketing Committee (APMC) Act in 2003. However, contract farming arrangements tend to exclude small producers (Gill, 2004) [4] and in many instances have benefited the buyers at the expense of the producers (Hellin *et al*., 2009) [5].

Agricultural cooperatives, formed under the Co-operative Credit Societies Act, 1904, have long been the dominant form of farmer collectives; however, the experience with cooperatives points too many limitations that prevent effective collective action. Hence the Indian government has been promoting a new form of collectives called Farmer Producer Organizations (FPOs) to address the challenges, faced by the small and marginal farmers, particularly those to do with enhanced access to investments, technological advancements, and efficient inputs and markets (Hellin *et al*., 2009) [5]. The basic purpose envisioned for the FPOs is to collectivize small farmers for backward linkage for inputs like seeds, fertilizers, credit, insurance, knowledge and extension services; and forward linkages such as collective marketing, processing, and market-led agriculture production (Mondal, 2010) [6].

However numerous questions arise about the delivery on the promises made by FPOs. Have FPOs been successful in reducing input costs and bridging gap between farm and market prices-a marker of farmer's bargaining power. Have they been successful in providing more markets and ease credit constraints of group members. The questions need to be found answers through empirical analysis. Against this background the present study entitled "To assess the technical efficiency of inputs on FPO and non-FPO farms in Kurnool District of Andhra Pradesh" has been taken.

2. Methodology

Purposive-cum-random sampling technique was employed for the selection of sample in the present study. FPOs are found functioning in Prakasam, Kurnool, Anantapur and West Godavari districts of Andhra Pradesh. Kurnool district was purposively selected, as the district is having nine actively functioning FPOs (six under NABARD and three under SFAC). The list of the mandals along with corresponding number of FPO farmers was prepared. One mandal from the district with maximum number of FPO farmers was selected purposively. The selected FPO was found covering four villages in Dhone mandal.

All the FPO farmers in selected villages were listed out and 40 farmers were randomly selected. Another sample of 40 non-FPO farmers from the same villages were also randomly selected to serve as a control group.

The information related to the present study was collected using a well-defined and pre-tested schedule through personal interview method. Detailed information was collected and it pertained to the agricultural year 2018-2019.

3. Tools used for analysis

Data envelopment analysis (DEA) was carried out in SPSS (IBM software version 21) to examine the Overall Technical Efficiency (OTE), Pure Technical Efficiency (PTE), Scale Efficiency (SE) and Congestion Efficiency (CE).

Technical Efficiency: The technical efficiency of a farm can be defined as the ability and willingness of the farm to obtain the maximum possible outcome with a specified endowment of inputs.

OTE: This is related to a given farm operating at constant returns to scale. OTE farms are DMUs (Decision Making Units)

PTE: This concept arises when a firm is operating at Variable Returns to Scale (VRTS). A Decision Making Unit (DMU) of a firm which is identified as technically not efficient on Constant Returns to Scale (CRTS) frontier can be recognized as Technical Efficiency (TE) on VRTS if decision making unit (DMU) fall on VRTS frontier. This unit falling on VRTS frontier is called Pure Technical Efficiency (PTE).

SE: A DMU is said to be scale efficient (SE) if it operates at CRTS.

SE = OTE/PTE

The technical efficiency of the resources was estimated using Data Envelopment Analysis (DEA).

The model was specified:

$$\text{Max } \emptyset_k \quad \ldots (1)$$

$$\text{Subject to } \sum_{j=1}^{n} Xij\ \lambda_j \leq X_{ik} \quad \ldots (2)$$

