Eco. Env. & Cons. 29 (November Suppl. Issue) : 2023; pp. (S256-S266)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i06s.037

Critical Analysis of Backward and Forward Linkages in Cotton Cultivation

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(Received 9 May, 2023; Accepted 23 July, 2023)

ABSTRACT

Backward and forward linkages will help cotton growers to plan their farm activities in advance from production to post production activities and gain information about inter-sectoral linkages operating in cotton cultivation.Understanding the significance of backward and forward linkages in the contemporary scenario, an attempt was made to find out the activity wise backward and forward linkages followed by cotton growers in cotton cultivation. Based on maximum area under cotton cultivation Kurnool and Guntur districts from the state of Andhra Pradesh were purposively selected. An ex-post facto research design was used for the study and the data were collected using pre-structured interview schedule from 240 respondents through multi-stages ampling. The results showed that, with respect to backward linkages more than half (58.33%) of the farmers were having moderate/medium backward linkages with various agencies followed by 21.25 per cent were having low and remaining 20.41 per cent were having high level of backward linkages with various agencies. With respect to forward linkages nearly half (49.58%) of the farmers were having forward linkages with various agencies followed by 30.41 per cent were having low and rest one-fifth (20.00%) were having high backward linkages with various agencies.These findings draw attention of researchers, policy makers and other stakeholders for the introduction of innovative methods in better indulgent of backward and forward linkages in cotton cultivation.

Key words: *Finance, Inputs, Marketing, Storage, Management, Kendras*

Introduction

Cotton is one of the most important fiber and cash crops of India and plays a dominant role in the industrial and agricultural economy of the country. India ranks first in the world in cotton cultivation with

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12.66 million hectares of area constituting about 38% to 41% of the world area under cotton cultivation and ranked first in production yielding 28.71 million bales production with productivity of 466 Kgs per ha. Around 6 to 6.5 million farmers grow the crop in about 10 States (Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu). In the state of Andhra Pradesh cotton is cultivated in area of 10 lakh ha with production of 50 lakh bales with productivity 880 kg/ha. In Andhra Pradesh Kurnool district alone accounts for more than fifty per cent of cultivated area with being cultivated in an area of 5.84 lakh acres followed by Guntur district with cotton being cultivated in an area of 4.27 lakh acres. Agricultural sector contributes to economic development in four different ways, it supplies the labour force, the raw materials, the savings and food needed to establish and maintain industrial production (Dawson, 2010). This input in form of raw materials that the agricultural sector contributes and outputs of material in relation to non-agricultural sectors is what forward and backward linkages explained (Richardson *et al.,* 2017). Strong and smooth backward linkages are needed to give a good output. In addition, Strong and flawless forward linkages are needed to reach to the ultimate end user (Sheikh *et al.,* 2016). Agriculture ranks second in forward linkages in terms of supplying its output to other sectors to the extent of 42 percent of its output and has the least input requirements (backward linkage) compared to nonfarm sectors and contributes 16 per cent to gross value added in the economy (Sharma, 2008).

Backward linkages are the channels through which information, material and money flow between a firm and its suppliers and create a network of economic independence. Forward linkages are distribution chains connecting producers or suppliers to its customers (Chowdary *et al.,* 2020). Cotton as one of the principal commercial export-oriented crops and is essential to address production and post-harvest losses through strengthening linkages among the three systems viz., research, extension and input systems in the production and marketing of cotton. The functional linkages have been further categorized into backward and forward linkages based on the purpose of contact made during the course of production, processing and harvesting of cotton. The backward linkages provide inputs, technical and financial services for cotton crop production activities; and forward linkages refers to links with harvesting and processing, marketing and storage of cotton (Adan *et al.,* 2020). Backward linkages will help cotton growers to get acquainted with demand-side feature and forward linkages with supply-side feature resultant in production changes in cotton (Abubakar *et al.,* 2022).

In the contemporary scenario, the magnitude of backward and forward linkages of farmers with various agencies plays a very crucial role for achieving a desired rate of growth in agriculture (Delgado *et al.,* 1998). Cotton farmers require a diverse range of information to support their farm enterprises. Information is needed not only on best practices and technologies for crop production, but also information needed about postharvest aspects including processing, marketing, storage and handling (Singhal *et al.,* 2011). To keep up the momentum of growth, a careful economic evaluation of inputs like seeds, fertilizers, irrigation sources, pesticides etc. (backward linkage) and harvesting, grading, packing, storage, transportation, marketing etc. (forward linkage) are of considerable importance (Priyanka *et al.,* 2021).Considering the significance of forward and backward linkages in agriculture sector, a study was conducted with properly devised framework to critically analyse the extent of backward and forward linkages followed by cotton farmers in cotton cultivation.

