Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 18 Issue 2 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Participatory Evaluation and Demonstration of Improved Forage Technologies under Small Scale Irrigated Condition in Amibara District of Afar Region

By Zeray Zeleke, Birhanu Megersa, Philimon Teshome & Tagel Alemu
Ethiopian Institute of Agricultural Research

Abstract- Participatory evaluation and demonstration of both grass and herbaceous legume forage crops namely Panicum antidotale, Rhodes grass, Cinchrus cilliaris and Medicago sativa and Dolichos lablab were undertaken under agro-pastoralist area under irrigated condition in middle awash irrigated area at farmers training centre during 2016 G.C. Agro-pastoralists PRG group formation and problem identification under taken prior to the implementation of demonstration activity. land preparation, sowing and overall husbandry was undertaken based on the agronomic recommendation so far developed by Werer Research Centre and the whole forage cultivation activity undertaken by the members of PRG. Variety evaluation in participatory way and organization of field days undertaken to collect the perception of agro-pastoralists towards the productivity of each forage crops and to create linkage for further adoption of the technology.

Keywords: pastoral research group, participatory variety evaluation, herbaceous grasses, herbaceous legumes.

GJSFR-D Classification: FOR Code: 079999

Strictly as per the compliance and regulations of:

Participatory Evaluation and Demonstration of Improved Forage Technologies under Small Scale Irrigated Condition in Amibara District of Afar Region

Zeray Zeleke [α], Birhanu Megersa [σ], Philimon Teshome [ρ] & Tagel Alemu [ω]

Abstract- Participatory evaluation and demonstration of both grass and herbaceous legume forage crops namely Panicum antidotale, Rhodes grass, Cinchrus cilliaris and Medicago sativa and Dolichos lablab were undertaken under agro-pastoralist area under irrigated condition in middle awash irrigated area at farmers training centre during 2016 G.C. Agro-pastoralists PRG group formation and problem identification under taken prior to the implementation of demonstration activity. land preparation, sowing and overall husbandry was undertaken based on the agronomic recommendation so far developed by Werer Research Centre and the whole forage cultivation activity undertaken by the members of PRG. Variety evaluation in participatory way and organization of field days undertaken to collect the perception of agro-pastoralists towards the productivity of each forage crops and to create linkage for further adoption of the technology. From herbaceous grasses panicum antidotale is found to be better in plant height, early maturity and higher fresh and dry matter yield. Rhodes grass is found to be late in maturity but with better biomass yield followed by panicum antidotal but cinchrus cilliaris is found to be tolerant to stress but with lower dry matter. From herbaceous legumes dolichos lablab is found to be superior in early maturing and biomass yield however due to the possibility of multiple harvest from Medicago sativa the annual biomass yield and cost of production is found to better for Medicago sativa. Agro-pastoral perception collected indicated that among the tested forage varieties from grasses interms of biomass yield, early maturing, leaf to stem ratio, ease of establishment, multiple harvest and nature of purpose as well a resistance to stress Panicum ranked first followed by rhodes there by cinchrus species, from leguminous species Dolichos lablab is found to be better in most of agro-pastoralists evaluation criteria but due to the possibility of multiple harvest without replanting and due to feed preference from domestic animals Medicago sativa is found to be superior feed and selected as best forage crop. From the above participatory variety evaluation work it's found that most of the parameters agro-pastoralists use to select variety have similarity with scientific criteria.

Keywords: pastoral research group, participatory variety evaluation, herbaceous grasses, herbaceous legumes.

Author α σ ρ ω: Ethiopian Institute of Agricultural Research, Werer Research Center, Ethiopia. e-mails: brmeg1900@gmail.com, zzeleke@gmail.com, zphili@gmail.com

I. Introduction

Pastoral areas in Ethiopia, cover about 0.7 million square km, support about 9.8 million people (12% of the total population) of which 56 % are pastorals, 32% are agro-pastorals and the remaining 22% are urban dwellers (EEA, 2005). Another report shows that, pastoral communities occupied about 63% of the country's land mass (MoARD, 2008). Although pastoralism plays significant role in the Ethiopian economy and provides social and environmental integrity in the lowlands, the sector has been largely marginalized by development policies and strategies in the past.

Afar Region covers 10% of the total area of the country and 29% of the pastoral lowlands (Yirgalem, 2011). Though most of the region is arid and semi-arid, it was possible to support the population of Afar pastoralists for centuries mainly due to the presence of extended rangelands and perennial rivers including the profound Awash River, which is the life-belt of Afar communities and their livestock. However, with increasing human population and environmental problems (including frequent drought and degradation of rangelands), the situation has changed the other way through time causing declining production and productivity of food and feed in the region. On the other hand, most of the large-scale irrigation farms and subsistence irrigated crop cultivation have continued to grow from time to time due to the presence of Awash and other rivers in the region. It also created an increasing demand of pastoralists and agro-pastoralist to be involved in irrigated cultivated crop, forage and pasture production.

