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Pre-scaling up of Groundnut *(Arachishypogaea* L*)* Technology in mid and lowlands of West Guji Zone, Southern Oromia, Ethiopia

Teshome Kassa Degu*, Feyissa Desiso Kebeto

Oromia Agricultural Research Institute, Yabello Pastoral and Dryland Agriculture Research Center, P.O.Box. 85, Yabello, Ethiopia
*Corresponding author email: teshomekassa528@gmail.com

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Abstract— *Though groundnut is largely produced in the mid and low lands of West Guji Zone, its productivity was below expectation due to biotic and abiotic factors, lack of improved varieties and appropriate production and post-harvest practices, and diseases. Therefore, this study was designed to solve three objectives: (1) to improve the productivity of groundnut technology (2) to improve farmers' knowledge of application of the improved groundnut technology (3) to develop local capacity for further promotion of groundnut technology. Abaya district was selected purposively with two kebeles based on the potentiality of groundnut production. Two farmers' research groups consisting of 10 members were established. Among the members, a total of 8 trial farmers were used whereby a land size of 0.25ha was used for each. Based on recommendation, a seed rate of 90kg/ha Tole-1 was used with a fertilizer rate of 100kg NPS/ha for the selected trial field. Both priāmary and secondary data were used where quantitative and qualitative data were generated. The data was analysed using descriptive statistics and narration. The result showed that the pooled mean yields of Tole -1 technology was 26.92qt/ha where the yield across the production years was significant ($p<0.05$). It was concluded that the productivity of improved groundnut could be enhanced through capacity building, access to farm inputs, and linkage formation. Therefore, Tole-1 groundnut variety was recommended for further promotion in Abaya district and similar agro-ecology until alternative variety released.*

Keywords— ***Abaya, Groundnut, Mid and Lowlands, Tole-1, West Guji***

I. INTRODUCTION

Globally, groundnut is one of the most important oilseed legumes grown. Asia and Africa account for more than 90% of global groundnut area and it is cultivated mostly under rain fed conditions by small-scale farmers. The African continent accounts for 31.1% of total global production (FAOSTAT, 2018). According to the report in 2018, worldwide groundnut is cultivated on 27.66 million ha, with an annual total production of 43.98 million tons where the leading groundnut producing countries in the world are India (20.97%), China (16.35%), Nigeria (9.68%), and Sudan (8.37%) (FAOSTAT, 2018).

In Ethiopia, groundnut is commonly produced for food, cash income, and animal feed. It is solely grown by smallholder farmers under dryland conditions in the lowland and drought-prone areas of the country. The total area under groundnut production is 80,841.57 ha (CSA, 2018). In the country, groundnut is largely produced in the Oromia Region, constituting 59.2% of the total national production, followed by Benishangul-Gumuz (24.83%), Amhara (7.43%), Harari (3.29%), and Southern Nation and Nationalities People (1.29%) regions (CSA, 2018).

Currently, the lowland areas of Ethiopia have considerable potential for increased oil crop production such as groundnut (Gutu *et al*., 2019). According to CSA (2017), the estimated production area and yield of groundnut in Ethiopia in 2016/2017 cropping season were 74,861.37 hectares and 1,296,364.18 quintals, respectively. The national mean yield of groundnut was estimated to be 17.96qt/ha (CSA, 2018). After a year, its average national

production was 17.80qt/ha (CSA, 2020). The cultivated area and productions increased marginally during the last few years; in 2010, it was around 24 million hectare with a total production of 38 million tons, while the cultivated peanut area in 2019 reached around 35 million ha with a total production of 73 million tons (FAOSTAT, 2022).

Like other parts of Oromia region, where groundnut is largely produced, in the mid and low lands of districts of West Guji Zone also one of the major cash crops grown in the area. However, the production and productivity in the area was below expectation due to similar problems faced at the country level, such that groundnut was mainly constrained by several biotic and abiotic factors, which include critical moisture stress especially during flowering, lack of improved varieties and appropriate production and post-harvest practices, and diseases affecting both above- and underground parts of the plant (Fredu *et al*., 2015). In addition, lack of mechanization hinders its production in the country (Sendekie, 2023).

