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Double-Crop Technology Demonstration and Promotion in Mieso District, Oromia Region, Eastern Ethiopia

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ABSTRACT: *Double cropping is one of the techniques used in multi-cropping. Multi-cropping refers to the various ways farmers can use a single piece of land in a particular time period, often a growing season. The double crop technology demonstration started in November 2020 and ended in November 2022 and aimed for the promotion and demonstration of suitable input and location-specific technology packages for intensive sorghum-producing areas in Mieso District with the objective of promoting double crop technology through increasing the yields of participant farmers. It was being implemented in three villages, namely Huse, Tekuma, and Hund Misoma, for a period of three cropping seasons. From those villages, 72 farmers were purposefully selected. The demonstration process included focus group discussions, stakeholder planning, the establishment of technology demonstration farms, an establishment advisory service team, capacity enhancement for extension workers and farmers, development promotion materials, monitoring and evaluation, field days, partnership, link aging, and organizing farmers. Melkam improved sorghum variety and N26-improved mung beans were used for the technology demonstration. The productivity of improved mung bean resulted in average yields of 9.5 qt/ha, 9.25 qt/ha, and 1.15 qt/ha in 2020, 2021, and 2022, respectively. Whereas for improved sorghum, average grain yields of 36 qt/ha, 39 qt/ha, and 42 qt/ha were recorded, respectively. There was a significant mean difference in three series production years in terms of mean yield per hectare at the 1% significance level. The technology shows their potential, and smallholder farmers have economically benefited. Finally, the technology advertising approach used has proven to be effective and efficient in marketing double crop technologies for high-yielding sorghum and mung bean cultivation. Double crop technology were more accepted and appreciated by farmers than sol cropping because they produced twice per single season. As a result, farmers in similar conditions should follow the double cropping technology to increase their grain yields as well as their incomes.*

KEY WORD: double cropping technology, demonstration, descriptive statistics

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INTRODUCTION

Double cropping is one of the techniques used in multi-cropping. Multi-cropping refers to the various ways farmers can use a single piece of land in a particular time period, often a growing season or calendar year. There are four forms of multi-cropping: double cropping; cover cropping, integrated crop-livestock systems, and woodland-based systems such as woodland pasture and agroforestry.

Multiple cropping methods, including as intercropping, double or sequential cropping, mixed cropping, and relay cropping, are used across the world to address environmental, production, efficiency, and disease challenges. These cropping systems are said to increase soil health, decrease pest and disease incidence, boost production, and reduce dangers associated with mono cropping (Azam-Ali, 2003; Agegnehu et al., 2008; Adarsh et al., 2019; Waha et al., 2020).Mungbean is one of the world's most significant pulse crops, growing from the tropics to the subtropics (Kumari et al., 2012; Khan et al., 2012). It is a significant wide-spreading, herbaceous, and annual legume pulse crop used mostly by traditional farmers (Ali et al., 2010). The crop grows quickly in warm weather, requires little water, and improves soil fertility through nitrogen fixation (Yagoob 2014). This crop is fertilized by self-pollination, which eliminates the need for other pollinators such as insects, water, and wind (Rashid et al., 2013). Mung bean has a high potential for crop rotation in drier agricultural farming regions (Ashraf et al., 2003), as well as the capacity to grow in both dry and irrigated circumstances (Rahim et al., 2010).

Sorghum [Sorghum bicolor (L.)] is one of Ethiopia's most reliable and diverse food crops. After maize, rice, wheat, and barley, sorghum is the world's fifth most significant cereal crop (Amelework, Beyene A., et al., 2016). It ranks third among cereals in terms of acreage and output. It is becoming increasingly important as a source of food for rural inhabitants, fodder for a growing cow population, and raw material for industry and construction. Furthermore, being a C4 plant, sorghum is at the heart of dry land agriculture during the present shortage issue. Sorghum is a self-pollinating monocotyledon crop, with levels of spontaneous cross-pollination ranging from 5 to 30% depending on panicle type (Hariprasanna, K. 2017).

