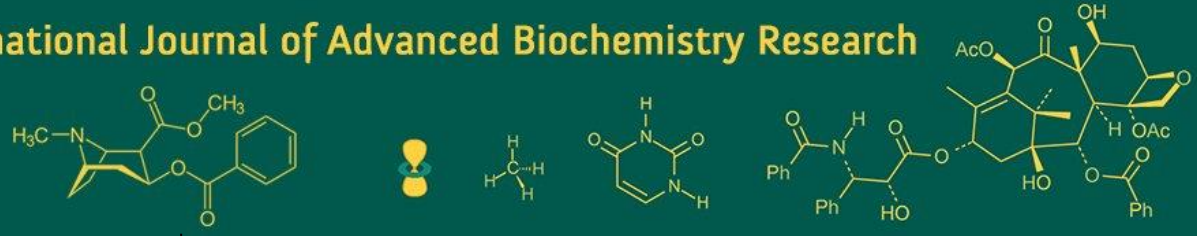
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(1): 814-820
www.biochemjournal.com
Received: 09-10-2023
Accepted: 21-11-2023

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Technological impact of evident pigeon pea improved variety BDN 711 grown by small landholders in Aurangabad and Jalna districts

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DOI: https://doi.org/10.33545/26174693.2024.v8.i1Sk.448

Abstract
The present study was undertaken in the Marathwada region of Maharashtra state during the years 2021–22. Purposively selected two districts, *viz*., Chhatrapati Sambhajinagar (Aurangabad) and Jalna districts of Marathwada region of Maharashtra state, on the basis of the maximum number of farmers cultivating red gram (BDN 711), were found in these two districts. The talukas were also selected purposefully on the basis of the maximum number of farmers cultivating red gram (BDN 711). So from Chhatrapati Sambhajinagar (Aurangabad), district two talukas were selected, namely Paithan and Gangapur; from Jalna, district two talukas, namely Ambad and Badnapur, were selected. Thus, a total of four talukas were selected. From each selected taluk, four villages were selected purposefully on the basis of the maximum number of farmers cultivating red gram (BDN 711); for that purpose, lists were obtained from NARP, KVK Aurangabad, Jalna, VNMKV, and Parbhani; hence, sixteen villages were selected for conducting the study. So from each village, fifteen farmers were selected purposefully from that list, and we considered them respondents, thus making a sample of 240 respondents. To study the impact, some respondents were analysed before and after cultivation of BDN 711, i.e., recall memories of farmers. An ex-post facto research design was adopted in this study. The findings with regard to total technological impact change percentage divided by the overall percentage of each component before and after cultivation of BDN 711 show that the farmers have established 17.41% technological impact.

Keywords: BDN 711, technological impact, before cultivation, after cultivation etc

Introduction
Red gram (*Cajanus cajan* L.)) is a perennial legume from the family *Fabaceaesince* its domestication in the Indian subcontinent at least 3,500 years ago, its seeds have become a common food in Asia, Africa and Latin America. It is consumed on a large scale mainly in south Asia and is a major source of protein for the population of the Indian subcontinent. Red gram is the most important pulse crop widely cultivated in all tropical and subtropical regions.

The total world acreage under pulses is about 93.18 (Mha) with production of 89.82 (Mt) at 964 kg/ha yields level. India, with >28 Mha pulses cultivation area, is the largest pulse producing country in the world. It ranks first in area and production with 31 percent and 28 percent respectively. During 2020-21 tur productivity at 885 kg/ha, has also increased significantly over last 05 year. In Maharashtra in 2022-23 area under Red gram was 12.7 lakh/ha., 13.3 lakh tonnes production and productivity was 1042 kg/ha. area under irrigation (1.59%) having.

In India pigeon pea is cultivated in 14 percent of the gross cropped area under pulses providing 20 percent of the national pulse production (Siddayya *et al.*, 2016) [26]. The crop is cultivated on 40.283 lakh ha and annual production of this pulse in India is about 29.295 lakh tonnes (Anonymous, 2016). This quantity is insufficient to meet the domestic needs; and hence a considerable amount (about 100,000 tonnes) of pigeon pea is imported each year (Saxena and Tikle, 2015) [23].