In recognizant of these problems, Yabello Pastoral and Dry land Agriculture research centre have conducted adaptation and demonstration studies on different groundnut varieties in Abaya district of West Guji Zone. The demonstration activity of the research was done with the close consultation of Agricultural Office on the plot areas of trial farmers through participatory approach (field day and field visit time). The result of demonstration indicated that one best performed variety, namely: **Tole-1** was found to be early maturing, high yielder (37qt/ha), highly preformed growth and better yield advantage as compared to both Fayo and NC4x varieties (Abdulla *et al*., 2016). The same authors found that farmers are interested and selected this variety during field day.

However, the previous study was neglected to address the wider users (number of farmers), demand creation and sustainable technology promotion options. Therefore, this study was intended to further promote and pre-scale up of this technology in Abaya district.

Objectives

- To improve productivity of groundnut technology in the study area
- To improve local capacity for further promotion of groundnut technology in the study area
- To strengthen stakeholders linkage through collaboration

II. MATERIALS AND METHODS

Description of the study area

The study was conducted in Abaya district found at 365 Km from Addis Ababa to the south direction. Abaya is located at 6^0 $14'_N$ latitude and $30^010'_E$ longitude. The altitude of the district ranges from 1200-2060m.a.s.l. It has an estimated average annual rainfall of about 1223mm and the average annual temperature ranges from 16^0C–28^0C (optimum range of temperature). It is bordered by regional state of Nations, Nationalities and people of southern Ethiopia in the North and East, Lake Abaya to the West and Gelana district in the South. The only two types of agro-climatic condition of the district are mid-land (Waynadega) and lowland (Kola). About 30% of the total area of the district falls under mid-land. The remaining 70% falls under lowland agro-climatic condition. According to the soil map of Borena Zone, the soil unit of Abaya Woreda are calcaric and euricfluvi soils, euricnitosols, chiromic and orthicluvis soils. Of these, the first two are the types of soils covering the largest part of the Woreda. According to the data obtained from District Agricultural office, the major crops produced were maize, groundnut, barley, 'teff', sorghum, haricot bean, wheat, field pea and faba bean (Abaya District Finance and Development Office, 2016).

Site and Experimental Farmers Selection

For this study, Abaya district of West Guji Zone was selected purposively. Two potential groundnut producing kebeles namely Guanga Badiya and Samaro and a total of 8 farmers (4 from each PA's) were selected purposively through close consultation of Agriculture Office and DAs in the district. The study used the selection criteria of trial farmers such as experience of the farmer, accessibility of the farm land and willingness of the farmer to be included in FRG, share experience and provide land for demonstration. Then, two FRGs consisting of 10 members (men, women, and youths) were established. Groundnut technology which characterized by an adaptable, early maturing and high yielder so called **Tole-1** was used for this activity. An area coverage of $2500m^2$ (0.25ha) was used at each field of the selected farmers. A total area coverage for the study was 4ha where 2ha per each kebele was used. Both theoretical and practical training was given for the selected farmers, DA's and experts basically on the overview to production, field design, and management practices such as weeding, fertilizer application, tillage, post-harvest management and the likes.

