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Factors for Value Realization of Tomato, Onion, and Potato (TOP) under Operation Greens Using DEMATEL Method

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ABSTRACT

Operation Greens Programme of the Government of India focuses on post-harvest management of Tomato, Onion, and Potato (TOP) crops, value chain development, and value realization of farmers' produce, which helps in enhancing livelihood security. The study conducted during 2022-2023 focused on factors determining the value realization of TOP crops under operation greens. The data were collected using a semi-structured interview schedule, with 90 farmers for each crop i.e., Tomato, Onion, and Potato. The government policy initiatives under Operation Greens were the most important factor, which mutually affected the socio-psychological, market intelligence, and input supply for TOP cultivation. About 42 per cent of respondents perceived Government policy under operation greens as important for value realization and 37.40 per cent of respondents perceived support from grassroots level extension agencies as important. Improving government policies followed for Operation Greens would result in the overall betterment of farmers and the agricultural sector of India.

INTRODUCTION

Around 52 per cent of the population of India is directly and indirectly associated in agriculture, contributing to 18.8 per cent of gross domestic product (Press Information Bureau, 2023). Currently the agricultural sector in the country is parallelly modernized with advancement in technology sector. However, post-harvest losses in fruits and vegetables continue to be a major issue, which is due to low capacity of food processing, approximately 2 per cent of fruits and vegetables (Ministry of Food Processing & Industries, 2022) and lack of infrastructure and poor economic condition of majority of the farmers. The other problems in the agricultural sector in India includes: non-realization of optimum price for farm produce by farmers due to damage of crops and deficit of strong marketing information system and price volatility of crops (Gulati & Wardhan, 2021). Among the vegetables; tomato, onion, and potato are the top three commodities included in consumption basket consumed by Indian households (Kishore et al., 2022). The problem with vegetable commodities is that on production increases sharply, their prices collapse because lack of enough modern storage capacity in the country (Majunder & Cherala, 2021). The linkage between processing and organized retailing are very weak and small in India, which often results in farmer receiving less than 1/4th of what consumers pay for their produce in major cities. As about 85 per cent of farmers in India are small and marginal category, which means they have less land holdings and other resources making them more vulnerable to stressed situations (Likhi, 2020). Government of India has taken several steps through implementation of schemes like Mission for Integrated Development of Horticulture (MIDH), Scheme for

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Integrated Cold Chain, Value Addition and Preservation Infrastructure under Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters (SAMPADA) scheme, Capital Investment Subsidy for Construction/Expansion / Modernization of Cold Storages and Storages for Horticulture Products to improve upon the situation of farmers. However, the results from these schemes does not show much improvement, so in 2018-2019, Operation Greens programme was launched by Government of India with the objectives; Enhancing value realization of TOP farmers by targeted interventions to strengthen TOP production clusters and their FPOs and linking them with the market; Price stabilization for producers and consumers by proper production planning in the TOP clusters and introduction of dual use varieties through convergence with the scheme implemented by Mission for Integrated Development of Horticulture (MIDH) and state governments; Reduction in post-harvest losses by creation of farm gate infrastructure, development of suitable agri-logistics, creation of appropriate storage capacity linking consumption centers; Increase in food processing capacities and value addition in TOP value chain by creating firm linkages with production clusters, and Setting up of market intelligence network to collect and collate real time data on demand and supply and price on regional and seasonal basis to moderate and check localized gluts of TOP crops. Hence, considering the view that farmers are unable to realize the value (in the form of income or livelihood betterment), the study on identification of key factors responsible for value realization of TOP crops under Operation Greens was taken up.

METHODOLOGY

The study with *exploratory research design* was conducted in Maharashtra, Gujarat, and Uttar Pradesh during 2022-2023. Two districts each from Maharashtra (Ahmednagar & Nashik), Gujarat (Anand & Kheda) and Uttar Pradesh (Meerut & Hapur) were selected purposively as per tomato, onion and potato clusters established by Government of India in 2018-2019. Cochran formula (n_0 = Z2* p* qe2) was used to calculate the essential sample size for the study. Where, n_0 is the sample size, Z2 is the area under the acceptance region in a normal distribution ($1–\alpha$), e is the preferred level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1- p. The total sample size for the study was 270, where 45 respondents were selected randomly from each cluster of villages in 6 districts (Ahmednagar, Nashik, Anand, Kheda, Meerut, Hapur) in the three selected states i.e., Maharashtra, Gujarat, UP, respectively. Decision Making Trial and Evaluation Laboratory (DEMATEL) method was adopted to identify influencing factors of value realization of TOP crops under Operation Greens.

After identification of factors for value realization of TOP crops under operation greens, these factors were administered to farmer respondents to know the importance of these factors from farmers' point of view. The data were collected on *Likert* type five-point continuum having i.e., Least important (1), less important (2), moderately important (3), Important (4) and Most important (5). The weighted mean score for each facilitating factor was worked out and ranking is done according to weighted mean score of each factor.