Where,

i = 1, 2, 3 inputs

j = 1 to 20 farmers

k = kth farmer's problem

$$\sum_{j=1}^{n} Y_j\ \lambda_j \geq \emptyset_k\ Y_k \quad \ldots (3)$$

Where,

$\phi_\kappa\ \alpha\nu\delta\ \lambda_j$ = Unknowns

n = Number of farmers

X_{ij} = ith input used by jth farmer

Y_j = crop output obtained by the jth farmer

λ_j = jth unknown parameter obtained from the programme

4. Results and discussions

Different types of efficiency measures

4.1 Onion-FPO farms

It is clear from Table 1 that farmers-1, 3, 5, 6, 7, 8, 11, 15, 16 and 18 were the most efficient considering OTE, PTE and SE. Farmers-2, 4, 9, 10, 12, 14, 19, and 20 were pure technical efficient. The overall technical efficiency for the farmers - 2, 9, 10, 12, 13, 14, 17, 19 and 20 was due to pure technical inefficiency. Overall technical efficiency was 98 per cent, pure technical efficiency 99 per cent and scale efficiency 98 per cent.

4.2 Groundnut-FPO farms

It is clear from Table 2 that farmers-3, 6, 7, 8, 14, 15 and 16 were the most efficient considering OTE, PTE and SE. Farmers-2 and 13 were pure technical efficient. The overall technical inefficiency for the farmers-1, 4, 5, 9, 10, 11, 12, 13, 17, 18, 19 and 20 was due to pure technical inefficiency. Overall technical efficiency was 78 per cent, pure technical efficiency 83 per cent and scale efficiency 95 per cent.

4.3 Onion non-FPO farms

In the case of non-FPO farms none of farmers turned out to be efficient by OTE, PTE and SE (Table 3). Farmers - 1, 5 and 6 were pure technical efficient. Overall technical efficiency on onion non-FPO farms was 91 per cent, pure technical efficiency was 96 per cent and scale efficiency 94 per cent. Between FPO farms and non-FPO farms of onion, FPO farms were better off in respect of OTE, PTE and SE.

4.4 Groundnut non-FPO farms

In the case of non-FPO farms only 7 farmers turned out to be efficient by OTE, PTE and SE (Table 4). Farmer's number 3 and 7 were pure technical efficient. The overall technical inefficiency for farmers-1, 2, 4, 5, 8, 11, 12, 13, 16, 17 and 20 was due to pure technical inefficiency. Overall technical efficiency on groundnut non-FPO farms was 71 per cent, pure technical efficiency was 78 per cent and scale efficiency 91 per cent. Between FPO farms and non-FPO farms of groundnut, FPO farms were better off in respect of OTE, PTE and SE.

Table 1: Technical efficiency of onion production on FPO farms

Farmer	OTE	PTE	SE
1	1	1	1
2	0.8867	1	0.9836
3	1	1	1
4	0.9836	1	0.9836
5	1	1	1
6	1	1	1
7	1	1	1
8	1	1	1
9	0.9578	1	0.9578
10	0.9836	1	0.9836
11	1	1	1
12	0.8852	1	0.8852
13	0.9677	0.9738	0.9937
14	0.9836	1	0.9836
15	1	1	1
16	1	1	1
17	0.9722	0.9729	0.9992
18	1	1	1
19	0.9578	1	0.9578
20	0.9836	1	0.9836
Mean	0.9829	0.9973	0.9825

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

Table 2: Technical efficiency of groundnut production on FPO farms

Farmer	OTE	PTE	SE
1	0.815	0.91	0.8956
2	0.5207	1	0.5207
3	1	1	1
4	0.8052	0.8266	0.9741
5	0.689	0.6926	0.9948
6	1	1	1
7	1	1	1
8	1	1	1
9	0.5733	0.5841	0.9815
10	0.4	0.4102	0.9751
11	0.6142	0.6245	0.9984
12	0.629	0.639	0.9844
13	0.7398	1	0.7398
14	1	1	1
15	1	1	1
16	1	1	1
17	0.7416	0.7626	0.9725
18	0.8686	0.8787	0.9885
19	0.7233	0.7324	0.9876
20	0.6286	0.6324	0.994
Mean	0.7874	0.8346	0.9496

