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Crop Technologies Scaling up and out Programme and Its Impact on Households Food Security Status in Metekel Zone, Benishangul-Gumuz Regional State, Ethiopia

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ABSTRACT

The study carried out to assess progress, weakness and strength and to measure impact of crop technologies scaling up and out programme on participants household food security status. The study used primary data through questionnaire based interviewing, focus group discussions and personal observation. It also used secondary data. Though it is not significant, there is difference in food security status between participants and non participants. And applying same way of treatment on indigenous Gumuz and non indigenous farming communities, limited effort to marketing and farmers' gaps in implementing information and skills they got were major limiting factors for further better successes of the programme. On contrary, implementation of participatory and demand driven technologies supply system, having strong supporting behavior within modern farming experienced non indigenous communities and indigenous Gumuz and active involvement of administrative officials contributed for existed success of the programme. Targeting participant communities independently based on their peculiar farming system, promoting innovation platform approach that allowed participation of interested and relevant stakeholders with their specific roles along crop value chain development, creating awareness about the relevance of marketing cooperatives and working more on community based roads development to solve marketing problems were forwarded as recommendations.

***Keywords*:** Crop technologies; Scaling up and out; Food security; Propensity Score Matching; Metekel zone

1. INTRODUCTION

Highly poverty influenced economy of Ethiopia is depend on agriculture, that takes a share of 47 % of GDP, employs 85% of labor force and supplies over 75% of the value of all exports (EEA, 2015). With in agriculture, share of crops, livestock and other areas is about 80.8%, 15.3% and 3.9% respectively (EEA, 2014).

Though there are many reasons, poor extension services were ranked as top in Ethiopia for lesser technology adoption (Elias *etal,* 2013, as cited Elias *etal*, 2015). In recent past, as to many poor countries, access to adequate knowledge, improved technology, financial services remain a critical issue for Ethiopia. Existing challenges in providing extension and advisory services (EAS) in these areas range from insufficient funds for supporting public extension, poor resourcing, disorganized structures resulting in poor infrastructure for attracting businesses, limited involvement of rural farmers and populations in extension processes to the lack of appropriate strategies for effective research and adequate extension methods (Mbo'o and Colverson, 2014).

Under Ethiopian Institute of Agricultural Research (EIAR) at Pawe Agricultural Research Centre (PARC), participatory technology development (PTD) practice had started on maize and wheat crops. PTD approach supported research and extension system through increasing farmers awareness of different crop varieties traits, building farmers capacity in evaluating crop varieties for different traits, improving access to different varieties for farmers own experiment and creating business opportunities in seed marketing for small scale farmers (Alemu and Shiratori, 2016). PTD integrates different social categories of people into research initiatives. It is also highly important to develop technologies to resource poor farmers through considering their indigenous knowledge (Chisholm and Crowley, n.d).

In recent past, government of Ethiopia has been actively investing in its agricultural extension system to achieve agricultural development, poverty reduction and food security (Catherine *etal*, 2013). In line with this facts after a critical evaluation of past extension approaches, government launched Participatory Demonstration and Training Extension System (PADETES) in 1995 as the national agricultural extension system that provides small amount of inputs mainly seed and fertilizers directly to farm households with minimum visiting frequency by development agents (Davis *etal*, 2009).

As part of PADETES, government has followed strategies, which could allow spreading out proven agricultural technologies and information to farmers to build Ethiopia's revival on sustainable base. Accordingly, EIAR has taken initiative in launching technology scaling up and out programme in Benishangul Gumuz region with the financial support of Rural Capacity Building Project (RCBP) which is World Bank financed program implemented to improve the access and quality of the agricultural extension system and make the service client oriented to address the demands of farmers and pastoralists (Thangata and Mequaninte, n.d). In doing so, in the recent past, different stakeholders have been done their significant efforts to disseminate crop technologies that are proven in bring concrete economic growth and capable of changing farming community living standard.

Hence this paper is prepared to assess process, identify strength and weakness and measure impact of crop technologies scaling up and out programme on food security status of participants of the programme being implemented in Metekel zone, Benishangul-Gumuz region from 2009-2013 cropping seasons.