Materials and Methods

Cotton is considered to be one of the prominent principal cash crops in India and enjoys a pride of place and unique position in our economy and it can be gauged from the extent of area under the crop, trade, processing manufacture, export of raw material, cotton textile goods etc. With this background, a survey was conducted using pre tested and structured questionnaire during 2020 to critically study thebackward and forward linkages in cotton cultivation. *Ex-post facto research* design was selected as an appropriate research design to critically analyze the backward and forward linkages in cotton cultivation. Andhra Pradesh state was purposively selected for the study, since the researcher belongs to the state and was familiar with local language and culture. Kurnool and Guntur were the two districts purposively selected for the study from Andhra Pradesh as these two districts comprises highest area under cotton cultivation. Three mandals from

each district were purposively selected based on the highest area of cotton cultivation thus constituting six mandals. Four villages from each mandal were selected by following simple random sampling procedure. The sample constituted to a total of twenty-four villages. From each of the selected village, ten farmers were selected by following lottery method of simple random sampling procedure. The sample constituted to a total of 240 respondents.

In this study backward linkages are operationally defined as the working relationship between cotton crop growers and agencies/organizations/individuals involved in supporting cotton crop production activities. Forward linkages are the working relationship between cotton growers and agencies/organizations/individuals involved in supporting post production activities in cotton.The forward and backward linkage services were categorized into sub heads based on their activity.

Backward linkages based on the activity

Backward linkages based on activity further categorized into Information input, Physical input, financial input and technical guidance. Information input includes activities like Information on layout and land preparation, Nutrient management, Irrigation management, weed management, Integrated Pest management (IPM), machinery and processing. Physical input includes cotton varieties/Hybrids, Nutrients (NPK), Organic fertilizers, Bio-Fertilizers/Fungicides, Plant Protection chemicals and Growth regulators/Hormones. Financial requirement includes government, commercial banks, cooperatives, non-banking financial companies (NBFCs), money lenders and traders. Technical Guidance includes activities like improved variety/Hybrids, Production technology, Weather information, Market information and Processing.

Activity wise backward Linkage with different Agencies

Cotton growers for Information activity, Physical activity and technical guidance followed wise linkages with different agencies *viz.,* Input agencies, State Department of Agriculture, Rythu Bharosa Kendra's (RBKs), Extension scientists of Krishi Vigyan Kendra (KVKs) and District Agricultural Advisory Transfer of Technology Centers (DAATTCs), Research Scientists of Regional Agricultural Research Stations (RARS), ICAR Institutes, FPOs and others (fellow farmers, relatives and friends).Cotton growers for financial activity followed linkages with different agencies viz., Government, Commercial banks, Cooperatives, Non- Banking Financial companies (NBFCs), Money lenders, Traders and others (fellow farmers, relatives, friends and online payment portals).

Forward linkages based on the activity

Forward linkages based on activity categorized intoHarvesting and Processing, Marketing and Storage. Harvesting and processing activity includes Maturity of harvesting, Time of harvesting, Duration of harvesting, Grading, Processing, Storage, Transportation, Cotton Ginning and Milling. Marketing activity includes time of marketing and place of marketing.

Activity wise forward Linkage with different Agencies

Cotton growers for Harvesting and Processing activity followed wise linkages with different agencies viz., Input agencies, State Department of Agriculture, Rythu Bharosa Kendra's (RBKs), Extension scientists of Krishi Vigyan Kendra (KVKs) and District Agricultural Advisory Transfer of Technology Centers (DAATTCs), Research Scientists of Regional Agricultural Research Stations (RARS), FPOs and others (fellow farmers, relatives and friends). In marketing, for time of marketing cotton growers had linkages with different agencies viz., Input agencies, State Department of Agriculture, Rythu Bharosa Kendra's (RBKs), Extension scientists of Krishi Vigyan Kendra (KVKs) and District Agricultural Advisory Transfer of Technology Centers (DAATTCs), Research Scientists of Regional Agricultural Research Stations (RARS), FPOs and others (fellow farmers, relatives and friends). In marketing, for place of marketing cotton growers had linkages with different agencies viz., Cotton Corporation of India (CCI), Agricultural Produce Market Committees (APMC), Seed Processors, Private traders, Online trading and others. For storage activity cotton growers had linkages with Private storage Center, Government Storage Center, Millers, FPOs, Community Hall and others.g

Results and Discussion

The completed and returned questionnaires from the sample of cotton growers revealed the extent of backward and forward linkages in cotton cultivation

with various agencies.