The important socioeconomic components are health and wellbeing, sustainable wildlife harvesting, land access and use, protection of heritage and cultural resources, business and employment opportunities, sustainability of population, services and infrastructure, ample

sustainable income and lifestyle, etc. (Glasson, J. (2017) [15], Socio-Economic Impact Assessment Guidelines).

Materials and Methods

Technological impact

The development of agrochemicals including fertilizers and pesticides have had a large impact on agricultural production. Agricultural technologies have negatively impacted the environment through soil degradation, air and water pollution, loss of biodiversity, and the disruption of food webs.

Results and Discussion

Mechanization in agriculture

Agricultural technologies have dramatically increased the carrying capacity of the land and have resulted in increased food production. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

From table 1. shows that technological impact in farm mechanization agriculture of majority of the BDN 711 growers were changed to before cultivation (60.83%) and after cultivation increased (67.50%), low level of mechanization in agriculture before cultivation of red gram BDN 711 35.00% which decrease in 24.58%, followed by high level increased respondents before cultivation of BDN 711, 4.7% of them using the combine harvesters changed to 7.92% of them using the combine harvester.

It was revealed that impact of red gram (BDN 711) about technological impact mechanization in agriculture impact, nearly more than half of respondents before cultivation (60.83%) and after cultivation more than half of respondents (67.50%) were belong to medium change category with (6.67) value. It could be concluded that, before cultivation of BDN 711, the main source of farmers from traditional crop cultivation like cereals, fodder by adopting mono cropping of local varieties or previous year seeds. But after cultivation of BDN 711 intercropping pattern or solo cropping of BDN 711, this is early variety which leads to maturity of whole crop at the same time hence with combine harvester can be used for harvesting, combine harvesting use than traditional harvesting practices like labour utilization increased cost of production and time consuming. While use of combine harvester its making benefit. For big farmers it is beneficial to harvest in one time with sole cropping pattern. But from research area mostly marginal farmers were used labour for harvesting also used residue as fodder as per requirement. However, mechanization in agriculture impact on the farmers before cultivation of BDN 711 was not enough to meet their basic needs of family and hence there was no scope for enough production, less income and sometimes they had to borrow to maintain their routine life. After cultivation of BDN 711, additional employment generated by farmers had made significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic mechanization in agriculture changes observed after cultivation of BDN 711.

The Z value mechanization in agriculture impact (23.46**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them. This result revealed that the mechanization in agriculture i.e sowing with tractor and harvesting at same time due to maturation of all crop at one time ready to harvest.

The similar findings with the result of Shetty *et al*. (2013) [25], Gaur *et al*. (2012) [13], Ghuge *et al*. (2019) [14] and Kumar *et al*. (2022) [18].

Involvement in seed production

Seed production plays a vital role in increasing the sown area. For every season, the timely availability of seeds is required. Red gram BDN 711variety is very popular in Aurangabad and Jalna, where the gross cropped area is under pigeon pea in draught area. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

From table 1. shows that the involvement of BDN 711 growers in seed production of majority of the BDN 711 growers were changed to low level at before cultivation (53.33%) and medium level at after cultivation increased (52.50%), followed by high level of seed production increasing 10.83% before cultivation of BDN 711 any other local seeds production to 19.17% of seed production enhanced after cultivation of red gram BDN 711. Through increased in production and productivity farmers involvement enhanced in seed production.

It was detected that technological impact of red gram (BDN 711) on involvement in seed production, less one sixth of the respondents before cultivation (35.83%) and after cultivation more than half of the respondents (52.50%) were belong to medium change category with (16.67) value. It could be concluded that, before cultivation of BDN 711, cultivation through local varieties or previous year seeds which leads to decrease production or sterility observed in plants. But after cultivation of BDN 711 intercropping pattern or solo cropping of BDN 711, this is early variety which leads to highest production achieved than other red gram variety in drought prone area. Increased seed production and saving cost on seeds for next three years benefit. BDN-711 is escape terminal drought than different varieties of pigeon pea.