According to the Central Statistical Agency report, the area covered by Ethiopian mung bean in 2017/18 was 41630.20 ha, the average grain yield was 1,235 kg ha–1, and the annual output was 51,413,297 kg and sorghum remains an important food security crop in Ethiopia, covering an area of 1.8 million hectare of land, with production of 4.7 million tons of grain (CSA 2017).Despite its importance, the sector is hampered by a variety of biophysical and man-made issues. Furthermore, crop productivity is vulnerable to low input usage, poor cropping systems, erratic rainfall, a scarcity of agro ecology-specific technologies, and an absence of an appropriate production system. West Hararghea has huge potential to adopt double cropping technology but have not used that potential executively.

Double cropping in the area is not commonly known. In the study area, farmers are producing local sorghum, which takes 6-8 months to mature, and maize year after year. The Chiro Agricultural Research Center takes the initiative to introduce double cropping by selecting the best-performing and highest-yielding early-matured sorghum and mungbean varieties to disseminate new practices and technologies for the study area. Therefore, this effort was carried out to spread different cropping techniques and better varieties through extensive demonstrations in order to raise productivity, increase revenue, and resolve issues brought on by weather unpredictability.

Objectives

1) To create awareness and demands for double cropping technology.
2) To demonstrate the importance double cropping technology and practices in the research region.
3) To strengthen linkage among various development practitioners.

MATERIALS AND METHODS

Description of the Study Area

The demonstration was carried out in the West Hararghe zone of the Mieso district at Huse, Hunde Misoma and Takuma Villages. Mieso is one of the districts in the West Hareghe Zone of Oromia Regional State. The district is located in the Eastern part of the Oromia Region of Ethiopia, which is located at a distance of 287 km from Addis Ababa. Mieso has a latitude and longitude of 9°14′N 40°45′E/ 9.233°N 40.750°E with an elevation of 1394a.m.s.l. It is bordered on the south and west by Gumbi Borderde, on the north by the Somali Region, on the east by Doba, and on the southeast by Chiro. The administrative center for this district is Mieso; other towns in Mieso include Asebot and Kora. Mieso district's annual rainfall is a major limiting factor for agricultural production in the area. Agro-ecologically, the district is classified as Kolla (lowland). The average annual rainfall in Mieso and its surroundings is 790 mm and the average annual temperature is about 18 °C. The area receives bimodal rainfall, where the small rains are between March and April while the main rains are between July and September (under normal conditions). During the small rains, farmers plant long-seasoned sorghum, which lasts about 8 months (April to November). However, during the main rains, all crops, including maize and sesame, are planted. Haricot bean is also planted during this time, but it is intercropped with maize in almost all places. In addition, there are some PAs that intercrop haricot beans with sorghum. Rainfalls during the main rains are erratic, as a result of which crops fail in most years due to a lack of even distribution.

Site and Farmers Selection

The demonstration took place in Mieso district at Huse, Hunde Misoma and Takuma Villages on 72 model farmers' fields. Farmers were selected purposefully based on the availability of suitable farm land, willingness to participate, and access to roads, and 30% of female farmers were

considered as farmers' selection criteria; unfortunately, we realized only 16%, while village were selected based on the status of sorghum production potential and criteria.

Table 1: Summery of commodity, site and Beneficiaries selected for double crop technology

Implementation years	Commodity	Variety	Area covered in ha	Location		Host farmers	
				District	Village	M	F
2020	Mungbean & Sorghum	N26 & melkam	18.5	Mieso	Huse	36	3
2021	Mungbean & Sorghum	N26 & melkam	10.5	Mieso	Hunde Misoma	13	4
2022	Mungbean & Sorghum	N26 & melkam	10	Mieso	Tekuma	14	2

Establishing Advisory Services Team

A technical team of five people was formed to conduct demonstrations of double cropping technology in the area. The team included agronomists, breeders and sociologists. Each member of the team shared duties and responsibilities, such as providing training to farmers and key stakeholders such as DAs and SMS, conducting follow-up, and tracking the activity's implementation to final harvesting crops. Land is shared by model farmers with the assistance of an advisory team. DAs and administrative bodies of the respective Village are fully involved in land preparation, plantation, recommended agronomic management, and yield harvesting activities.