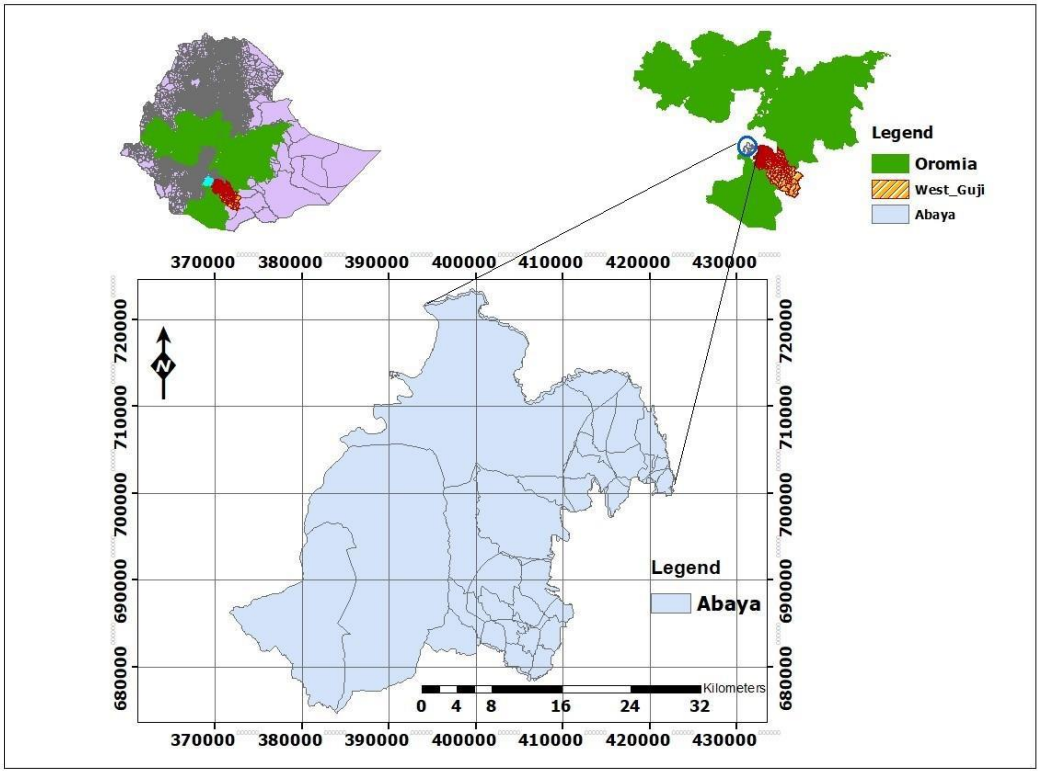

Fig.1. Map of Abaya District

Source: Own sketch using ArcGIS Version 10.4, 2023

Technology Transfer Approaches

Pre-scaling up of groundnut was conducted in Abaya district of West Guji Zone through participatory approach. In this regard, farmers research group (FRG) was established as a prime movers whereby different stakeholders (DAs, Expert, farmers etc) were involved in the intervention. The FRGs were composed of ten (10) members which have different age category of farmers such as adult male and female, and youth. As inputs, YPDARC provided groundnut seed (Tole-1) for each group empowered them to handle all management activities. The best mechanism to transfer the technology was training of participants, demonstrating performance of the technology on the farm and field day on the production of the technology and linking them with different stakeholders.

Study Design

Tole-1 variety was used during the study period (2019/20-2021/22) at the fields of 8 experimental farmers. There was no local variety used at Abaya district except the newly recommended (Tole-1) and introduced to the area. For this variety, a recommended seed rate of 90kg/ha and 100kg DAP/ha was used on the 50mx50m plot area of each trial farmer and a line spacing of 35cm between rows was used where the seed was drilled in the line of rows. Hand weeding was used to control weeds. Harvesting was done by hand while threshing was done manually. Training was given for trial farmers as well as experts and DAs at FTC. The activity was monitored by researchers and Development Agents assigned at each kebele.

Data Collection Methods

Based on the nature, both primary and secondary data were employed for this study. Appropriate primary data collection methods such as simple survey using check lists (knowledge and skill tests of before and after training), personal observation, direct record (yield measurement in kg) and farmers' group discussion were employed to generate both qualitative and quantitative data. Whereas, secondary data (published and unpublished) was collected through critical review of annual report documents, journal articles, proceedings and journal books. Quantitative data such as yield data, total number of farmers participated on extension events (training, demonstration, field day), and stakeholders participated in the study were collected and triangulated with qualitative data including farmers' opinion/feedbacks on the production process.

Data Analysis Methods

Both quantitative and qualitative data were generated for this study. Quantitative data was analysed through descriptive statistics such mean, SD and percentage using

SPSS software (version 21) whereas qualitative data was analysed using narrative explanation.

III. RESULT AND DISCUSSIONS

This section presents the finding in line with the sets of objectives regarding yield obtained through scaling up of groundnut production, capacity building (number of trained farmers, experts and DAs), stakeholders linkage, farmers' knowledge and skill test on the technology transfer approaches.

Capacity Building on Tole-1 Variety

For success of the intervention implementation, the multidisciplinary researchers at Yabello Pastoral and Dryland Agriculture Research centre were participated in training provision. The team members involved in the training delivery were research-extension, oil and pulse crop, socio-economic and crop agronomics researchers of the centre. The training was provided on different sub-topics such as improved groundnut production packages, agronomic practices, market information, experience sharing and technology transfer approaches. As shown in the table 1 below, the participation of the stakeholders in the training who could influence and benefited from the intervention.