RESULTS AND DISCUSSION

The demographic profile of the respondents revealed that majority of the respondents (91.48%) was male and only 8.50 per cent were female and most of the respondents (59.62%) were between age group of 31-50 years and followed by more than 50 years (22.90%) and less than 30 years (17.40). All the selected respondents were engaged in agriculture as main occupation and majority (40.37%) of the respondents were having secondary level of education followed by illiterate (30.74%) and primary level education (22.59%); and only 6.29 per cent respondents were having senior secondary level of education. Findings are in line with Ranjit & Sharma (2021), & Bharti et al., (2022).

A perusal of the results (Table 1) regarding factors and their importance show that according to perceived degree of importance, favorable policy of government under operation greens (mean score = 4.325) was perceived to be most important factor followed by support from grassroot level extension agencies (mean score = 4.320), high market intelligence (mean score = 4.309), farmers' socio psychological factors (mean score = 4.270), and sufficient input support under operation greens (mean score = 4.200). Results have shown that the important values of the factors do not have much variation; therefore, it is very reasonable to have all the factors to be very important from the farmers' point of view (Li

Table 1. Factors determining value realization of TOP crops under Operation Greens

S.No.	Factors	Degree of importance (Mean Score)
1.	High knowledge of cultivation practices of TOP crops	3.956
2.	Ownership of large land	4.172
3.	Availability of high yielding varieties and other inputs	4.039
4.	High risk involved in TOP crops	3.825
5.	Sufficient credit /subsidy support under operation greens	4.152
6.	Sufficient input support under operation greens	4.200
7.	High market intelligence	4.309
8.	Easy availability of market and easy marketability	3.963
9.	Favorable policy of government under operation greens	4.325
10.	Attractive price for produce	3.621
11.	Support from grassroot level extension agencies	4.320
12.	Avenues for more value addition/food processing	4.015
13.	Farmers' socio psychological factors	4.270

& Wu, 2022). After the identification of important factors, it is not possible to improve all the factors with limited resources. So, in order to study more critically, five major factors were identified after discussion with farmer respondents, which included farmers socio-psychological factors, market intelligence of farmers regarding Tomato, Onion, and Potato crops and input support provided under Operation Greens, government policies followed under operation greens, support from grassroot level extension agency. After identification of key factors, the second interview schedule for applying DEMATEL was administered to experts in subject area to first prioritize the importance of key factors and then construct the causal relations among them. With this process, the key factors for improving the value realization of TOP crops under operation greens were identified to make improvements by observing causal relationship among these key factors.

To follow the procedure of DEMATEL method, the first survey data from 20 expert respondents were taken and mentioned in 5×5 non-negative matrices, as follows:

Table 2 depicts the direct and indirect effects of five factors. Finally, the threshold value used in step 4 computed the average of the elements in matrix T, which was found to be 1.1870 and the diagram of these five factors, is depicted in Figure 1.

Based on results from Table 2, the importance of the five factors was prioritized as D>C>E>B>A based on (r+c) values, where government policies under operation greens was the most important with the value of 12.163, while farmers' socio-

According to the procedure followed in methodology section, the average matrix A was constructed based on Eq. (1):

A=

0	2.35	2.80	1.65	2.45
2.15	0	2.35	2.20	2.50
2.25	2.40	0	2.65	2.00
3.05	2.70	2.65	0	2.95
2.20	2.80	2.35	2.65	0

In step 2, calculation of the normalized initial direct-relation matrix D, depicted below:

D =

0000	0.2070	0.2466	0.1453	0.2158
0.1894	0000	0.2070	0.1938	0.2202
0.1982	0.2114	0000	0.2334	0.1762
0.2687	0.2378	0.2334	0000	0.2202
0.1938	0.2466	0.2070	0.2334	0000

In Step 3, calculation of matrix T by the following formula:

T=

0.9877	1.2133	1.2323	1.0807	1.1515
1.1505	1.0442	1.2071	1.1154	1.1570
1.1688	1.2296	1.0474	1.1519	1.1376
1.3509	1.3898	1.3788	1.0915	1.3014
1.2265	1.3186	1.2825	1.2115	1.0480

$$X^1=\begin{bmatrix}0&2&3&3&3\\1&0&2&2&2\\0&3&0&1&3\\3&2&3&0&2\\3&2&3&2&0\end{bmatrix}\quad X^2=\begin{bmatrix}0&1&2&2&3\\3&0&2&1&2\\3&2&0&1&3\\3&3&3&0&3\\2&2&3&1&0\end{bmatrix}\quad X^3=\begin{bmatrix}0&1&3&2&4\\2&0&2&1&2\\1&2&0&2&2\\2&2&3&0&2\\2&3&2&2&0\end{bmatrix}\quad X^4=\begin{bmatrix}0&2&2&1&2\\3&0&1&2&2\\1&2&0&2&2\\3&4&3&0&3\\3&2&2&3&0\end{bmatrix}$$