Site and Farmers' Selection

Mieso district of Eastern Hararghe zone was selected purposively based on potential for sorghum production. From the district, Hunde Misoma, Huse and Tekuma kebele was selected with the collaboration of experts from district agriculture and natural resource office and respective development agents based on their interest, land provision for this activity, willingness to manage the field and share experiences for other farmers.

Training

To simplify the implementation farmers, DAs, and specialists received practical training. A multidisciplinary team of researchers delivered training on the following topics: participatory agricultural research and promotion; suitable agro-ecologies and weather conditions for sorghum and mung bean production; agronomic practices; the economic importance of double crop technology; and post-harvest management.

Input Distribution

All relevant materials were properly delivered to the demonstration site by the Chiro National Sorghum Research and Training Center as follows:

Table 2: Input Delivered

No	Village	Area Covered	Variety		Fertilizer	
			26 (Qt)	Melkam (Qt)	NPS (Qt)	UREA (Qt)
1	Hese	18.5	5.55	2.75	18.5	18.5
2	Tekuma	10.5	3.15	1.6	10.5	10.5
3	Hunde Misoma	10	3	1.5	10	10

Agronomic practices

At intervals of one month, field was supervised to assess the situation on the spot and identify any gaps. In advance of the planting date, the demonstration field were accordingly plowed and prepared for planting. To demonstrate the technology an improved sorghum cultivar of mulkam and mung bean of N26 were used in the district. All demonstration locations were subjected to the necessary and recommended agronomic techniques. A 75 cm by 15cm gap was employed between rows and plants, respectively, for sorghum and mung bean, and a 50cm by 20cm gap was employed between rows and plants, respectively, for mung bean. Drilling was done in the prepared rows using the appropriate seed rate of 13 kg ha^1 for sorghum and 30 kg ha^1 for mung bean. In the presence of sufficient soil moisture, shallow planting (3-6 cm depth) was used. Based on the recommended fertilizer rates of 100 kg ha^1 for NPS and 50 kg ha1 for UREA were used for sorghum, and 50 kg ha^1 for NPS were used for mung bean. All necessary field management, such as weeding, manual past control, and post-harvest technology, took place.

Data collection methods

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation, and measurements. Data like grain yield was collected. The total number of farmers who participated in extension and promotional events such as training, field visits, and field days was recorded by gender composition. The assessment of the performance of the demonstrated technology was recorded.

Data analysis methods

Using STATA, descriptive statistics such as Minimum, Maximum, Mean, SD and t-test were used to examine the data collected.

RESULT AND DISCUSSION

Farmers, DAs, and specialists were received practical training. A multidisciplinary team of researchers delivered training on the following topics: participatory agricultural research and promotion; suitable agro-ecologies and weather conditions for sorghum and mung bean production; agronomic practices; the economic importance of double crop technology; and post-harvest management. The yield obtained from both individual and overall plots shows how training improves stockholders' adoption of the double crop technique.

Table 3: Targeted Participant Resaved Training

No	Participants	No of targeted Participant		
		Male	Female	Total
1	Researcher	1	1	2
2	Specialists	3	1	4
3	DAs	4	2	6
4	Farmer	63	9	72

A field day was conducted at the crop's maturity stage by inviting various stakeholders, including the Chiro National Sorghum Research and Training Center (CNSRTC), Fedis Agricultural Research Center (FARC), Melkasa Agricultural Research Center (MARC), Mechara Agricultural Research Center (MARC), cooperatives, zonal and woreda agricultural experts, DAs, and farmers, to participate in the promotion event. A field trip, an in-depth discussion of the activities, and perspectives from farmers and stakeholders on the varieties and double crop technology's performance were all included in the field day program. Additionally, participants decided on future directions for scaling up and commercializing technology.