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

Table 3: Technical efficiency of onion production on non-FPO farms

Farmer	OTE	PTE	SE
1	0.9344	1	0.9344
2	0.9342	0.9685	0.9648
3	0.9334	0.9879	0.9458
4	0.8491	0.9579	0.8864
5	0.9578	1	0.0978
6	0.9935	1	0.9935
7	0.9058	0.9443	0.9591
8	08700	0.9367	0.9393
9	0.8852	0.9483	0.9334
10	0.8541	0.9924	0.8605
11	0.8835	0.9819	0.8997
12	0.9032	0.9911	0.9113
13	0.9275	0.9655	0.9606
14	0.8784	0.9499	0.9247
15	0.9600	0.9760	0.9835
16	0.8852	0.9298	0.9520
17	0.8709	0.9162	0.9505
18	0.8800	0.9482	0.9280
19	0.9616	0.9813	0.9798
20	0.9898	0.9956	0.9942
Mean	0.9134	0.9686	0.943

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

Table 4: Technical efficiency of groundnut production on non-FPO Farms

Farmer	OTE	PTE	SE
1	0.3496	0.3597	0.9719
2	0.8194	0.8295	0.9878
3	0.3294	1	0.3294
4	0.5652	0.5754	0.9823
5	0.5199	0.6219	0.836
6	1	1	1
7	0.5644	1	0.5644
8	0.5402	0.5502	0.9818
9	1	1	1
10	1	1	1

11	0.6244	0.7214	0.8655
12	0.6503	0.6604	0.9847
13	0.6576	0.6616	0.994
14	1	1	1
15	1	1	1
16	0.3392	0.3493	0.9711
17	0.4294	0.5214	0.8236
18	1	1	1
19	1	1	1
20	0.9236	0.9466	0.9757
Mean	0.7156	0.7899	0.9134

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5 Estimation of wastage of inputs

Input wastage for onion and groundnut crops under FPO and non-FPO farms were estimated and presented below.

4.5.1 FPO farms-wastage of seed in onion

For onion crop of FPO farms, very less number of farmers were identified as inefficient based on overall technical efficiency, pure technical efficiency and scale efficiency. (Table5). These varied levels of inefficiencies of the farmers led to the seed wastage of 0.16, 0.04 and 0.15 kg/ha respectively.

Table 5: Seed wastage in onion cultivation on FPO farms (kg/ha)

Farmer	OTE	PTE	SE
1	0	0	0
2	0.163934	0	0.163934
3	0	0	0
4	0.163934	0	0.163934
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0.294737	0	0.294737
10	0.163934	0	0.163934
11	0	0	0
12	0.57377	0	0.57377
13	0.483871	0.391872	0.094467
14	0.163934	0	0.163934
15	0	0	0
16	0	0	0
17	0.5	0.486486	0.013889
18	0	0	0
19	0.294737	0	0.294737
20	0.163934	0	0.163934
Mean	0.1483	0.0439	0.1045
Mean/ha	0.1594	0.04272	0.151

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.2 FPO farms-wastage of fertilizer in onion

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in onion crop of FPO farms resulted in a wastage of fertilizer to an extent of 7.36, 2.14 and 5.22 kg/ha respectively (Table 6).

Table 6: Fertilizer wastage in onion cultivation on FPO farms (kg/ha)

Farmer	OTE	PTE	SE
1	0	0	0
2	7.377049	0	7.377049
3	0	0	0
4	7.377049	0	7.377049
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	14.73684	0	14.73684
10	7.377049	0	7.377049
11	0	0	0
12	25.81967	0	25.81967

13	22.58065	18.28737	4.408442
14	7.377049	0	7.377049
15	0	0	0
16	0	0	0
17	22.22222	21.62162	0.617284
18	0	0	0
19	14.73684	0	14.73684
20	7.377049	0	7.377049
Mean	6.849	1.9954	4.86
Mean/ha	7.364	2.145	5.22

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.3 FPO farms-wastage of pesticide in onion

The overall technical inefficiency, pure technical inefficiency and scale inefficiency caused a wastage of pesticides to an extent of 0.03, 0.009 and 0.003 litres/ha respectively (Table 7).