Activity wise backward linkages followed by farmers in cotton cultivation

Activity wise backward linkages followed by 240 farmers in cotton cultivation revealed in Table 1 shows that in information input for information on lay out and land preparation more than one-third (36.25%) farmers had stated that they had linkage with extension scientists of KVKs and DAATTCs, followed by 31.66 per cent had linkage with input agencies, 22.50 per cent had linkage with Rythu Bharosa Kendra (RBK) of Department of Agriculture, 17.50 per cent had linkage with scientists of Regional Agricultural Research Station (RARS), 2.91 per cent had linkage with Farmer Producer Organizations of Society for Elimination of Rural Poverty (SERP), Sree Neelakanteswara Organic Farmers Producer Organization, Tolakari Farmer Producer Organizations, Tungabhadra Organic Farmers Producer Organization. It might be because of their frequent interaction with scientific staff and attending training programmes and demonstrations conducted by them.

In Nutrient management activity in cotton cultivation 45.00 per cent farmers had linkage with input agencies, followed by 32.50 per cent had linkage with extension scientists, 21.66 per cent had linkage with department of agriculture, 16.25 per cent had linkage with Research scientists, 6.66 per cent had linkage with FPOs and 5 per cent had linkage with others (social media, friends and neighbors). This might be due to the existence of Input dealers' shops and accessibility of input dealers within the village premises and regular purchase of nutrients from input agencies.

In irrigation management activity in cotton cultivation 35.55 per cent had backward linkage with extension scientists, followed by 24.58 per cent had linkage with department of agriculture, 17.50per cent had linkage with input agencies, 15.41 per cent farmers had linkage with research scientists, 8.88 linkage with FPOs and 3.88 per cent had linkage with other sources. This might be due to existence of KVK in their nearby vicinity and regular interaction with extension scientists of KVKs and DAATTCs.

In weed management activity in cotton cultivation nearly half (48.00%) farmers with backward linkages with extension scientists, followed by 47.50 per cent had linkage with input agencies, nearly one-fourth (23.75%) had linkage with department of agriculture, 15.83 per cent had linkage withresearch scientists, 1.66 per cent farmers had linkage with ICAR institutes (IIRR, Hyderabad and CICR, Nagpur) and 1.25 per cent had linkage with other sources. This might be due to existence of input dealers' shops and accessibility of input dealers within the village premises and recurrent acquire of herbicides from input dealers.

In Integrated Pest Management (IPM) activity in cotton cultivation 47.08 per cent farmers had backward linkage with input agencies, followed by nearly one-third (32.22%) farmers had linkage with extension scientists, more than one-fourth (26.66%) had linkage with department of agriculture, 17.50 per cent farmers had linkage with research scientists, 2.50 per cent linkage with FPOs, 1.66 per cent farmers had linkage with ICAR institutes and 1.25 per cent had linkage with other sources. This might be due to nearby vicinity and regular interaction with extension scientists of KVKs and DAATTCs and attending training programmes and demonstrations conducted by them and registration of farmers in mKisan and AKPS for reception of voice and text based agro-advisories over mobile phones.

In Equipment and machinery activity more than one-fourth (27.50%) farmers had backward linkage with input agencies, 25.41 per cent farmers had linkage with research scientists of (RARS Nandyal and ARS Ananthapuramu), 23.75per cent farmers had linkage with extension scientists and 23.33per cent farmers had linkage with Rythu Bharosa Kendra's of department of agriculture, 3.75 per cent farmers had linkages with FPOs, 2.50 per cent farmers had linkages with other sources (friends and neighbors). This might be due to frequent interaction, availability of equipment and accessibility to farm machinery through Custom Hiring Centers (CHCs) within their village premises.

In processing (Ginning and milling) activity in cotton cultivation more than one-third (37.08%) farmers had backward linkage with input agencies, 21.25per cent had linkage with extension scientists of KVKs and DAATTCs, 17.50 per cent had linkage with Rythu Bharosa Kendra's of department of agriculture, 15 per cent had linkage with research scientists of RARS Nandyal and 3.33 per cent had linkage with FPOs (Tolakari FPO, SERP FPOs, Tungabhadra organic farmers producer organization). This might be because of frequent interaction with cotton millers and availability of infrastructure facilities with private agencies.