Table 4: Field day Participants

No	Participants	Participant Male	Female	Total
1	Researcher	8	1	9
2	Expert	13	3	15
3	DAs	12	4	16
4	Cooperatives	3	0	3
5	Farmers	257	49	306

Double cropping technology (DCT) has different benefits in the farmer's observation; its benefits they would justify in two categories. The first is earning additional income and reducing the cost of cultivation and fertilizer requirements for the next crop. The second and most important benefit of the DCT is to increase soil fertility, lessen weed pressure, and ultimately protect me from loss risk due to climate change.

In a farmer's opinion, the first crop of mung beans must be sown when starting a Belg rain shower. Following crop, which means sorghum has to be sown immediately within one week after harvesting the first crop.

Our main issue was a lack of adequate market demand, which we attempted to solve through cooperatives. According to them, they did not receive the projected amount of yields prior to this year. The lack of improved varieties, location-appropriate technology, and rainfall variability, which were all significant issues, were the causes of the low yield and productivity. Our land became more productive after they started using double cropping techniques and the appropriate

mung bean and sorghum varieties, and they were happy with the high yield it produced. The majority of farmers adopted the technique when it shown its best performance. They expressed gratitude for Chiro's national Sorghum research and training center.

In addition, the farmer response and area of interest is that cluster-based farming fosters teamwork because humans have a variety of capacities for both thinking and functioning. Because of this, the cluster cooperated to aid one another and benefit from one another in the field.

Agricultural Experts and Researcher Feedback

According to experts, farmers were able to raise the yield and productivity of sorghum and mung bean in the area by using a double crop system combined with improved varieties. Actually, we think maturity is the most critical to make this system successful, and growers should take the time to figure it out. There is a strong interaction between the planting date and the optimum or best-fit variety, so as we plant on July 1st and we plant on July 15th, it may not be the same variety recommended.

The professionals offer their advice, finance for land preparation, fertilizer purchases, a well-planned strategy, and timely implementation is all critical components of the double-cropping production system. Considerations is needed that full-season cropping is not the same as double cropping.

Finally, they said, the district and zonal agricultural offices are responsible for expanding the technology to other potential districts and villages by mobilizing farmers, DAs, and agricultural experts.

Yield of the technology

The crops used for double crop technology were melkam for the sorghum variety and N26 for the mung bean variety. The Sorghum covered plot sizes of 18.5, 10.5 and 10 hectares in 2020, 2021, and 2022, respectively. The average yield obtained per hectare of sorghum was 31.5 Qt/ha, 33.5 Qt/ha, and 45.5 Qt/ha in 2020, 2021, and 2022, respectively.

Comparing the yield of the two years (2020 and 2021) in pairs revealed that, the two-year mean difference was substantial in terms of mean yield per hectare. At the 10% significance level, there was a significant mean difference between the two years. Table 3.2 below demonstrates this:

Table 5: Two sample t- test and mean yield difference of Melkam for 2 production years

	Production Year	N	Mean	Std. Dev.	t-test
Yield quintal/ha	2020	39	31.5	5.85	**-1.1856***
	2021	17	33.52	5.98	

Source: Own data, 2023
Note: * Shows significance level at 10%

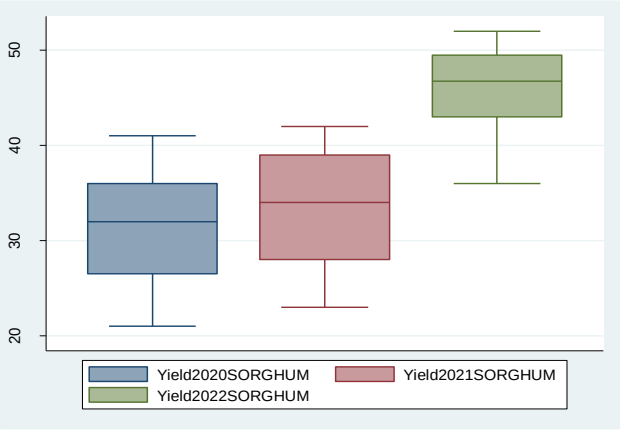
Pair-wise comparison of the yield of the two years (2020 and 2021) indicated that in terms of the average yield per hectare, the two-year mean difference was important. At the 1% significance level, there was a significant yield variation between the two years. Table 3.3 below demonstrates this:

Table 6 :Two sample t- test and mean yield difference of Melkam for 2 production years

	Production Year	N	Mean	Std. Dev.	t-test
Yield quintal/ha	2020	39	31.5	5.85	**-8.6551*****
	2022	16	45.75	4.68	

Source: Own data, 2023

Note: *** Shows significance level at 1%



The yield of the two years (2020 and 2021) were compared to sample t-test, and the results showed that the yield advantage for 2021 was greater than 2.63%, with the mean yield of 2021 (0.925 tons/ha) being practically identical to the mean yield of 2020 (0.95 tons/ha) (Table 3.3). Given a yield differential of 0.025 ton/ha between 2020 and local 2021.

Table 7 :Two sample t- test and mean yield difference of N26 for two production years

Yield quintal/ha	Production Year	N	Mean	Std. Dev.	t-test
	2020	39	9.5	2.03	**0.4688**
	2021	17	9.25	1.32	

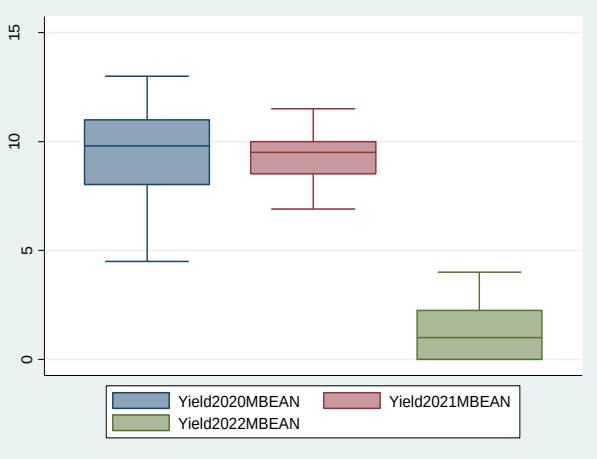
Source: Own data, 2023

Pair-wise comparison of the yield of the two years (2020 and 2021) indicated that the mean yield of 2021(0.95 tons/ha) was significantly higher than the mean yield of 2020 (0.115 tons/ha) amounting to above 89.89 % yield advantage (Table 3.3). Given a yield differential of 0.835 ton/ha between 2020 and local 2021.

Table 8: Two sample t- test and mean yield difference of N26 for 2 production years

Yield quintal/ha	Production Year	N	Mean	Std. Dev.	t-test
	2020	39	9.5	2.03	**15.0944*** **
	2022	16	1.15	1.33	

Source: Own data, 2023
Note: *** Shows significance level at 1%



Generally, the result indicates that, there is yield difference. The fluctuation in the three production years of the study could be attributed to variations in temperature, management, competitive relationships, sowing date, moisture at sowing, and rain fall volume and distribution or other unknown factors may responsible which need further stud

CONCLUSION

The main purpose of this study is to promote and disseminate double cropping technology to smallholder sorghum producer. The study has shown that farmers are responding appreciably to intervention that promotes the use of double crop technology in the district and other similar area. However, as indicated above the average yield for the study area has been improved. This has indicated that the double crop technology have an appreciable impact on productivity.

Double cropping boosts overall food, feed, fiber, and fuel production without requiring more land. This is becoming increasingly important with the growing population, greater demand for higher-protein diets, and dwindling land resources. Yield gains alone will likely not meet the country's needs. In order to satisfy the needs of the population, new cropland will be needed; this extra cropland can be acquired by double-cropping. Moreover, double cropping has substantial environmental advantages.

Recommendations

- Double cropping is possible when considering four critical factors. Time of sowing, moisture at planting, harvesting time, And strategic plan aligned with rainfall forecasts. So, the farmers should have concisely plan and implement the technology.
- Using this foundational demonstration work, the district and zonal agriculture offices should disseminate scale up the technology.
- In order to intensify the producer, concerned body should work on market linkage.
- Researchers should constantly strive to improve sorghum grain yield and Stover quality.

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