Table 7: Pesticide wastage in onion cultivation on FPO farms (litres/ha)

Farmer	OTE	PTE	SE
1	0	0	0
2	0.040984	0	0.04984
3	0	0	0
4	0.032787	0	0.032787
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0.063158	0	0.063158
10	0.032787	0	0.032787
11	0	0	0
12	0.114754	0	0.114754
13	0.096774	0.078374	0.018893
14	0.040984	0	0.040984
15	0	0	0
16	0	0	0
17	0.09722	0.094595	0.002701
18	0	0	0
19	0.063158	0	0.063158
20	0.032787	0	0.032787
Mean	0.0307	0.0086	0.0221
Mean/ha	0.033	0.009	0.003

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.4 FPO farms-wastage of seed in groundnut

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in groundnut of FPO farms resulted in a wastage of seed to an extent of 38.88, 30.32 and 9.16 kg/ha respectively (Table8).

Table 8: Seed wastage in groundnut cultivation on FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	32.375	15.75	18.27
2	67.102	0	67.102
3	0	0	0
4	34.09	30.345	4.5325
5	31.1	30.74	0.52
6	0	0	0
7	0	0	0
8	0	0	0
9	59.738	58.226	2.59
10	105	103.215	4.3575
11	67.515	65.765	2.8
12	37.1	36.1	1.56
13	45.535	0	45.535
14	0	0	0
15	0	0	0
16	0	0	0

17	54.264	49.854	5.775
18	18.396	16.982	1.61
19	38.738	37.464	1.736
20	77.994	77.196	1.26
Mean	33.447	26.081	7.88
Mean/ha	38.88	30.326	9.16

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.5 FPO farms-wastage of fertilizer in groundnut

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in groundnut crop of FPO farms resulted in a wastage of fertilizer to an extent of 56.75, 43.8 and 13.83 kg/ha respectively (Table 9).

Table 9: Fertilizer wastage in groundnut cultivation on FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	46.25	22.5	26.1
2	107.8425	0	107.8425
3	0	0	0
4	48.7	43.35	6.475
5	38.875	38.425	0.65
6	0	0	0
7	0	0	0
8	0	0	0
9	96.0075	93.5775	4.1625
10	150	147.45	6.225
11	96.45	93.95	4
12	46.375	45.125	1.95
13	65.05	0	65.05
14	0	0	0
15	0	0	0
16	0	0	0
17	77.52	71.22	8.25
18	29.565	27.2925	2.5875
19	62.2575	60.21	2.79
20	111.42	110.28	1.8
Mean	48.81	37.669	11.894
Mean/ha	56.755	43.8	13.83

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.6 FPO farms-wastage of pesticide in groundnut

The overall technical inefficiency, pure technical inefficiency and scale inefficiency caused a wastage of pesticides in groundnut crop to an extent of 0.41, 0.32 and 0.10 lt/ha respectively (Table 10).

Table 10: Pesticide wastage in groundnut cultivation on FPO farms (litres/ha)

Farmer	OTE	PTE	S E
1	0.37	0.18	0.2088
2	0.71895	0	0.71895
3	0	0	0
4	0.3896	0.3468	0.0518
5	0.311	0.3074	0.0052
6	0	0	0
7	0	0	0
8	0	0	0
9	0.64005	0.62385	0.02775
10	1.2	1.1796	0.0498
11	0.7716	0.7516	0.032
12	0.371	0.361	0.0156
13	0.5204	0	0.5204
14	0	0	0
15	0	0	0
16	0	0	0
17	0.5168	0.4748	0.055
18	0.1971	0.18195	0.01725
19	0.41505	0.4014	0.0186

20	0.7352	0.7352	0.012
Mean	0.3581	0.2771	0.0866
Mean/ha	0.416	0.322	0.1006

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.7 Non-FPO farms-wastage of seed in onion

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in onion of non-FPO farms resulted in a wastage of seed to an extent of 1.603, 0.385 and 0.70 kg/ha respectively (Table 11).