2. MATERIAL AND METHODS

2. 1. Description of the study area

Metekel zone is one of the three zones of Benishangul-Gumuz National Regional State (BGNRS) located in the northwestern part of Ethiopia-Sudan borderlands occupying an estimated total area of 22,028 Km^2 (Wolde-Selase, 2002). It has seven districts namely Pawe, Dangur, Mandura, Dibate, Bulen, Wembera and Guba. Altitude of the zone ranges from 600 to 2731 meter above sea level and rainfall ranges from 900 to 1450 mm per year. Availability of different agro ecologies and fertile farm land gives chance for small holder farmers and commercial agricultural investors to cultivate high value pulses and oil crops like soybean, sesame, haricot bean, mug bean and ground nut and also cereal crops like sorghum, finger millet, rice and maize etc.

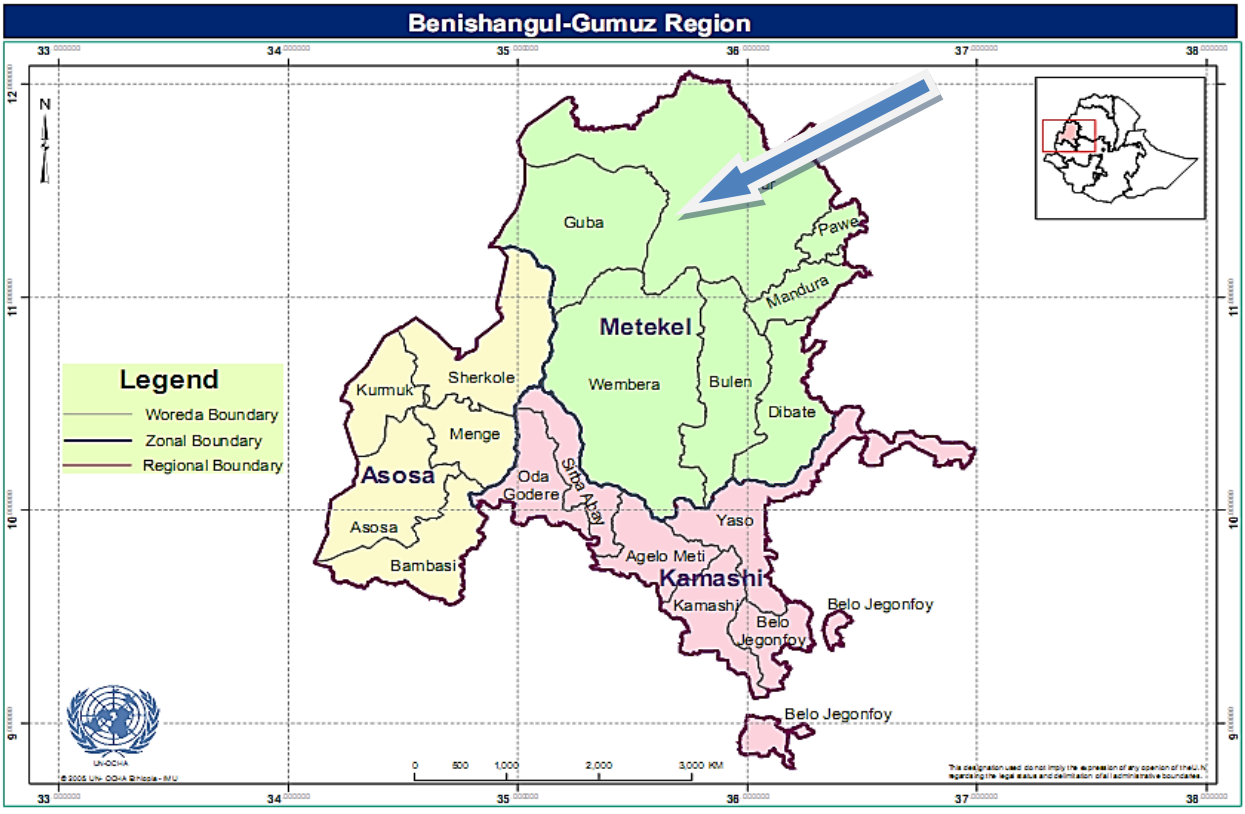

Figure 1. Map of Metekel zone (Green shaded)

According to central statistics agency (2013), population projection values of Metekel zone in 2016 is 364,588, of whom 182,779 are males and 181,809 are females; 288,232 or 79.05% of its population are rural dwellers. Metekel zone encompass indigenous ethnic group (Gumuz and Shinasha) and non indigenous ethnic group like Amhara, Agew, Kembata and others who have relatively better agricultural experiences compared with indigenous one. Metekel has a road density of 28.4 kilometer per 1000 square kilometers.