The traditional Afar pastoral system involves mobility between dry and wet season pastures within a radius of approximately 50 kilometers (Yacob et al., 2009). However, over the past decades this pattern of mobility in particular and the Afar subsistence pastoral system in general have been under pressure due to various socio-economic and other internal and external factors. These factors include recurrent drought and famine, flash floods, disease outbreaks, bush

encroachment, loss of livestock, pastoral conflict and population growth. Moreover, climate change added new and largely uncertain dimension to existing development problems by compounding the risks of natural hazards and complicating existing social and economic imbalances. It is widely recognized that failure to respond to these challenges would impede efforts aimed at reducing pastoral poverty and insecurity (EPA, 2010).

Given the impact of socio-economic and other internal and external factors including climate change on the highly livestock dependent pastoral communities; diversifying livelihood and practicing alternative options is becoming a question of survival than choice. Because livelihood diversification builds household's resilience through risk spreading (EPA, 2010). Pastoralists can diversify their livelihood by engaging in any income generating activities such ascultivation. Therefore, enhancing and securing pastoralists' access to strategic resources like agricultural technology is basic and essential if they are to adequately prepare and effectively respond to the multitudes of stresses and challenges they face.

In the past, pastoral community's temporal and spatial mobility coupled with poor linkage among relevant stakeholders have been the bottleneck for undertaking a coordinated intervention targeted in enhancing the community's access to improved agricultural technologies and management practices, but recently the transition of pastoralists to agro-pastoralists created an opportunity. Hence, livelihood diversification interventions such as expansion of opportunistic and irrigated crop production activities are critically important in these areas there by to improve the feed and food security and income of settled agro-pastoral households and to improve their resilience to different shocks. These in turn demand all relevant stakeholders, which are important along the value chain of agricultural technology generation and dissemination, to intervene in partnership. By this it is possible to enhance agro-pastoralists' access to improved agricultural technologies and management practices thereby to improve production and productivity, livestock feed availability and food security situations in the area.

a) Purpose

The overall purpose of this participatory research activity is to conduct joint experimentation and evaluation of forage grasses and legume varieties and introduce best bit forage technologies to agro-pastoralists. The intervention can benefit agro-pastoralists with improved availability and access to forage varieties based on their needs. The joint experimentation and evaluation can build up the capacity of the community in feed and forage seed production techniques by participating farmers in the research activities, giving training on forage production and arranged field visit on farmers forage production fields. The feedback from this project will benefit the national and regional participatory forage feed and seed research and technology dissemination process. It will also provide direct information to the participatory forage variety technology transfer process by highlighting promising varieties that address the needs of livestock farming and agricultural communities.

b) Objectives

i. *General objective*

Is to identify varieties that meet the needs of pastoralists and improve adoption of forage crop technologies in pastoral and agro-pastoral areas.

ii. *Specific objective*

- To demonstrate and evaluate the performance of improved forage varieties with the participation of pastoralists and agro-pastoralists in middle awash irrigated areas
- To introduce feed crop production scheme to the area and enhance livestock productivity.
- To develop varieties that best meets the needs and demand of pastoral and agro-pastoral communities
- Create new and strengthen exiting linkages and partnership among concerned stakeholders for enhanced technology transfer
- To improve the know-how and skill of agro-pastoralists, DAs and agricultural experts with regard to improved forage production and management practices
- To develop and document base line information for further research and development on participatory forage evaluation

II. Methodology

a) Description of study sites

This particular participatory research project has conducted in Amibara district which is found in Afar Regional States. Amibara district is situated in Zone Three of Afar Regional State along the Awash River in the North Eastern part of Ethiopia. Amibara which is one of the six districts of Zone three and has nineteen kebeles. In terms of geographical reference, the district is located between 09'N to 10'N and 39'45 E to 40'30 E longitude covering a total area of 925,450 hectare (Getachew, 2001). The average altitude of the district is 740m.a.s.l. with mean annual temperature of 34.10C. The rainfall distribution varies from year to year, but the average mean annual rainfall is about 575 mm. In general, arid and semi-arid climatic environment is the typical characteristics of the district (Getachew, 2001).

The total population of the district is 63,280 of which, 44 % are women. The rural population of the district is 31,194 of which 43.3 % are women. About 91 % of the population lives in rural areas. The district is inhabited by both Afar and non-Afar. The non-Afar are

mainly highlanders who came after the introduction of irrigated agriculture in the 1960s. The livelihood of the district largely depends on traditional pastoralism with seasonal movement of people and livestock to other areas in search of water and forage.