BDN 711 choose mostly due to taste and well-cooked also easy to mixed. BDN-711 seeds are in white in colour. However, involvement in seed production impact on the farmers before cultivation of BDN 711 was not enough to meet their basic needs of family and hence there was no scope for enough production, less income and sometimes they had to borrow to maintain their routine life. After cultivation of BDN 711, additional employment generated by farmers by selling seeds to the farmer to farmer had made significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic involvement in seed production observed after cultivation of BDN 711.

The Z value involvement in seed production (18.14**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them.

The similar findings with the result of Zade *et al*. (2020) [31] and Gowda *et al*. (2013) [16].

Source of seed availability (BDN 711)

The data collected on the basis of seed availability on Last year produce / use variety, University, KVK, Purchased from market, Purchased from farmers, Gifted by farmers,

Received from relatives, etc. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

Data 1.1 shows that sources of seed availability of majority of the BDN 711 growers were changed to before cultivation (26.75%) and after cultivation increased (35.61%), 57.50% low level of sources of seed availability to farmers before cultivation while changed to 22.50% followed by high level before cultivation of BDN711 15.00% percent changed to 18.75% after cultivation of BDN711.

It was perceived that impact of red gram (BDN 711) on sources of seed availability, less than one seventh of the respondents before cultivation (27.50%) and after cultivation more than half of the respondents (58.75%) were belong to medium change category with (31.25) impact change value. In fact, seed saving is an important crop management and livelihood strategy for the poor farmers but it limits their access to technological improvements embodied in seed. It could be concluded that, before cultivation of BDN 711, cultivation through local varieties or previous year seeds which leads to decrease production or sterility observed in plants. But after cultivation of BDN 711 intercropping pattern or solo cropping of BDN 711, this is early variety which leads to highest production achieved than other red gram variety in drought prone area. Increased seed production and saving cost on seeds for next three years benefit. However, sources of seed availability increased impact on the farmers before cultivation of BDN 711 was not enough to meet their basic needs of family and hence there was no scope for enough production, less income. After cultivation of BDN 711, additional employment generated by farmers by selling seeds to the farmer to farmer had made significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic sources of seed availability increased production observed after cultivation of BDN 711.

The Z value sources of seed availability (21.94**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them. The main issue in resolving access to quality seed would be a thorough understanding and critical assessment of the status of existing seed sector (both formal and informal), their bottlenecks and comparative advantages and complementarity.

It was found in the study that majority of the farmers were not purchasing seeds from the market instead of using own home saved seeds or exchanging with fellow farmers, from before cultivation of BDN 711 low 57.50 percent changed to medium level of category 58.75 percent of after cultivation of BDN 711 which also reflects imperfection in the seed market. The other important sources of seed purchases were government agencies and private seed dealers.

The similar findings with the result of Reddy, A Amarender, (2007) [20], Rubyogo *et al*. (2011) [22], Gowda CLL *et al*. (2013) [16], Kumar *et al*. (2022) [18], Labeyrie *et al* (2023) [19].

Intercultural Operations

The data collected on the basis of the intercultural operations increased or decreased which needs to be done before cultivation and after cultivation of BDN 711. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

From table 1. shows that intercultural operations of majority of the BDN 711 growers were changed to before cultivation (65.83%) and after cultivation increased (76.25%). Followed by low level at intercultural operations before 29.17% to 10.42% changed. At high level of respondents changed 5.00 percent intercultural operations to before cultivation of BDN 711 to 13.33 percent after cultivation of BDN 711. This variety had given good performance after intercultural operations.