2. 2. Materials and methods

This study used primary and secondary data sources. For collecting primary data, interviewing farmers using semi structured questionnaire, focus group discussion with farmers, key informant interviews with head and experts of districts and zone level agricultural offices and personal observation methods were implemented. For secondary data, different reports were used from EIAR, particularly from PARC. The study used data summarization, simple descriptive, propensity score matching and monthly food intake calorie measurement analysis methods. In this study, a given household is said to be food secured if it could achieve 2100 kilo calorie per adult equivalent per day.

3. RESULTS AND DISCUSSION

3. 1. Process of crop technologies scaling up and out programme.

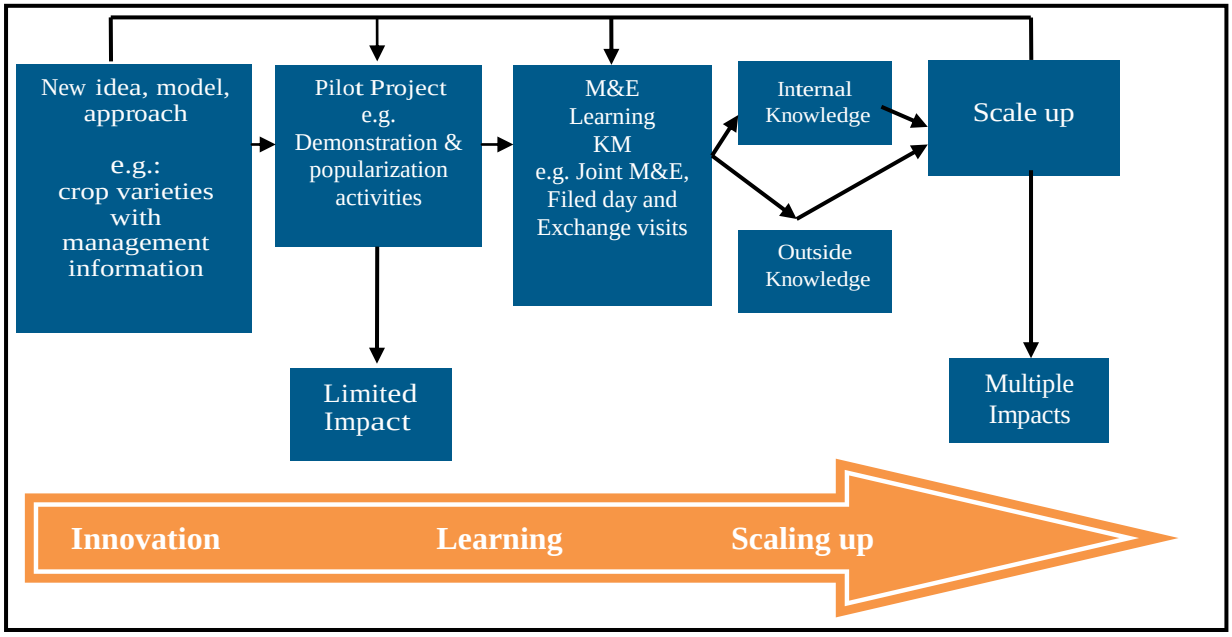

Figure 2. Innovation, Learning and Scaling Up Linkage
Adopted from Linn et al (2011)

Holcombe in 2012 defined scaling up as "expanding, adapting and sustaining a successful technology, innovation or policy in different places and over time to reach a greater number of people". Another definition is from a 2004 Shanghai conference, cited in Jonasova and Cooke (2012) "expanding and sustaining successful policies, programs and projects in different places over time to reach a greater number of people". Linn in 2012 defined scaling up as the "expansion, replication and adaptation that sustains successful policies, programmes or projects to reach a greater number of people". Primarily reaching to scaling up demands new and proven idea, knowledge or technologies that have been exhibited and shown success at local level. In the process there will have knowledge sharing and accumulation that will be the base for future scaling up. Hence, scaling up is seen as a process along a pathway towards

a goal of impact at scale under which multiple impact is achieved with continuous learning and innovation (Hartmann *etal*, 2013) as shown in Figure 2