Activity wise backward linkages followed by farmers in cotton cultivation revealed in Table 1 that in physical input; for cotton varieties/hybrids more than majority (92.91%) of the farmers had backward linkage with input agencies, followed by more than half (50.45%) had linkage with RBKs of the Department of Agriculture, 6.25 per cent of farmers had linkage with extension scientists of RARS, Nandyal and RARS, Lam, 5 per cent had linkage with extension scientists of KVKs and DAATTCs, 2.91 per cent had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO), 1.25 per cent had linkage with others (Friends, neighbors and online e-commerce websites). The reason might be that patent of Bt-cotton technology with private seed companies and amicable with input dealers and recurrent purchase of Boll guard-II cotton seed from them followed by more than half had linkage with RBKs of the Department of Agriculture as it had input kiosks for keeping order of inputs and sale of Bt-cotton hybrids.

For Nutrients (NPK) more than three-fourths (76.66%) farmers had backward linkage with input agencies, followed by 17.50 per cent had linkage with RBKs of Department of Agriculture, 8.75 per cent had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO), 6.66 per cent had linkage with others (APAGROS, Cooperative societies), 5 per cent had linkage with extension scientists and 2.50 per cent had linkage with research scientists of ANGRAU.This might be due to localite nature of Input dealers and amicable with them, availability and accessibility of NPK fertilizers with input agencies.

For organic fertilizers (FYM, Vermicompost) more than two-thirds (67.50%) had backward linkage with input agencies, followed by 18.75 per cent had linkage with extension scientists of KVKs, 15.41 per cent had linkage with Department of Agriculture, 13.33 per cent had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, Annadata FPO) and 2.91 per cent had linkage with other sources (Friends and neighbors, online e-commerce websites). The reason might be that availability and accessibility of organic manures from input dealers.

For Bio-Fertilizers/Bio-Fungicides and Bio-Pesticides more than half (50.83%) farmers had backward linkage with RBKs and Bio-Control labs of the Department of Agriculture, followed by 43.75 per cent had linkage with extension scientists of KVKs, 7.77 per cent had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, Annadata FPO), 7.50 per cent had linkage with research scientists of RARS Nandyal and RARS Lam. The reason might be that production, availability and accessibility of bio-control agents at cheaper rates when compared to other input agencies.

For Plant Protection Chemicals majority (91.25%) farmers had linkages with Input agencies, followed by 13.33 per cent had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, Annadata FPO), 6.66 per cent had linkage with other sources (Online e-commerce websites, friends and neighbors), 6.66 per cent had linkage with extension scientists of KVKs. This might be due to existence of Input dealer's shops within the village premises and frequent interaction with input dealers, availability and accessibility of plant protection chemicals with input agencies

For Growth regulators/hormones more than three-fourths (78.33%) had backward linkage with input agencies, followed by 13.33 had linkage with FPOs (SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, Annadata FPO), 11.66 had linkage with the Department of Agriculture, 6.25 per cent had linkage with extension scientists of KVKs (OFTs, FLDs) and 5.00 per cent had linkage with others (Online e-commerce platforms).This might be due to existence of input dealer's shops within the village premises and frequent interaction with input dealers, availability and accessibility of growth regulators with input agencies.

Activity wise backward linkages followed by farmers in cotton cultivation revealed in Table 1 that for financial requirement 100% of the farmers had linkage with government for their credit requirements, followed by more than two-thirds (71.25%) of the farmers had backward linkage with Cooperatives (Andhra Pragathi Grameen bank), 47.50 per cent of the farmers had linkage with commercial banks like State Bank of India (SBI), HDFC and Axis bank, 20.83 per cent of the farmers had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO and Annadata FPO, one-fourth (20.55%) of the farmers had linkage with other sources i.e., relatives, friends and neighbors. 18.75 per cent of the farmers had linkages with traders of market yards. 6.66 per cent of the farmers had linkage with money lenders and 6.25 per cent had linkage with Non-Banking Financial Companies like chit fund agencies. The reason might be that direct

Table 1. Activity wise backward linkages followed by cotton growers in cotton cultivation n=240