It was perceived that impact of red gram (BDN 711) on intercultural operations, more than one fourth of respondents before cultivation (65.83%) and after cultivation nearly one third of the respondents (76.25%) were belong to medium change intercultural operations category with (10.42) impact change value. It conclude that the intercultural operations before cultivation of BDN 711 was increased but after cultivation the intercultural practices reduced due to height of plant. Intercultural operations are easier due to appropriate growth of plants, BDN-711 is superior for intercrop. For BDN-711 if use BBF technology has been increases production also followed university recommended sowing distance for BDN-711. After cultivation of BDN 711, additional labour cost saved after timely spraying which significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic changes in source of income intercultural operations increased production observed after cultivation of BDN 711.

The Z value intercultural operations (24.98**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them.

The similar findings with the result of Gowda CLL. *et al*. (2013) [16], Keshvareddy *et al*. (2018) [17].

Location specific in-situ moisture conservations practice

The respondent's used location specific in-situ moisture conservations practices developed which leads to enhance production cultivation of BDN 711 variety. The respondents response score calculated by summing the difference obtained by the subtracting the value of after cultivation from before cultivation of BDN 711 about location specific in-situ moisture conservations practice. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

From table 1. shows that Location specific in-situ moisture conservations practice of majority of the BDN 711 growers were changed to before cultivation (42.33%) and after cultivation increased (70.02%). Low level of 27.08% Location specific in-situ moisture conservations practice changed to 14.58% followed by high level at 5.00% to 14.58% changed. This variety is indeterminate hence might provide retaining moisture due to height of plant.

It was observed that impact of red gram (BDN 711) on location specific in situ moisture conservations practice, more than half of the respondents before cultivation (67.92%) and after cultivation nearly one third of the respondents (70.83%) were belong to medium change category with (2.92) impact change value. It conclude that the intercultural operations before cultivation of BDN 711 was increased but after cultivation the Location specific in-situ moisture conservations practice reduced due to more intercultural operations. Location specific in-situ moisture

conservations practice helps due to BDN 711 can overcome the effect of dry spells during vegetative and or reproductive stages of crops resulting in increased rainwater use efficiency, better performance of crops and additional net returns. Farmers have continuity in utilization of recommended cropping pattern. After cultivation of BDN 711, additional labour cost saved after timely spraying which significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic changes in location specific in-situ moisture conservations practice increased production observed after cultivation of BDN 711.

The Z value location specific in situ moisture conservations practice (22.03**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them.

The similar findings with the result of Saxena *et al*. (2015) [23], Brithal (2014) [6] and Ayenan (2017) [3].

Transfer of Technology

The respondents response score calculated by summing the difference obtained by the subtracting the value of after cultivation from before cultivation of BDN 711 about transfer of technology impact. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

Table 1. shows that transfer of technology of majority of the BDN 711 growers were changed to before cultivation (60.83%) and after cultivation increased (76.25%), from low level to 35.00% changed after cultivation of BDN 711 upto 10.42%, followed by high level increased from before cultivation 4.17% to after cultivation of BDN 711 upto 13.33%. Due to better transfer of technology through extension workers and farmers to farmer was increased as benefit increased per hectare area.

It was observed that impact of red gram (BDN 711) on transfer of technology, majority of growers before cultivation (60.83%) and after cultivation (76.25%) were belong to medium change category with (15.42) impact change value. It is concluded that before cultivation BDN 711TOT from WhatsApp cultivation groups, University, KVK increases awareness about BDN-711 as good alternative for higher production in Marathwada region, government organized awareness programmes through farmers rally, farmers fair, group discussion etc., Agricultural service centre works as technical guidance, Learn through Videos on YouTube, Through opinion leaders in village farmers following the traditional seeds and practices but after cultivation of BDN 711 while practicing it they get acquainted with the technology through progressive farmers and KVK. After cultivation of BDN 711, additional labour cost saved after timely spraying which significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic changes in transfer of technology increased production observed after cultivation of BDN 711.

The Z value location specific in situ moisture conservations practice (22.03**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them.

The similar findings with the result of Chinchmalatpure *et al*. (2011) [9], Anonymous (2013-A) [1] and Zade *et al*. (2020) [31].