Accordingly, before starting of crop technologies scaling up and out programme, PARC has generated different cereal, pulse and oil crops varieties with their management information as full package. Then using these full package technologies, the centre has implemented pre-scaling up on farm demonstration activities on 3-5 farmers filed for each crop to show their productivity potential to limited number of farmers and agricultural experts. After collecting feedbacks from farmers and agricultural experts about the technologies and its means of transfer, it has progressed to crop technologies popularization process that has involved 15-20 participant farmers from each crop technology. Then since 2009, it has evolved to scaling up level to address higher number of farmers for higher impacts. With this process, crop technologies scaling up and out programme in its five implementation years could benefit 4254,3540, 3286, 2855, 690 and 3758 farmers using sesame, soybean, haricot bean, finger millet, sorghum and maize technologies respectively. Addressing such number of farmers was implemented under many production constraints like weeds (eg Striga), insects (termite) and many crop specific diseases and rat infestations (Mulualem and Melak, 2013) that has hindered productivity potentials of many scaling up crops severely that ultimately will put negative impact on food security status of farmers. As a programme, it had planning, implementation and monitoring and evaluation phases.

3. 1. 1. Planning

What Works Scotland evidence review paper on Scaling up innovations in 2015 pointed out that adequate time and planning is vital to have successful scaling up programme. Planning phase should considered the resources and support they could access, choices they made about who to partner with and how to achieve impact, and the windows of opportunity - political, cultural and social condition of intervention area (Darcy and Michele, 2015). Considering availability of crops technologies and amount of seeds from different sources, core unit of Zonal Agriculture and Rural Development Advisory Council (ARDAC) has arranged scaling up and out plan based on the information gathered from Development Agents (DAs) in every district and kebeles. Members of the advisory council discussed on the plan in detail at zonal ARDAC meeting. The plan included number of participant farmers, area covered, type and amount of crop technologies required per districts. At the planning meeting, all stakeholders' roles and responsibilities were defined clearly for effective networking of activities and sharing of information. Collaboration and networks play pivotal roles in spreading innovation by increasing buy-in from stakeholders and increasing the share of resources, knowledge and experience (Davis et *al*, 2015). In this regard, the following were crop technologies scaling up and out programme stakeholders with their respective roles and responsibilities

PARC

- Supplying crop technologies seed in cash.
- Providing trainings to Subject Matter Specialist (SMSs), DAs and farmers
- Involved in periodic monitoring and evaluation of farmers field
- Involved in market assessment activity
- Played leading role in establishing and strengthening FRGs

- Played leading role in organizing zone level farmers filed day

Agriculture and Rural Development Office (ARDO)

- Involved in selecting participant farmers
- Organizing zonal and district level ARDAC
- Involved in periodic monitoring and evaluation together with PARC and NGOs staffs
- Involved in establishing and strengthening FRGs
- Play leading role in market assessment activity
- Played leading role in organizing farmers exchange visit

NGOs

- Organizing consultative meeting
- Providing additional budget to the programme
- Involved in periodic monitoring and evaluation together with PARC and ARDO staffs

Farmers

- Implementing advice getting from researchers, SMSs and DAs synchronizing with their own indigenous knowledge
- Participating in FRGs to multiply selected scaling up and out crop seeds
- Play key role in farmers filed days and farmer exchange visits

Though existing stakeholders could implement their priority roles and responsibilities and had got some success mainly from production aspect of crop value chain development, the programme had concentration gaps on marketing aspects. According to key informants response, rather than giving marketing roles to PARC and district ARDO, there were organizations that could take and discharge marketing role and responsibilities like trade and industry office, cooperative offices and Ethiopian Commodity Exchange etc. lucking such kinds of stakeholders and giving marketing responsibilities for inappropriate stakeholders has hindered scaling up participants income earned from output market.

3. 1. 2 Implementation

There were different activities that have been implemented by different stakeholders separately as well in collaboration. It included provision of training, dissemination of seeds, organizing of farmers' field day and farmers exchange visits.