Table 1. Stakeholders training on Tole-1 production

Stakeholders	Number of participants across production years						
	2019/20			2021/22			Grand Total
	Male	Female	Sub-total	Male	Female	Sub-total	
Experts	2	1	3	3	1	4	7
DA's	2	1	3	2	2	4	7
Farmers	7	3	10	7	3	10	20
Others	2	1	3	2	2	4	7
Total	13	6	**19**	14	8	**22**	41

Source: Own data (2019/20-2021/22)

Field Day

One of the information dissemination mechanism is field day where it jointly organized with district level agriculture office so as create opportunities for all relevant stakeholders', to create awareness on the importance and availability of the technology, to learn from the technology promotion activities and also to evaluate the performance of improved variety under farmers' condition, to enhance farmers' knowledge and skill on groundnut production and management and to collect feedback from all relevant stakeholders' for further way forward. Considering gender, a total of 22 farmers, 2 development agents, 1 district expert and others 6 from others (GOs and NGOs) were invited and attended on the field day event as shown in the table 2 below.

Table 2. Number of participants on field day

Stakeholders	Participants by gender		
	Male	Female	Total
Farmers	16	6	22
DA's	1	1	2
Experts	1	0	1
Others	5	1	6
Grand-total	23	8	**31**

On farm yield performance of Tole-1 variety

The activity was conducted during the main rain season starts from March to June on farmers' field whereby the data of two consecutive years collected using data sheet. The result in table 3 revealed that the higher mean yield was obtained in 2019/20 production season. The pooled mean

yield in the first year was 27.46qt/ha while mean yield in 2021/22 was 26.38qt/ha (Table 3). Overall, the pooled mean amount of the yield in the district accounts 26.92qt/ha using representative kebeles (Guanga Badiya and Samaro) in Abaya district. This implies that a desired yield obtained across production years was statistically significant at 5% precision level. It was remarkably noticed that a favourite environmental conditions and best management practices would help to enhance a better production.

Table 3: Yield performance of pre-scaled up Tole-1 (Qt/ha)

Years	N	Mean	SD	Min.	Max.	Std. Error of mean	t-value(sig.)
2019/20	8	27.46	0.87	25.96	28.52	0.309	2.309(0.037)**
2021/22	8	26.38	0.99	25.12	27.92	0.351	
Total	16	26.92	1.06	25.12	28.52	0.265	

Source: Own data computation, 2023. ** indicates 5% significance level.

As compared to the result of both recommended and demonstration, the pooled mean yield obtained under pre-scaling up was higher and lower than the recommended (17.8qt/ha) and demonstration (37qt/ha), respectively (Figure 2).

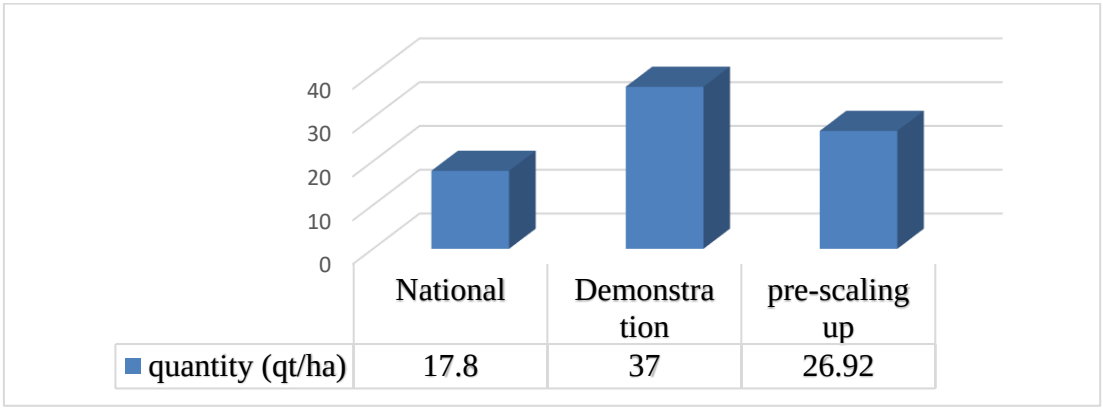

Fig.2. Comparison of mean across different production stages

Intervention Impacts

This study reveals the impacts or change due to the intervention on pre-scaling up of groundnut technology which indicated in terms of linkage status among stakeholders, farmers' knowledge developed, feedback of farmers' towards the improved technology.