Table 1: Distribution of the respondents according to their change in technological impact on farmers before and after cultivation of BDN 711

1.	**B. Technological impact 1. Mechanization in agriculture**							
SR.		Before cultivation BDN 711			After cultivation BDN 711			'Z' Value
No.	Category	Score	N	%	Score	N	%	
1	Low	Up to 7	84	35.00	Up to 11	59	24.58	23.46**
2	Medium	6 to 9	146	60.83	12 to 15	162	67.50	
3	High	10 and above	10	4.17	16 and above	19	7.92	
			240	100.00		240	100.00	
	Mean	8.6375			14.9958			
	S.D.	2.0673			3.5600			
2.	**Involvement in Seed Production (BDN 711)**							
1	Low	Up to 7	128	53.33	Up to 11	68	28.33	18.14**
2	Medium	6 to 10	86	35.83	12 to 18	126	52.50	
3	High	11 and above	26	10.83	19 and above	46	19.17	
			240	100.00		240	100.00	
	Mean	10.0500			12.450			
	S.D.	1.4221			1.3528			
3.	**Source of seed availability (BDN 711)**							
1	Low	Up to 7	138	57.50	Up to 11	54	22.50	21.94**
2	Medium	6 to 10	66	27.50	12 to 18	141	58.75	
3	High	11 and above	36	15.00	19 and above	45	18.75	
			240	100.00		240	100.00	
	Mean	9.3625			12.4541			
	S.D.	1.7253			1.3467			
4.	**Intercultural operations**							
1	Low	Upto 8	70	29.17	Upto 11	25	10.42	24.98**
2	Medium	9 to 11	158	65.83	12 to 16	183	76.25	
3	High	11 and above	12	5.00	17 and above	32	13.33	
			240	100.00		240	100.00	
	Mean	8.9125			13.9708			
	S.D.	0.9919			2.9760			

5.	**Location specific in-situ moisture conservations practice**								
		Before cultivation BDN 711			After cultivation BDN 711			'Z' Value
SR. NO.	Category	Score	N	%	Score	N	%	
1	Low	Upto 6	65	27.08	Upto 10	35	14.58	22.03**
2	Medium	7 to 9	163	67.92	11 to 14	170	70.83	
3	High	10 and above	12	5.00	15 and above	35	14.58	
			240	100.00		240	100.00	
	Mean	8.4625			14.0083			
	S.D.	1.7011			3.4977			
6.	**Transfer of Technology**							
1	Low	Upto 7	84	35.00	Upto10	25	10.42	21.79**
2	Medium	8 to 9	146	60.83	11 to 17	183	76.25	
3	High	10 and above	10	4.17	18 and above	32	13.33	
			240	100.00		240	100.00	
	Mean	8.4250			13.9916			
	S.D.	1.7651			3.5298			
7.	**Yield 1. Grain yield**							
1	Low	Upto 7	88	36.67	Upto 11	39	16.25	21.95**
2	Medium	6 to 9	126	52.50	12 to 16	146	60.83	
3	High	10 and above	26	10.83	17 and above	55	22.92	
			240	100.00		240	100.00	
	Mean	8.4333			13.9958			
	S.D.	1.7678			3.5031			
2.	**Stalk Yeild**							
1	Low	UPTO 7	98	40.83	UPTO 11	39	16.25	22.99**
2	Medium	8 TO 9	129	53.75	12 TO 16	146	60.83	
3	High	10 and above	13	5.42	17 and above	55	22.92	
			240	100.00		240	100.00	
	Mean	8.5000			14.0958			
	S.D.	1.6389			3.3366			

Yield

Grain yield

The respondents response score calculated by summing the difference obtained by the subtracting the value of after cultivation from before cultivation of BDN 711 from grain yield impact. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

Data table 1 shows that yield in grain production of majority of the BDN 711 growers were changed to before cultivation (52.50%) and after cultivation increased (60.83%). Followed by low level of grain yield changed from before 36.67% to after cultivation of BDN 711 upto 16.25% and high level of cultivation 10.83% to 22.92% increased. Before cultivation of BDN 711 the production per hectare was upto 7-8 quintal but after cultivation of red gram BDN 711 increased per pods per branches production and increased height of plants. Also, it is indeterminate so farmers could take second crop on the same field which induce the annual income.