Training

Training delivered to farmers, SMSs and DAs believed to be one of the prominent inputs to speed up adoption of high yielding crop varieties and its agronomic practices. In this regard, in the past crop scaling up and out years, PARC, district ARDO and NGOs like Mojijigo Loka Gumuz Women's Development Association (MLWDA) and Canada Physician Aid and Relief (CPAR) had jointly organized training programs to farmers, SMSs and DAs. In this process of joint training delivery system, the study identified that GOs and NGOs have solved wasting of double budgeting to train similar target beneficiaries on same intervention areas. As the result of collaborative works, efficiency of GOs has improved and the extra

budget resulted from GOs and NGOs joint planning, supported the programme to increase additional beneficiaries in training program.

Dissemination of Seeds

Having successful scaling up and out programme demanded timely multiplication of expected amounts and types of seeds with expected quality. In the past scaling up and out intervention years, farmers have got seed from PARC, seed multiplier FRGs and farmers to farmers' seed exchange systems. All the three sources are discussed below

PARC

At the beginning years of the programme, there was no agent other than PARC which has taken responsibility of supplying improved seed to fulfill farmers' seed demands. As shown in table 1, except soybean and maize, the amount of seed multiplied and distributed through PARC has increased consistently within the first four scaling up years and decreased at the end of scaling up and out years. The reason for decreasing at the end of scaling up and out year was the programme was highly supplemented by seed produced from FRG and farmers to farmers seed exchange schemes. The reasons for the fluctuation of soybean and maize seeds were (1) PARC seed multiplication programme was totally demand driven. Before seed multiplication, farmers' seed demand from each district has been collected. With this procedure, at the time of high soybean production period (in 2012), there was soybean marketing problem. Due to this reason, farmers' interest to participant in soybean crop for 2013 cropping season has decreased. Accordingly, the amount of soybean seed multiplied and distributed has decreased. (2) though, farmers' interest in using improved hybrid maize has increased from time to time, the amount of seed multiplied and distributed to the farmers has fluctuated due to technical problem of hybrid maize seed multiplication process, lack of isolated seed multiplication farm land and budget constraints.

Table 1. Quantity of Seeds (in KG) produced and distributed by PARC over years

Crop	Years (2009- 2013)					
	2009	2010	2011	2012	2013	Total
Sesame	2800	3394	4725	6031	5400	22350
Soybean	1850	8795	25525	26670	6480	69320
Finger milt			79	5034	3633	8746
Sorghum			150	5050	2390	7590
Maize	14910	9768	15522	6361	21640	68200
Total	19560	21957	46001	49146	39543	176207

FRGs

FRG is group of farmers involved in joint problem identification, experiment designing, execution and monitoring and evaluation in the process of agricultural technology generation, evaluation and transfer (JICA/EIAR, 2015). As technologies transfer process, the programme played vital role in establishing FRGs that could produce sesame, finger millet, sorghum, haricot bean and soybean seeds to fill the demand- supply gap existed in the zone. In 2012 six and in 2013 eight FRGs were established in different districts of Metekel zone. In two years, FRGs could cover 25 % and 35% seed required for the programme respectively.

Farmer to farmer seed exchange

Because of lack of governmental and private seed enterprises, remoteness of the area that has poor infrastructure (mainly road) to get seeds from nearby region's seed enterprises and limited experiences of using FRGs for seed multiplication (specially seed marketing issues), crop technologies scaling up and out programme has faced seed demand-supply gap problem. Owing to these reasons, the programme has modified the system that valued indigenous knowledge and encouraged farmers to join themselves in to farmer to farmers' seed exchange system. Before promoting this system, district level ARDO experts identified farmers who were initially taken certified seed from reliable seed supplier like PARC and seed multiplier FRGs. After identified those farmers who has got certified seed, experts have arranged training of trainers for selected model farmers on quality seeds production. Then the model farmers as a trainer will have responsibility to assist their neighbor farmers to produce high quality seeds. Farmer trainers are considered to be more effective means to capacitate farmers (Matata, 2013) to produce high quality local seed. Though the system might have minimal drawbacks, regarding qualities of the seeds, it has considerably minimized seed demand-supply gaps existed in the zone and covered about 35% and 50% of scaling up and out programme seed requirement for 2012 and 2013 cropping season respectively.