S.No	Activity	Agency													
A.	Information Input	Input Agencies		Department of Agriculture (RBKs)		Research Scientists		Extension scientists		ICAR institutes		FPOs		Others	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
1.	Informationon layout & Land preparation	10	31.66	54	22.50	42	17.50	87	36.25	0	0	7	2.91	0	0
2.	Nutrient Management	108	45	52	21.66	39	16.25	78	32.50	0	0	16	6.66	12	5
3.	Irrigation Management	42	17.50	59	24.58	37	15.41	64	35.55	0	0	16	8.88	7	3.88
4.	Weed Management	114	47.50	57	23.75	38	15.83	115	48.0	4	1.66	0	0	3	1.25
5.	Integrated Pest Management	113	47.08	64	26.66	42	17.5	78	32.5	4	1.66	6	2.5	3	1.25
6.	Equipments & Machinery	66	27.5	56	23.33	61	25.41	57	23.75	0	0	9	3.75	6	2.5
7.	Processing	89	37.08	42	17.5	36	15	51	21.25	0	0	8	3.33	0	0
B	Physical Input	Input Agencies		Dept. of Agriculture (RBKs)		Research Scientists		Extension scientists		ICAR institutes		FPOs		Others	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
1.	Cotton Varieties /Hybrids	223	92.9 1	121	50.41	15	6.25	12	5	3	1.25	7	2.91	4	1.66
2	Nutrients (NPK)	184	76.66	42	17.5	6	2.5	12	5	0	0	21	8.75	16	6.66
3	Organic Fertilizers	161	67.5	37	15.41	0	0	45	18.75	0	0	32	13.33	7	2.91
4	Bio-Fertilizers/ Fungicides	30	12.5	122	50.83	18	7.5	105	43.75	0	0	18	7.77	0	0
5	PP Chemicals	219	91.25	0	0	0	0	16	6.66	0	0	32	13.33	16	6.66
6	Growth Regulators /Hormones	188	78.33	28	11.66	0	0	15	6.25	0	0	32	13.33	12	5
C.	Financial Requirement	Govern-ment		Commercial banks		Coopera-tives		NBFCs		Money		Traders lenders		Others	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
		240	100	114	47.5	171	71.25	15	6.25	16	6.66	45	18.75	50	20.83
D.	Technical Guidance	Input Agencies		Dept. of Agriculture (RBKs)		Research Scientists		Extension scientists		ICAR institutes		FPOs		Others	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
1	Improved variety/ Hybrids	85	35.41	128	53.33	42	17.5	122	50.55	8	3.33	23	9.58	9	3.75
2	Production Technology	52	21.66	90	37.5	43	17.91	119	49.58	6	2.5	5	2.08	33	13.75
3	Weather information	25	10.41	54	22.5	21	8.75	140	58.33	0	0	6	2.5	31	12.91
4	Market information	90	37.5	60	25	11	4.58	68	28.33	0	0	28	11.66	16	6.66
5	Processing	91	37.91	28	11.66	31	12.91	48	20	0	0	24	10	18	7.5

income support of Rs.13,500 per annum to all land holding farm families under PM-Kisan-YSR Rythubharosa, Zero percent interest crop loans, availing of crop insurance scheme to mitigate the hardship of the insured cotton farmers against the anticipated crop loss resulting from adverse weather conditions relating to rainfall, temperature, wind, humidity etc and provision of Kisan Credit Cards (KCC) to all the farmers to avail short term credit loans up to Rs. 3 lakhs per annum.

Activity wise backward linkages followed by farmers in cotton cultivation are revealed in Table 1, that for technical guidance on improved varieties/ hybrids more than half (53.33%) of the farmers had backward linkage with RBKs of Department of Agriculture, followed by half (50.55%) of the farmers had linkage with extension scientists of KVKs and DAATTCs followed by more than one-third (35.41%) of the farmers had linkage with input agencies, 17.50 per cent of the farmers had linkage with scientists of RARS, Nandyal and RARS Lam, 9.58 per cent of the farmers had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO and Annadata FPO. 3.75 per cent of the farmers had linkages with others like Friends, neighbors, social media and online websites and portals. 3.33 per cent of the farmers had linkage with ICAR institutes like IIRR, Hyderabad and CICR, Nagpur. The reason might be subsistence of RBKs in the village premises and availability of Village Agriculture Assistants (VAA) and accessibility of crop specific literature in library of RBKs followed by more than half had linkage with extension scientists of KVKs and DAATTCs it might be due to subsistence of KVK and DAATTCs in their nearby vicinity and frequent attending of training programmes and demonstrations, supply of literature on improved production technology by KVKs and DAATTCs, registration of farmers in mKisan and AKPS for reception of voice and text based crop specific agro-advisories over mobile phones.

For production technology nearly half (49.58%) of the farmers had backward linkage with extension scientists of KVKs and DAATTCs, followed by 37.50 per cent of the farmers had linkage with RBKs of the Department of Agriculture, more than one-fifth (21.66%) of the respondents had linkage with input agencies, 17.91 per cent of the farmers had linkage with research scientists of RARS Nandyal and RARS Lam, 13.75 per cent of the farmers had linkage with others like Friends, neighbors, social media, Apps, online websites and portals. 2.50 per cent per cent of the farmers had linkage with ICAR institutes like CICR Nagpur and 2.08 per cent per cent of the farmers had linkage with FPOs like SERP FPOs, Tolakari FPO. The reason might be frequent interaction with extension scientists of KVKs and DAATTCs and supply of literature on improved production technology in cotton cultivation and reception of voice and text-based crop specific agro-advisories over mobile phones through mKisan and AKPS.