Table 11: Seed wastage in onion cultivation on non-FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	0.655738	0	0.655738
2	0.655738	0.314961	0.351859
3	0.655738	0.120482	0.541783
4	2.262248	0.631281	1.702622
5	0.294737	0	0.294737
6	0.116129	0	0.116129
7	1.41294	0.834798	0.612214
8	1.44	0.758454	0.727529
9	1.147541	0.516899	0.665017
10	2.188406	0.112611	2.091496
11	1.39759	0.216857	1.202464
12	1.741935	0.159884	1.59623
13	1.304348	0.619846	0.708914
14	1.822967	0.751412	1.128063
15	0.48	0.287338	0.197389
16	1.147541	0.701754	0.479431
17	1.935484	1.256499	0.741061
18	1.44	0.621027	0.86367
19	0.690909	0.335444	0.362215
20	0.181818	0.078928	0.103343
Mean	1.1485	0.4159	0.757
Mean/ha	1.063	0.385	0.7009

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.8 Non-FPO farms-wastage of fertilizer in onion

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in onion crop of non-FPO farms resulted in a wastage of fertilizer to an extent of 48.74, 17.64 and 32.14 kg/ha respectively (Table 12).

Table 12: Fertilizer wastage in onion cultivation on non-FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	29.5082	0	29.5082
2	29.5082	14.17323	15.83367
3	29.5082	5.421687	24.38025
4	105.5716	29.4598	79.45569
5	14.73684	0	14.73684
6	5.16129	0	5.16129
7	65.9372	38.95723	28.56998
8	66	34.76248	33.34508
9	51.63934	23.26044	29.92577
10	102.1256	5.255203	97.60315
11	64.05622	9.939273	55.11292
12	77.41935	7.10595	70.84356
13	57.97101	27.54872	31.50728
14	85.07177	35.0591	52.64296
15	22	13.16964	9.044685
16	51.63934	31.57895	21.57439
17	90.32258	58.63663	34.58284
18	66	28.46373	39.58487
19	30.70707	14.90863	16.09845
20	8.080808	3.507912	4.593036
Mean	52.64	19.06	34.71
Mean/ha	48.74	17.64	32.138

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.9 Non-FPO farms-wastage of pesticides in onion

The inefficiencies noticed on overall technical, pure technical and scale caused in a wastage of pesticides to an extent of 0.21, 0.07 and 0.15 lt/ha respectively (Table 13).

Table 13: Pesticides wastage in onion cultivation on non-FPO farms (litres/ha)

Farmer	OTE	PTE	S E
1	0.131148	0	0.131148
2	0.131148	0.062992	0.070372
3	0.131148	0.024096	0.108357
4	0.45245	0.126256	0.340524
5	0.063158	0	0.063158
6	0.022581	0	0.022581
7	0.282588	0.16696	0.122443
8	0.3	0.158011	0.151569
9	0.229508	0.10338	0.133003
10	0.437681	0.022522	0.418299
11	0.291165	0.045179	0.250513
12	0.33871	0.031089	0.310378
13	0.253623	0.120526	0.137844
14	0.364593	0.150282	0.225613
15	0.1	0.059862	0.041123
16	0.229508	0.140351	0.095886
17	0.387097	0.2513	0.148212
18	0.3	0.129381	0.179931
19	0.134343	0.065225	0.07431
20	0.035354	0.015347	0.020095
Mean	0.2307	0.0836	0.152
Mean/ha	0.2136	0.077	0.1407

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.10 Non-FPO farms-wastage of seed in groundnut

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in groundnut of non-FPO farms resulted in a wastage of seed to an extent of 50.58, 37.59 and 15.25 kg/ha respectively (Table 14).

Table 14: Seed wastage in groundnut cultivation on non-FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	91.056	89.642	3.394
2	25.284	23.87	1.708
3	117.355	0	117.355
4	76.09	74.305	3.0975
5	100.821	79.401	34.44
6	0	0	0
7	76.23	0	76.23
8	64.372	62.972	2.548
9	0	0	0
10	0	0	0
11	78.876	58.506	28.245
12	73.437	71.316	3.213
13	83.888	82.908	1.47
14	0	0	0
15	0	0	0
16	138.768	136.647	6.069
17	99.855	83.755	30.87
18	0	0	0
19	0	0	0
20	16.044	11.214	5.103
Mean	52.1038	38.72	15.7145
Mean/ha	50.585	37.59	15.256

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.11 Non-FPO farms-wastage of fertilizer in groundnut

The overall technical inefficiency, pure technical inefficiency and scale inefficiency observed in groundnut crop of non-FPO farms resulted in a wastage of fertilizer to an extent of 54.11, 39.76 and 16.7 kg/ha respectively (Table 15).