The study identified that, all three ways of seed disseminations had promising linkages that have solved the dilemma between supply capacities of formal seed sectors versus huge demands of the technologies and capacity of informal seed sectors/agents on quality seed production (Alemu, 2011). This interlinked system has minimized the burden of formal seed suppliers (PARC). It is also taken as good solution for the study area having infrastructure development gaps and a number of farmers who have lesser seed purchasing power.

Farmers Field day

Field day is an event on which an area containing successful farming practices is open for people to visit and learn (JICA/EIAR, 2015). Such agricultural shows create demand for technologies and encouraged farmers to buy the technologies being demonstrated (Stephen and John, 2014). Field days were organized every year at zonal, district and kebele level to create awareness on technologies availability, suitability and market opportunity. It was also one forum to get feedback from farmers and other stakeholder about the programme for the better future works. According to district ARDO expert and heads responses, participating in field day events were the leading sources of information to increase number of participants on crop technologies scaling up and out programme. And organizing kebele level filed days were also found to be cost effective and fundamental for better adoption of crop technologies in large scale. Study by Asmelash (2014) indicated that participation of farmers in extension

event, especially in field day has significant contribution to higher adoption of crop technologies.

Exchange visit

It is one of experience sharing and learning tool whereby farmers visited other farmers' crop farms to learn from good, as well as poor practices. Scaling up and out programme used exchange visits to disseminate information from successful districts using model and most successful farmers who were participated in scaling up and out programme to the surrounding farmers, especially to farmers living in a place where technologies were not wildly expanded. Accordingly, 467, 540 and 675 farmers from three districts that majorly inhabited indigenous farming community (Guba, Wembera and Mandura) have participated and have got experience on different crops cultivation in 2011, 2012 and 2013 cropping seasons respectively. Key informant interviews result reveled that though it was costly, applying farmer to farmer exchange visit increased interest of other farmers to be involved in the programme and to be more effective in their farm activities.

3. 1. 3. Monitoring and evaluation

Reasons why it is important to evaluate a project are getting evidence about what project has achieved, what works and what doesn't work and it is useful for taking the project forward, demonstrating effectiveness and satisfying sponsors, government and community (Ahmed, 2014). In the programme, based on the schedule arranged in planning phase, responsible bodies prepared and send reports to higher officials and funding agents monthly, quarterly and annually to evaluate progress of the programme. In addition, most stakeholders had separate and joint field visits based evaluation program. For instance, from joint evaluations, core executive members of zonal ARDAC and regional ARDAC have been executed field evaluations twice in a year to throughout programme implementation years to assess what is reported and what is practically executed on farmers' fields. Core executive members used to discuss with participant farmers about interventions (trainings, advisory services) effectiveness to check reliability of the reports. Joint monitoring and evaluation process at filed level had contributed for stakeholders to understand their strength and weakness and to access additional feedback directly from farmers for their future plans. Report level monitoring and evaluation supported the programme which stakeholders were missed and should be incorporated in for the better success.

3. 2. Strength and weakness of the programme

3. 2. 1. Strength

Established system which was client oriented and demand driven

To some extent technology development system implemented by PARC had participatory nature. In addition from technology supply side, out of a number of crop technologies developed by PARC, scaling up and out crop technologies were selected only based on participants interest collected during ARDAC meeting that involved a number of relevant stakeholders including farmers

Farmers tendency to support each other

Some of the scaling up and out programme participants had long year enriched experiences on utilizing and getting benefits from agricultural technologies at the time of former regime through Tana Belese Project. Because of their previous experience on participating in similar programme, they had the chance to accept crop technologies easily. This group had tendency to help their neighboring Gumuz farming community by sharing their knowledge and skill from land preparation, crop management and post harvest handling.

Active involvement of researchers

PARC as a stakeholder has allocated researchers who specialized in different disciplines in all crop types used in the programme. These researchers had responsibility to prepare grain and seed production manuals for each crop which is very convenient to users like SMS and DAs. They developed a lot of posters in selected farming practices. Researchers have also assisted SMSs and DAs when they faced some challenges in their day to day farmers' follow ups process.