For weather information 58.33 per cent of the farmers had linkage with extension scientists of KVKs, 22.50 per cent of the respondents had linkage with RBKs of Department of Agriculture, 12.91 per cent of the respondents had linkage with other sources like Apps, Portals and social media. 10.41 per cent of the respondents had linkage with input agencies, 8.75 per cent of the respondents had linkage with scientists of RARS Nandyal and Lam. 2.50 per cent of the respondents had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO and Annadata FPO. The reason might be due to existence of District Agro Meteorological Units (DAMU) in the KVK premises and reception of crop specific weather based agro-advisories to farmers over their mobile phones.

For market information 37.50 per cent of the respondents had linkages with input agencies followed by, 28.33 per cent of the respondents had linkage with extension scientists of KVKs and DAATTCs, one-fourth (25.00%) of the respondents had linkage with RBKs of the Department of Agriculture, 11.66 per cent of the farmers had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, 6.66 per cent of the farmers had linkage with other sources like Online marketing platforms, social media, friends and neighbors and 4.58 per cent of the farmers had linkage with research scientists of RARS Nandyal and Lam. The reason might be due to some traders in the market yard having input dealer's shops within the village premises and reliability over them as they are engaged in marketing activities.

For processing more than one-third (37.91%) of the farmers had linkage with input agencies, followed by one-fifth (20.00%) had linkage with extension scientists of KVKs and DAATTCs, 12.91 per cent of the farmers had linkage with research scientists of RARS Nandyal and Lam, 11.66 per cent of the farmers had linkage with RBKs of the Department of Agriculture, 10.00 per cent of the farmers

had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO and Annadata FPO and 7.50 per cent of the farmers had linkage with other sources like friends and neighbors and social media.This might be due to existence and management of cotton ginning mills under private management and recurrent interaction of input dealers with private ginning mills. The findings are similar with the findings of Khandave *et al.,* (2019).

Activity wise Forward linkages followed by cotton growers in cotton cultivation

Activity wise forward linkages followed by 240 farmers in cotton cultivation revealed in Table 2 shows that in Harvesting and Processing activity for maturity of harvesting more than three-fourth (80.41%) had forward linage with others, followed by 36.25 per cent had linkage with department of agriculture, 18.75 per cent farmers had linkage with extension scientists of KVKs and DAATTCs, 18.75 per cent farmers had linkage with input agencies, 11.66 per cent had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, 8.33 per cent had linkage with research scientists of RARS Nandyal and RARS Lam. It might be due to self-experience gained in cotton cultivation and cultivation of cotton by fellow farmers and discussion with them on cultivation aspects of cotton might have contributed to it.

For time of harvesting more than two-thirds (67.50%) of the farmers had forward linkage with others, more than one-fourth (26.25%) had linkage with RBKs of Department of Agriculture, 17.77 per cent of the farmers had linkage with input agencies, 12.50 per cent had linkage with extension scientists of KVKs and DAATTCs, 6.66 per cent had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, 6.66 per cent had linkage with research scientists of RARS Nandyal and RARS Lam. For duration of harvesting (from one picking to another picking) majority (89.58%) farmers had forward linkage with others, followed by 15.00 per

Table 2. Activity wise Forward linkages followed by farmers in cotton cultivation n=240

S.No	Activity	Agency											
I	Harvesting and Processing	Input Agencies		Department of Agriculture		Research Scientists		Extension scientists		FPO/FPC		Others	
		F	P	F	P	F	P	F	P	F	P	F	P
A.	Maturity of Harvesting	45	18.75	87	36.25	20	8.33	45	18.75	28	11.66	193	80.41
B.	Time of Harvesting	42	17.50	63	26.25	16	6.66	30	12.50	16	6.66	162	67.5
C	Duration of Harvesting	36	15	28	11.66	9	3.75	24	10	15	6.25	215	89.58
D	Grading, Processing, Transportation	121	50.41	39	16.25	24	10	56	23.33	30	12.5	12	5
E	Cotton Ginning	119	49.58	42	17.5	12	5	45	18.75	21	8.75	8	3.33
F	Cotton Milling	119	49.58	42	17.5	12	5	45	18.75	21	8.75	8	3.33
II	Marketing of Produce	Agencies											
A	Time of marketing	Input Agencies		Department of Agriculture		Research Scientists		Extension scientists		FPO/FPC		Others	
		F	P	F	P	F	P	F	P	F	P	F	P
		69	28.75	114	47.5	20	8.33	90	37.5	28	11.66	21	8.75
B	Place of Marketing	CCI		APMCs		Seed Processors		Private traders		Online trading		Others	
		F	P	F	P	F	P	F	P	F	P	F	P
		150	62.5	96	40	31	12.91	43	17.91	18	7.5	15	6.25
III	Storage	Private storage Center		Govt. Storage Center		Millers		FPOs/ FPCs		Community hall		Other	
		F	P	F	P	F	P	F	P	F	P	F	P
		56	23.33	30	12.5	18	7.5	9	3.75	0	0	3	1.25