Linkage

In this study, a desired linkages between/among stakeholders which helps to promote the groundnut technology was created. The interaction mostly rely on the role of each stakeholder in groundnut production (Table 4). A complex interaction among actors was observed in both vertical and horizontal relations. This means that the interaction between actors was vertical (e.g. farmers to YPDARC, farmers to DAs, YPDARC to experts, farmers to cooperatives etc. and vice versa) while within actors (e.g. farmer to farmer) was horizontal relation. In this regards, every stakeholders played a vital roles to enhance the production. Two types of linkages (material and technical) were created where most of the stakeholders interacted in both types (Table 4).

Table 4: Stakeholders' role on groundnut production

Stakeholders	Roles	Linkage types		
		Material (a)	Technical (b)	Both (c)
YPDARC	Seed provision, training, monitoring, site and farmers selection, information delivery			✓
DAs	Monitoring, site and farmers selection, information delivery			✓

Experts	Monitoring, site and farmers selection, information delivery			✓
Farmers	Management, information, follow up farm, land provision			✓
Agricultural cooperatives	Input provision (seeds, pesticides, fertilizer, herbicide), information etc.			✓
Other farmers	Information/experience, seeds etc.			✓

The study used a total of six (6) different stakeholders during the study period. According to Kebede *et al*. (2021), linkage needs multi stakeholders who had common goal for improvement of agricultural production. Thus why this study used both material (represented by one headed arrow) and technical (two headed arrow) to indicate linkages among stakeholders (Figure 3). To effect this, the interaction among different actors (Yabello Pastoral and Dryland Agricultural Research Centre, Abaya District Agricultural Offices, Agricultural Cooperatives, Development Agents, Experts, hosting farmers and local community) was developed via provision of agricultural inputs (material): seed distribution, pesticides, herbicides, fertilizers etc. and information (technical) flow for groundnut production. This finding was consistent with Choo (2009). Most of the stakeholders had participated during training and mini-field day. Meanwhile, the famers (prime movers) participated throughout the production seasons.

For this study, both technical and material linkages were developed thereby actors interact each other through their respective roles. Technically, appropriate site and farmers selection, training, information delivery was conducted by YPDARC in the support of DAs, experts and Agriculture Office in Abaya District. It was ideal that the diagram was constructed manually to represent the stakeholders' interaction during the production seasons.

It was also observed that the linkage among farmers was strengthened through horizontal seed distribution and experience/information shared. Due to the fact that high demand of Tole-1 variety was created. Therefore, there is a need to emphasis on further scaling up to wider area and users which helps to satisfy farmers.

Farmers' knowledge

As shown in the table 4 below, majority of farmers (75%) were developed the knowledge of seed rate and sowing in rows and spacing after training provided while the remaining (25%) used the existed practices. The supportive bodies such as DAs, experts and NGOs in the locality helps the farmers to develop the knowledge and skill of sowing different agricultural crops. As compared to before intervention, the knowledge of farmers on application of fertilizer, management practices (weeding, pest control etc.) and the use of new variety were improved. However, poorly execution of post-harvest handling (12.5%), plant spacing (12.5%) and seed rate (25%) was observed under farmers' conditions (Table 5). This could be due to the shortage of storage, labour and finance. Overall, a desired change in knowledge and skills was recognized among farmers due to full technical support, inputs delivery, training (theoretical and practical) as well as continuous follow up throughout intervention lifespan.

Table 5: Evaluation of knowledge and skill improvement before and after training (n=8)

Criteria	Before				After			
	yes	%	no	%	yes	%	no	%
Application of seed rate	2	25	6	75	6	75	2	25
Application of fertilizer rate	3	37.5	5	62.5	8	100	0	0
Sowing in rows & spacing	2	25	6	75	7	87.5	1	12.5
Management practices	4	50	4	50	8	100	0	0
Seed preference and use of new variety	2	25	6	75	8	100	0	0
Pre and post-harvest management	1	12.5	7	87.5	7	87.5	1	12.5

Farmers' feedback towards Tole-1 variety

The intervention of improved groundnut technology was conducted in the selected potential area of West Guji zone. The test on farmers' knowledge on Tole-1 production and productivity, marketability, its uses in local food process as well as typical problem have been assessed. A group discussion has been conducted with a sample unit of 8 trial farmers by which a qualitative data was generated from their views/opinion. Lists of checklist was used to collect and record farmers' opinion. Accordingly, farmers explained that Tole-1 variety is highly appreciated due to disease and pest tolerant, high yielder, fits the local conditions, and good market price. Respondents have argued that the use of the variety helps in family food consumption, income diversity with other agricultural income sources. In food process, farmers used roast of groundnut with maize, wheat, and barley to feed their family. It was also considered to be a means of income diversity in the locality.