Higher involvement of zone and district administrative officials

Performances of different districts, in the programme were highly depended on the performance of their respective administrative officials. In the programme, out of the seven districts, zone and three districts (Pawe, Dangur and Debate) administrative officials had significant contribution for the programme. Administrative officials were very crucial in two aspects. (1) On technology need assessments at PAs level; higher officials are responsible for facilitating awareness creation about the benefit of utilizing improved crop technologies. (2) On money collection from farmers for inputs (seeds and fertilizers) purchase.

3. 2. 2. Weakness

Participants targeting problem

In Metekel, there are indigenous (Gumuz) and non indigenous (Amhara, Agew, Kembata and others) who came to the area by resettlement programme and by their own. In the area, indigenous Gumuz has been practiced shifting cultivation with simple hand farm tools. However, non indigenous used oxen as drafting power for land preparation. Assumption taken in implementing crop technologies scaling up and out programme was all participants expected to execute every activities as per technologies and knowledge recommendations (for example, implement line sowing and keeping sowing depth). However, due to farming implements they have and used, most indigenous Gumuz could not implement as per recommendations. The programme had same way of treatment to indigenous and non indigenous farming communities. The approach did not favor indigenous community as much as expected.

District level SMS had limited technical know-how

Metekel zone is considered as remote area that is highly malaria infested, has hot temperature and has less access to electricity and telecommunication services. As a result, most agricultural graduated professionals were not voluntary to work in majority of districts in Metekel zone. As a result, district ARDOs had less access to recruit competent agricultural professionals. On the other side, ARDOs efforts to improve SMS capacity through on job training were very minimal.

Limited rural roads access

Due to undulated and mountainous nature of the area it has been difficult to construct Kebele level roads in scaling up and out intervention districts more specifically in Guba and Wembera. This situation hampered crop technologies scaling up and out programme by limiting monitoring and evaluation process and also limiting input as well as output marketing.

Having less focus for output marketing

Daniel and Teferi in 2015 indicated that agricultural production in Ethiopia has, for long, remained subsistence with limited market orientation and poor institutional support. Similarly this programme dominantly focused on crop production aspect and gave less focus for output marketing. Weakness on output marketing was mainly caused by limited performance of cooperative offices at zonal and districts level. Less marketing focus was also caused by missing of incorporating relevant and appropriate stakeholders which could play active roles in output marketing.

3. 3. Impact of scaling up and out programme on households food security

3. 3. 1. Estimation of propensity score match

This part presents the results of the logistic regression model employed to estimate propensity scores for matching treatment household with control households. The dependent variable in this model is binary indicating whether the household was a participant in crop technologies scaling up and out programme which takes a value of 1 and 0 otherwise. STATA 12 computing software using the propensity scores matching algorithm, psmatch2 was used for the estimation purpose. As shown in Table 2, the pseudo-R^2 value of the estimated model result is 0.1454 which is fairly low. This low pseudo- R^2 value indicates that allocation of the programme has been fairly random. The result, therefore, suggests that treatment households do not have diverse characteristics over all and hence obtaining a good match between treatment and control households becomes easier.

Table 2. Estimation result of the Binary logit model

Variables	Coef.	Std. Err.	z	P > z	[95% Conf. Interval]	
Age	0.019408	0.024215	0.8	0.423	-0.02805	0.066868
Sex	-0.11845	0.574631	-0.21	0.837	-1.2447	1.007809
Education	-0.54303	0.47183	-1.15	0.25	-1.4678	0.38174
Active Labor	-0.03654	0.194411	-0.19	0.851	-0.41757	0.344502
Livestock owned	0.025602	0.097619	0.26	0.793	-0.16573	0.216932
Number of Oxen	0.096366	0.044089	2.19	**0.029**	0.009953	0.182778

Market Distance	0.097736	0.094069	1.04	0.299	-0.08664	0.282108
On farm Income	0.000935	0.000543	1.72	**0.085**	-0.00013	0.001998
Off farm Income	0.00098	0.000558	1.76	**0.079**	-0.00011	0.002073
Total income	-0.00091	0.000549	-1.65	**0.098**	-0.00198	0.000169
_cons	-1.9177	1.218801	-1.57	0.116	-4.3065	0.471109
Number of obs = 120 LR chi2(10) = 23.79 Prob > chi2 = 0.0082 Log likelihood = - 69.925951 Pseudo R^2 = 0.1454						

The estimated coefficient results indicate that participation in crop technologies scaling up and out programme was significantly influenced by four explanatory variables which were number of oxen, on farm, off farm and total incomes. Numbers of oxen owned and on farm and off farm income were found to have positive and significant influence on participation in crop technologies scaling up and out programme at 5% and 10 % level of significances. In the study area, oxen are used for land preparation and thrashing of crops. Oxen are also important for increasing crop production through access of land by exchange of oxen labor. It is suggested that the households who own more oxen have better chance to participate in scaling up programme since it is source of labor and land access which are the main inputs in participating in the programme.