It was observed that impact of red gram (BDN 711) on yield measured in grain and stalk, more than half of the respondents before cultivation (52.50%) and after cultivation more than one fourth of the respondents (60.83%) were belong to medium change category with (8.33) impact change value. It conclude that before cultivation of BDN 711 not increased seed weight and quintal per hectare but after cultivation of BDN 711 the production of seed weight per gram increased.

It is concluded that before cultivation of BDN 711 the farmers not getting more grain yield because they were utilizing own saved previous year seeds. Also improper management of intercultural operations yield reduced. But after cultivation of BDN 711 the farmers got technical knowledge to enhance seed production seed treatment is very important also for wilting can be avoided through this process. After cultivation of BDN 711, additional labour cost saved after timely spraying which significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic changes in grain yield due to better transfer of technology increased production observed after cultivation of BDN 711.

The Z value yield measured in grain and stalk, (21.95**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them.

The similar findings with the result of Sheldrake and Naryanan, (1979) [24], Wallace *et al*. (1993) [29], Chauhan *et al*. (1995) [7], Chavhan *et al*. (2019) [8], David *et al*. (2002) [10], Rimal N.S. (2014) [21], Sivasankar, S. *et al*. (2018) [28], Singh, A *et al*. (2020) [27], Zade *et al*. (2020) [31].

Stalk yield

The data collected on the respondents response score calculated by summing the difference obtained by the subtracting the value of after cultivation from before cultivation of BDN 711 stalk yield changed hence the as also changed in stalk yield impact. The respondents' use of stalk yield as income source considered. The total score the respondents were obtained and they were categorized into three groups on the basis of mean ± S.D.

Data table 1. shows that stalk production of majority of the BDN 711 growers were before cultivation (53.75%) and after cultivation increased (60.83%) was increased. Low level of 40.83% before cultivation of BDN 711 to 16.25% after cultivation of BDN 711, followed by high level at

5.42% before cultivation of BDN 711 to 22.92% after cultivation of BDN 711 increased stalk yield which due to good plant height upto 10 feet.

It was observed that impact of red gram (BDN 711) on stalk yield, majority of growers before cultivation (53.75%) and after cultivation more than half of the respondents (60.83%) were belong to medium change category with (7.08) value. It is concluded that before cultivation of BDN 711 the farmers not getting more grain yield because they were utilizing own saved previous year seeds hence biomass reduced. Also improper management of intercultural operations yield reduced. But after cultivation of BDN 711 the farmers got technical knowledge to enhance seed production seed treatment is very important also for wilting can be avoided through this process which leads to biomass enhancement. After cultivation of BDN 711, which significant changes in the annual per capita income of the farmers after cultivation of BDN 711. It was observed from the above table that, drastic changes in stalk yield due to better biomass in plant increased production observed after cultivation of BDN 711.

The Z value yield measured in stalk, (22.99**) of before cultivation and after cultivation of BDN 711 was found significant at 0.01 percent level of probability, which indicate that there was highly significant difference among them. The biomass production among pigeon pea varieties varies considerably due to a number of agronomic and production factors. These include climatic conditions, cropping systems, duration and plant population, and this has resulted in a wide variety of yields being observed.

This similar findings with the result of Faris D. G. and Singh U. (1990) [12], Wani (2006) [30], Ding *et al*. (2016) [11], Ayenan (2017) [3], Blazos A. K. and Belski R.,(2016) [5], Sivasankar *et al*. (2018) [28].

Conclusion

The technological impact studied with different component such as farm mechanization in agriculture, involvement seed production, sources of seeds availability, intercultural operations, location specific in-situ moisture conservations practice, and transfer of technology1. Grain yield, 2. Stalk yield, etc.

Total technological impact change percentage divided by the overall percentage of each component of before cultivation impact was found 17.41%. Hence, it conclude that after cultivation of BDN 711 the farmers has established 17.41% technological impact.

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