$$X^5=\begin{bmatrix}0&2&3&1&2\\2&0&3&3&2\\3&1&0&3&3\\4&3&4&0&4\\2&3&2&2&0\end{bmatrix}\quad X^6=\begin{bmatrix}0&2&3&2&3\\2&0&4&3&1\\4&1&0&3&3\\4&1&2&0&3\\4&1&2&3&0\end{bmatrix}\quad X^7=\begin{bmatrix}0&3&2&1&2\\4&0&1&2&3\\2&1&0&3&1\\3&4&3&0&4\\1&2&4&4&0\end{bmatrix}\quad X^8=\begin{bmatrix}0&2&3&1&2\\2&0&3&3&1\\3&1&0&3&3\\4&3&4&0&4\\2&3&2&2&0\end{bmatrix}$$

$$X^9=\begin{bmatrix}0&1&4&2&1\\2&0&3&1&4\\1&3&0&4&2\\4&2&1&0&4\\1&2&3&2&0\end{bmatrix}\quad X^{10}=\begin{bmatrix}0&4&4&1&4\\3&0&3&2&3\\2&3&0&3&2\\4&2&1&0&1\\1&4&2&3&0\end{bmatrix}\quad X^{11}=\begin{bmatrix}0&3&4&2&3\\3&0&3&4&4\\4&3&0&3&2\\2&4&3&0&4\\3&4&2&4&0\end{bmatrix}\quad X^{12}=\begin{bmatrix}0&2&3&4&1\\1&0&4&4&2\\2&3&0&3&1\\1&4&4&0&1\\1&4&3&2&0\end{bmatrix}$$

$$X^{13}=\begin{bmatrix}0&3&4&1&3\\1&0&1&2&2\\2&1&0&3&2\\3&1&3&0&3\\2&4&2&3&0\end{bmatrix}\quad X^{14}=\begin{bmatrix}0&1&4&2&3\\1&0&2&3&4\\4&2&0&3&1\\2&3&3&0&4\\3&4&1&4&0\end{bmatrix}\quad X^{15}=\begin{bmatrix}0&1&4&2&3\\2&0&3&1&4\\2&4&0&4&2\\4&3&2&0&4\\1&3&1&2&0\end{bmatrix}\quad X^{16}=\begin{bmatrix}0&3&2&2&1\\2&0&2&2&3\\3&3&0&3&1\\3&4&4&0&4\\1&2&3&2&0\end{bmatrix}$$

$$X^{17}=\begin{bmatrix}0&4&3&1&4\\2&0&1&1&2\\3&2&0&1&2\\3&3&1&0&3\\2&4&2&3&0\end{bmatrix}\quad X^{18}=\begin{bmatrix}0&4&1&1&2\\3&0&2&1&4\\2&4&0&3&1\\4&2&1&0&1\\4&1&2&3&0\end{bmatrix}\quad X^{19}=\begin{bmatrix}0&2&1&2&1\\2&0&4&4&1\\1&3&0&2&3\\1&2&4&0&1\\3&2&4&2&0\end{bmatrix}\quad X^{20}=\begin{bmatrix}0&4&1&3&2\\2&0&1&2&2\\2&4&0&3&1\\4&2&1&0&1\\3&4&2&4&0\end{bmatrix}$$

Table 2. Prioritization of factor dimensions of farmers

	Factor dimensions	r	c	r+c	r-c	Indicator
A	Farmers' socio-psychological factors	5.665	5.884	11.550	-0.219	Effect
B	Market intelligence for TOP crops	5.674	6.195	11.870	-0.521	Effect
C	Input supply under operation greens	5.735	6.148	11.883	-0.412	Effect
D	Government policies under operation greens	6.512	5.652	12.163	0.861	Cause
E	Support from grassroot level extension agency	6.087	5.795	11.882	0.291	Cause