3. 3. 2. Matching participants and comparison households

Table 3. Distribution of estimated propensity scores

Variable	Obs	Mean	Std. Dev.	Min	Max
total	120	0.425	0.210678	0.039151	0.999555
treated	51	0.5286007	0.206718	0.119583	0.999555
control	69	0.3484256	0.179592	0.039151	0.82548

As shown in Table 3, the estimated propensity scores vary between 0.119583 and 0.999555 (mean = 0.5286007) for programme participant households and between 0.039151and 0.82548 (mean = 0.3484256) for non participants (control) households. The common support region would therefore, lie between 0.119583 and 0.82548 which means households whose estimated propensity scores are less than 0.119583 and larger than 0.82548 are not considered for the matching purpose.

3. 3. 3. Choice of matching algorithm

Different alternatives of matching estimators were conducted to match the treatment programme and control households fall in the common support region. The decision on the final choice of an appropriate matching estimator was based on three different criteria as suggested by Dehejia and Wahba (2002). First, equal means test (referred to as the balancing test) which suggests that a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups) after matching is preferred. Second, looking into pseudo-R^2 value, the smallest value is preferable. Third, a matching estimator that results in the largest number of matched sample size is preferred. To sum up, a matching estimator that balances all explanatory variables, with lowest pseudo-R^2 value and produces a large matched sample size is preferable. Accordingly table 4 presents estimated results of tests of matching quality based on the three performance criteria. Under kernel matching estimator with band width of 0.25 found to be the best for the data we have at hand.

Table 4. Matching performance of different estimators

Matching Estimator	**Performance Criteria**		
	Balancing test*	Pseudo-R^2	Matched sample size
Caliper Matching			
0.1	10	0.078	72
0.25	10	0.061	86
0.5	10	0.094	92
Kernel Matching			
Band width of 0.1	9	0.011	111
Band width of 0.25	10	0.003	111
Band width of 0.5	10	0.016	111
Nearest Neighbor matching			
1 neighbor	10	0.091	94
2 neighbor	9	0.161	111
3 neighbor	9	0.124	111
4 neighbor	8	0.127	111
5 neighbor	9	0.104	111

* Number of explanatory variables with no statistically significant mean differences between the matched groups of programme and non-programme households

3. 3. 4. Impact estimation on household food security status

As shown in Table 5, though it was not significant, there is effect difference within food security status of participants and non participants of crop technologies scaling up and out programme.

Table 5. ATT (Average Treatment Effect on Treated).

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Calorie per adult equivalent	Unmatched	9190.917	4065.888	5125.029	3022.37	1.7
	ATT	8952.611	4011.604	4941.007	3735.207	1.32
	ATU	4109.316	7509.132	3399.816	.	.
	ATE			4052.392	.	.

4. CONCLUSIONS

In the process of crop technologies scaling up and out programme, to some extent, there were gaps from farmers' side in implementing information and skills they got in to practice. This phenomenon was the result of applying same way of treatment on indigenous and non indigenous farming communities. This programme had faced grass root level follow up problem because of availability of inadequate number of qualified DAs and limitation on technical know-how of district SMS. It has also lack working more on marketing aspect for the better benefit of participant farmers. However, though the programme was implemented under above mentioned challenges, existences of organized demand driven crop technologies supplying system, farmers to farmers' knowledge and skill sharing tendency, higher commitments of researchers and active involvement of zone and districts level administrative officials, it had relatively better contribution to its participant households food security status. Targeting participant communities independently based on their peculiar farming system, promoting innovation platform approach that allowed participation of different stakeholders with their possible specific roles along crop value chain development, creating awareness about the relevance of marketing cooperatives and working more on community based infrastructure (roads) development beside government effort to solve agricultural marketing problems were forwarded as recommendations.

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