cent had linkage with input agencies, one-tenth (10.00%) had linkage with extension scientists of KVKs and DAATTCs, 6.25 per cent had linkage with FPOs and 3.75 per cent had linkage with research scientists. The probable reason that could be attributed to this might be that self-experience gained in cotton cultivation and cultivation of cotton by fellow farmers and discussion with them on cultivation aspects of cotton might have contributed to it.

For grading, processing, transportation activity more than half (50.41%) had linkage with input agencies, followed by 23.33 per cent had linkage with extension scientists of KVKs and DAATTCs, 16.25 per cent farmers had linkage with RBKs of Department of Agriculture, 12.50 per cent had linkage with FPOs like SERP FPOs, Tungabhadra Organic FPO, Tolakari FPO, one-tenth (10.00%) had linkage with research scientists of RARS Guntur and Lam, 5.00 per cent had linkage with others i.e., friends and neighbors. It might due to availability and accessibility of required infrastructure facilities for grading, processing and transportation subsist with input agencies.

For cotton ginning nearly half (49.58%) farmers had linkage with input agencies, followed by 18.75 per cent had linkages with extension scientists of KVKs and DAATTCs, 17.5 per cent had linkage with RBKs of Department of Agriculture, 8.75 per cent had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, 5.00 per cent had linkage with research scientists of RARS Nandyal and Lam and 3.33 per cent had linkage with others.It might be due to availability and accessibility of infrastructure facilities required for cotton ginning subsists with input agencies.

For cotton milling nearly half (49.58%) farmers had linkage with input agencies, followed by 18.75 per cent had linkages with extension scientists of KVKs and DAATTCs, 17.50 per cent had linkage with RBKs of Department of Agriculture, 8.75 per cent had linkage with FPOs like SERP FPOs, Tolakari FPO, Tungabhadra organic FPO, 5.00 per cent had linkage with research scientists of RARS Nandyal and Lam and 3.33 per cent had linkage with others. It might be due to availability and accessibility of infrastructure facilities required for cotton milling subsists with input agencies like millers and private traders.

Activity wise forward linkages followed by farmers in marketing of cotton revealed that for time of marketing nearly half (47.50%) of the farmers had linkage with RBKs of Department of Agriculture, followed by 37.50 per cent of the farmers had linkage with extension scientists of KVKs and DAATTCs, 28.75 per cent of the farmers had linkage with input agencies, 11.66 per cent of the farmers had linkage with FPOs like SERP FPOs, Tungabhadra FPO, Tolakari FPO, Annadata FPO, 8.75 per cent had linkages with other sources like friends, neighbors and fellow farmers, 8.33 per cent farmers had linkage with research scientists of RARS Nandyal and Lam. The reason might be due to subsistence of RBKs in the village premises and availability of Village Agriculture Assistants (VAAs) and VAAs are facilitated with CM (Commodity Marketing) App an online marketing platform for registering farmers for procurement and purchase of cotton and entering for daily arrivals of cotton produce.

For place of marketing nearly two-thirds (62.50%) of the farmers had linkage with Cotton Corporation of India (CCI), followed by 40.00 per cent of the farmers had linkage with e- NAM of Market committees, 17.91 per cent farmers had linkage with private traders, 12.91 per cent of the farmers had linkages with seed processors as they are engaged in seed production, 7.50 per cent of the farmers had linkage with online trading i.e., e-commerce trading portals, 6.25 per cent of the farmers had linkage with other sources like direct marketing of their produce. This might be due to CCI is the Nodal Agency to undertake Minimum Support Price (MSP) based procurement operations of raw cotton procurement from cotton growers.