Overall, the seed was highly demanded in the local market due its valuable advantage in the local food system, means of income and improved seed. Mostly, it was collected by private and cooperatives and sold at super market in the study area.

However, farmers claimed price problem at farm gate because the collectors reduce the price per kilogram. Moreover, farmers also disliked the manual work to unshelled the groundnut because it consumed more labor, time and budget.

Exit strategy

Considering the mandate and scope of YPDARC, it was proven that technology generation, agro-ecology base adaptation and demand creation through demonstration and pre-scaling activities has been conducted under farmers' circumstances. As the main collaborator of YPDARC, District Office of Agriculture played a vital role in the success of the intervention. However, the sustainability of the intervention still remained under Office of Agriculture. Therefore, the wider scope or dissemination of the technology (Tole-1) should be handover and implemented by Office of Agriculture in Abaya district. To do so, a formal discussion was held at Abaya District in the presence of leaders, DAs, experts, researcher at which formal discussion conducted and agreement signed on exit strategy on how to be promoted sustainably so as to reach out wider scale. Hence, the responsibility of further technology dissemination has been given to Abaya district agricultural office with minimal research centre intervention in sustainable diffusion of the technology.

IV. CONCLUSION AND RECOMMENDATION

Though groundnut is largely produced in most areas of West Guji Zone, its production and productivity was below expectation due to several biotic and abiotic factors including moisture stress, shortage of improved seeds, disease (leaf rust) and pests. But, the previous studies were neglected to attain a wide beneficiaries in Abaya district. In order to solve these problems, the study by Yabello Pastoral and Dryland Agricultural Research Centre (YPDARC) was intended to pre scale up, strengthen linkage and disseminate the technology in the study area. Participatory approach has been used to reach out and educate wide users. After capacity building, farmers recognized that the use of this technology helps to minimize shortage of seeds and maximizes farmers' benefits.

In addition, the result of group discussion shows that Tole-1 variety was well appreciated because of pest tolerant, fits local conditions and high yielder in the area. A narration information obtained from farmers' views shown that "*producing this variety is alleviating the existed seed in the locality. The variety was believed as a source of food and income for farmers' benefit*." "*This could be assured if and only if multiple stakeholders contributes the required farm inputs, knowledge, skills as well as motivation*." But the price inflation on farm input (fertilizer) was claimed as a major challenge which needs critical attention.

It was proven that improving the productivity of our farmers' remains under challenge that has to be evaluated intentionally. Typically, knowledge deficiency was observed after training and intensive technical support in the areas of plant spacing, seed rate and pre and post-harvest management practices.

Therefore, the researchers concluded that the productivity of groundnut was enhanced through capacity building, access to farm inputs, and linkage formation. The variety was well accepted by farmers and suggested to widely promote to make farmers beneficial through the Office of Agriculture in Abaya district with the minimal intervention of research centre. This could be achieved through applying appropriate extension approaches such as providing training experience sharing, field day organizing and collaborative work with stakeholders, private producers, NGOs and other responsible bodies. Farmers' knowledge improved in fertilizer rate, management and use of improved seeds so that a desired pooled mean yield (26.92qt/ha) was obtained in the production seasons.

Based on the findings of this study, the researchers recommended the following points:

- Participatory extension approach should be used to further scale up of improved groundnut (Tole-1) in Abaya district and similar agro-ecology. Extension

events such as training and field day should be used to share experience among farmers and technology promotion.

- District level technical support, seed multiplication and distribution from experts, DAs and practitioners should be enhanced in order to reach a wider beneficiaries. The technical support would help to improve the skill gap of seed rate, raw spacing and pre and post-harvest management practices.
- Linkage among stakeholders should be strengthened to help farmers' access to market, farm inputs (seeds, fertilizers, pesticides, herbicides etc.), advisory services and the likes. The linkage would solve the information gap.

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