Table 15: Fertilizer wastage in groundnut cultivation on non-FPO farms (kg/ha)

Farmer	OTE	PTE	S E
1	97.56	96.045	4.215
2	26.5482	25.0635	1.7934
3	131.4376	0	131.4376
4	84.3512	82.3724	3.4338
5	92.1792	72.5952	31.488
6	0	0	0
7	90.6048	0	90.6048
8	72.4185	70.8435	2.8665
9	0	0	0
10	0	0	0
11	67.608	50.148	24.21
12	74.8358	72.6744	3.2742
13	92.448	91.368	1.62
14	0	0	0
15	0	0	0
16	145.376	143.154	6.358
17	0	104.3348	38.4552
18	0	0	0
19	0	0	0
20	14.9744	10.4664	4.7628
Mean	55.736	40.9532	17.225
Mean/ha	54.11	39.76	16.7

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

4.5.12 Non-FPO farms-wastage of pesticides in groundnut

The inefficiencies noticed on overall technical, pure technical and scale caused in a wastage of pesticides to an extent of 0.53, 0.38 and 0.16 lt/ha respectively (Table 16).

Table 16: Pesticides wastage in groundnut cultivation on non-FPO Farms (litres/ha)

Farmer	OTE	PTE	S E
1	0.9756	0.96045	0.04215
2	0.2709	0.25575	0.0183
3	1.3412	0	1.3412
4	0.8696	0.8492	0.0354
5	0.9602	0.7562	0.328
6	0	0	0
7	0.8712	0	0.8712
8	0.6897	06.747	0.0273
9	0	0	0
10	0	0	0
11	0.7512	0.5572	0.269
12	0.6994	0.6792	0.0306
13	0.856	0.846	0.015
14	0	0	0
15	0	0	0
16	1.3216	1.3014	0.0578
17	1.1412	0.9572	0.3528
18	0	0	0
19	0	0	0
20	0.1528	0.1068	0.0486
Mean	0.545	0.3972	0.1718
Mean/ha	0.53	0.385	0.166

Note: OTE: Overall Technical Efficiency
PTE: Pure Technical Efficiency
SE: Scale Efficiency

The technical efficiency analysis brings out some very important observations. Mean technical efficiency of inputs was relatively higher on FPO farms over non-FPO farms. Particularly the mean technical efficiency was superior in onion over groundnut, but between FPO and non-FPO farms, the technical efficiency was encouraging for both the crops on FPO farms. This evidently shows that FPO had a role in extracting higher efficiency of inputs for the crops grown by the FPO farmers. However a comparision technical efficiency of onion and groundnut on FPO farms exclusively revealed that the former had fared better over the latter. Therefore it calls for additional efforts by the concerned for improving groundnut economics on FPO farms.

5. Conclusion

Data envelopment analysis (DEA) was carried out to examine the overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) in onion crop. Overall technical efficiency was 98 per cent, pure technical efficiency was 99 per cent and scale efficiency was 99 per cent on FPO farms. Overall technical efficiency on non-FPO farms was 91 per cent, pure technical efficiency was 89 per cent and scale efficiency was 87 per cent. Between FPO and non-FPO farms of onion, FPO farms were better off in respect of OTE, PTE and SE than non-FPO farms.

Overall technical efficiency was 78 per cent, pure technical efficiency was 83 per cent and scale efficiency was 95 per cent on groundnut FPO farms. Overall technical efficiency on non-FPO farms was 72 per cent, pure technical efficiency was 79 per cent and scale efficiency was 91 per cent. Between FPO and non-FPO farms of groundnut, FPO farms were better off in respect of OTE, PTE and SE than non-FPO farms.

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