Activity wise forward linkages followed by farmers in cotton cultivation revealed that in storage activity 23.33 per cent of the farmers had linkage with private storage center, followed by 12.50 per cent of the farmers had linkage with government storage center, 7.50 per cent had linkage with millers, 3.75 per cent of the farmers had linkage with FPOs like SERP FPOs, Tungabhadra FPOs, 1.25 per cent of the farmers had linkage with other sources like rented houses and fellow farmers godowns. For time of storage activity majority (23.33%) of the farmers had forward linkage with private storage center, this might be due to existence of cold storage facilities and negotiable e-warehouse receipts which will facilitate them to get bank loans on 75 per cent of the produce. This might be due to existence of cold storage facilities and negotiable e-warehouse receipts which will facilitate them to get bank loans on 75 per

cent of the produce. The findings are similar with the findings of Khandave *et al.* (2019).

Activity wise backward and forward linkages followed by farmers in cotton cultivation

From the perusal of Table 3 it could be inferred that in activity wise backward linkages, with regard to'information input'more than one-third (36.18%) of the farmers had developed linkages with input agencies followed by the Department of Agriculture (22.85%). In 'physical input' majority (65.24%) of the farmers had linkages with Input agencies followed by the Department of Agriculture (29.16%). In 'financial requirement' cent per cent had linkage with government, followed by cooperatives (71.25%). In 'Technical guidance' majority (30.00%) had linkage with department of agriculture followed by 28.57 per cent had linkage with input agencies.

From Table 3. it could be inferred that in activity wise forward linkages, in 'harvesting and processing' activity majority of the farmers had developed linkages with input agencies followed by the Department of Agriculture. In 'marketing' activity majority had linkage with CCI followed by department of agriculture and in 'storage' activity majority had linkage with private storage center followed by government storage center

Overall level of 'extent of backward and forward linkages' in cotton cultivation

It could be inferred from Table 4 that with respect to backward linkages more than half (58.33%) of the farmers were having moderate/medium backward linkages with various agencies followed by 21.25 per cent were having low and remaining 20.41 per cent were having high level of backward linkages with various agencies. With respect to forward linkages nearly half (49.58%) of the farmers were having forward linkages with various agencies followed by 30.41 per cent were having low and rest one-fifth (20.00%) were having high forward linkages with various agencies.

From Table 4 it could be inferred that more than half (58.33%) of the farmers were having backward linkages when compared to forward linkages (49.58%) with various agencies in cotton cultivation. The probable reason might be that for activities like information input, physical input, credit requirement and for technical guidance majority of the farmers have developed backward linkages with

Table 4. Distribution of cotton farmers according to their overall level of backward and forward linkages' in cotton cultivation n=240

Item	Extent of linkage	Frequency	Percentage
Backward linkage	Low	51	21.25
	Medium	140	58.33
	High	49	20.41
	Total	240	100
	Mean = 33.33;		SD= 19.123
Forward linkage	Low	73	30.41
	Medium	119	49.58
	High	48	20.00
	Total	240	100
	Mean=33.33;		SD= 19.31

Table 3. Activity wise backward and forward linkages followed by farmers in cotton cultivation n=240

Activity wise Backward Linkages	Agency	Percentage
Information input	Input agencies	36.18
	Department of Agriculture (RBK)	22.85
Physical Input	Input agencies	65.24
	Department of Agriculture (RBK)	29.16
Financial Requirement	Government	100.00
	Cooperatives	71.25
Technical Guidance	Input agencies	28.57
	Department of Agriculture (RBK)	30.00
Activity wise forward Linkages	Agency	Percentage
Harvesting and Processing	**Input Agencies**	**33.47**
	Department of Agriculture (RBK)	20.90
Marketing	**Cotton Corporation of India (CCI)**	**62.50**
	Department of Agriculture (RBK)	47.50
Storage	**Private storage Center**	**23.33**
	Government Storage Center	12.50

input agencies, extension scientists of KVKs and DAATTCs, RBKs of department of agriculture, research scientists and others. As these production activities have to be normally met for cultivation of cotton and as they were easily accessible, they have developed backward linkage with various agencies. For harvesting and processing, marketing and storage they have developed fewer forward linkages because lack of development of infrastructure facilities for storage, harvesting and processing when compared to production activities.

Conclusion

Backward and Forward linkages play a crucial role in helping the cotton farmers to increase the production and productivity on one hand and getting remunerative price, generating additional income and employment on the other. It may be concluded that farmers had developed backward linkages for purchase of inputs, finance and technical guidance regarding cotton production with input dealers, Co-operatives, SAUs/KVKS and also forward linkages were developed for timely harvesting, storage, processing and marketing with various agencies'. The results have shown that, more than half (58.33%) of the farmers were having moderate/medium backward linkages with various agencies. With respect to forward linkages nearly half (49.58%) of the farmers were having forward linkages with various agencies. Considering this, there is a wide scope to establish linkages with other agencies by expanding the horizons of cotton growers through technical, financial and infrastructure support from the public and private sector agencies.

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