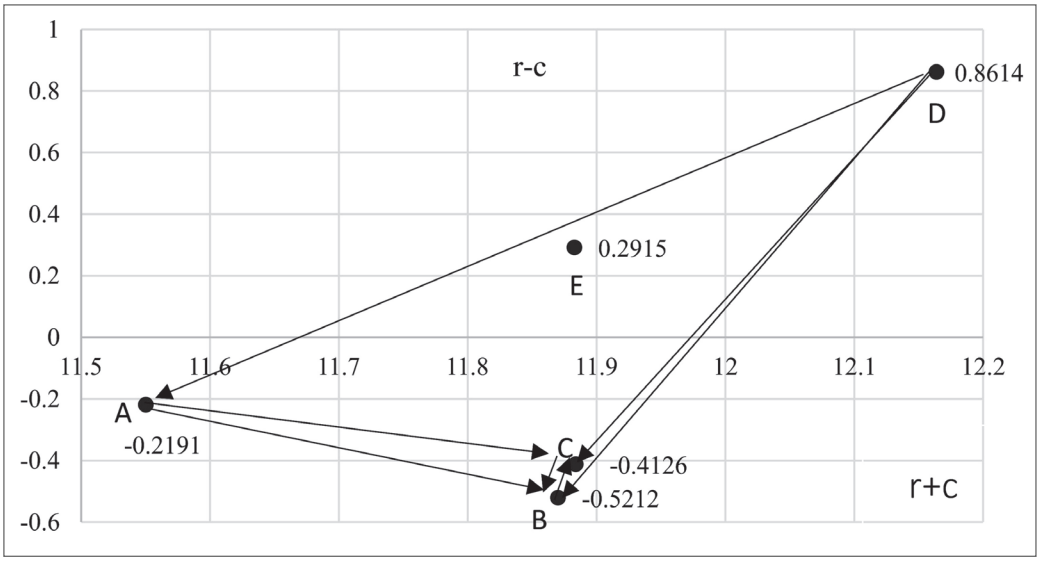

Figure 1. Causal Relationship among the five key criteria

psychological factors were the least important factor with the value of 11.550. In contrast to importance (D) government policies under operation greens and (E) support from grassroot level extension agency were the net cause, whereas (A) farmers' socio-psychological factors, (B) Market intelligence for TOP crops, (C) Input supply under operation greens were observed as the net effects/receivers based on (r-c) values. As per results these key factors are interrelated and essential for value realization of TOP crops as they provide a framework for decision making at farm level and helps in mitigating the risks. Prioritizing these factors could lead to improved socio-economic status and farmers' satisfaction and sustainability. The findings are in line with studies done by Wei & Xia Wu (2022); Xia & Ruan (2020).

Figure 1 observed that factor (D) Government policies under operation greens is not affected by others but affects (A) Farmer socio-psychological factors, (B) Market intelligence for TOP crops, (C) Input supply under operation greens and likewise (A) Farmer socio psychological factor is only affected by (D) government policies under operation greens but affects (C) Input supply under operation greens and (B) Market intelligence for TOP crops. Whereas, factor (B) Market intelligence for TOP crops and (C) Input supply under operation greens mutually affects each other. The factor (E) Support from grassroot level extension agency as factor (D) Government policies under operation greens is not affected by any other factor hence acts independently. In summary, it is worth mentioning that under operation greens much attention is paid to two causes (D, E) rather than (A, B, C) factors. The government policies under operation greens are a key factor of utmost importance because it is not only a cause but also did not affect by any other factor. The improvement in government policies under operation greens would result in better targeting of the scheme and achievement of the objectives along with the support from grassroot level extension agencies in promotion of the programme in large area and dissemination of technologies promoted under operation greens.

Results (Table 3) of perceived importance of respondents on factor dimensions revealed that 42.23 per cent respondents have perceived government policies under operation greens is most important factor followed by support from grassroot level extension agency (37.40%) whereas, 39.25 per cent respondents have

Table 3. Distribution of respondents based on their perceived importance

S.No	Factor dimensions	Least important	Less important	Undecided	Important	Most important
A	Farmers socio-psychological factors	30.00	39.25	8.51	5.92	16.29
B	Market intelligence for TOP crops	17.77	34.07	4.07	19.25	24.81
C	Input supply under operation greens	8.88	19.25	12.96	32.96	25.92
D	Government policies under operation greens	5.56	17.03	7.40	27.78	42.23
E	Support from grassroot level extension agency	8.14	21.48	2.23	30.74	37.40

perceived farmers socio-psychological factors as of less importance. In case of input supply under operation greens factor it is revealed that 32.96 per cent respondents perceived as important for them for TOP crops. Strengthening of government policies under operation greens could enhance the value realization as these policies affects the farmers and processors at every stage of decision making at farm. Creating well-structured market infrastructure and market intelligence system could build confidence among farmers regarding market and selling of their crops at optimum prices. The similar findings are reported by Patil & Kokate (2021).

CONCLUSION

A total of 13 factors were identified related to value realization of TOP crops under operation greens, five out of 13 factors were selected based on the importance scores as given by the respondents. The second study based on DEMATEL method was conducted with the help of 19 experts. Using DEMATEL method the importance of five key factors was determined along with causal relationship among themselves. The results revealed that government policies under operation greens were the most important factor. Though there are many factors, which were influenced by government policy under operation greens but no factor influencing government policies under operation greens was found. So, the improvement in government policies under operation greens would result in better targeting of the scheme and achievement of the objectives.

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