The district is one of the richest areas of the region with fertile arable land, huge livestock number, tourist destinations and some mineral resources. The area is mostly known for large scale irrigated cotton plantation schemes. These private and state farm schemes make the area one of the major cotton producing locations in the country. It is suitable to grow different crops and vegetables all year round using the perennial Awash River (Ali, 1997). Moreover, the area is accessible to regional and external markets, as it is found 250 km from Addis Ababa on the main road to Djibouti port. And this particular research has been conducted at farmers training centre at Ambash kebele.

b) Participant selection and experimental procedure

WARC jointly with Zonal MST and Woreda Project Office as well as district PADO identified intervention kebeles and from selected kebeles a PRG which comprises of 25 members inclusive of women's formed. Discussion forums organized, problem identification and ranking undertaken in participatory way. Based on the identified problems possible interventions identified. Among the problems identified feed shortage and lack of skills in production of high yielding improved forage crops husbandry are the high ranking.

Five forage crop varieties that was recommended by Werer Research Centre for irrigated area of Afar namely Panicum antidotal, Rhodes grass, Cinchrus cilliaris, Alfalfa and Dolichos Lablab have been selected and used as an experimental crop. Prior to the implementation of demonstration and participatory variety evaluation practical training organized and all PRG members trained on forage husbandry. The land which is labeled and access to irrigation water over the year has been selected inside the FTC found in the intervention kebele. the land which is enough to accommodate 10m*10m for five crops having three replication each identified and ready for sowing and the Randomized complete block design has been used as an experimental design.

Land preparation, sowing and irrigation was undertaken by members of the PRG based on the agronomic recommendation of each forage crops. Based on this the spacing of 40cm distance between rows for Panicum, Rhodes, Cinchrus, Alfalfa, and Dolichos lablab is used. Spacing between seeds were 10cm for dolichos lablab and no spacing for other feed crops. Seeding rate for each experimental crop is 10kg/ha for Rhodes and cinchrus spp, 5 kg/ha for Panicum, 8kg/ha for Alfalfa, and 20kg/ha for lablab. Prior to well establishment irrigation frequency of 5to7 days used and after well establishment 15 days irrigation frequency was practiced for all crops. Other agronomic practices like weeding, pest management and other related activities also considered as a routine activity during experimental period.

Data collection was undertaken for planting date, germination date, irrigation frequency, tolerance (pest and water stress), days to maturity, leaf to stem ratio, biomass yield for both fresh and dry matter and seed yield as well as preference/selection ranking undertaken by the participating agro-pastoralists. Half of the plot (5m*10m) has been used to collect the above data's and the remaining half plots used to collect seed yield. Biomass sampling was undertaken using 1m * 1m quadrants, 300gm sample taken randomly, oven drying undertaken at 62 degree celsius for 72 hours.

Fig. 1: Field Status of Forage Demonastration Site in Pastoralists Plot

III. Result and Discussion

a) Herbage yield, plant height and maturity date

i. *Grass*

In forage research, variety development and feed production more than the grain much emphasis is given to the herbage yield. As indicated at table1 36 to 42 tone (36,000kg to 42,000 kg) fresh biomass was obtained from a single harvest. From this demonstration and participatory variety trial its observed that statistically insignificant yield difference was obtained from chloris gayana (Rhodes grass) and panicum antidotale (Blue panic) 10.44 and 10.37 respectively whereas the dry matter yield of cinchrus cilliaris is statistically significantly lower than other intervention grasses. Because of the possibility of multiple harvest from those perennial grasses it was possible to have 5, 6 and 7 times harvest from chloris, cinchrus and panicum respectively. Plants height is one of the factor that can influence the herbage yield of forage species, plant height measurement result indicated that panicum antidotale registered maximum height as compared to other species but the result is found to be statistically insignificant as compared to chloris gayana but both grasses are significantly different from cinchrus cilliaris. The data collected on optimum harvesting date indicated that chloris gayana and cinchrus cilliaris attain physiological maturity at 78 and 73 days which is significantly late than that of Panicum Antidotale is 61 days after sowing.

Table 1: Agronomic Characteristics of Forage Crops (Grasses)

Variety	Plant Height (meter)	Date to physiological maturity	Fresh biomass yield (ton/ha)	DM yield ton/ha/harvest	DM yield ton/ha/year	Remark
Chloris gayana	1.92a	78a	36,2c	10.44b	52bc	5*10.4=52
Cenchrus cilliaris	1.34c	73ab	36,6bc	8.12c	48.72c	6*8.12=48.72
Panicum Antidotale	2.03ab	61c	42,7a	10.37ab	72.59a	7*10.37=72.59
LSD 0.05	24	8.73	3,63	1.13	12.9	

ii. *Herbaceous legumes*

Agronomic result summarized at table 2 indicated that for non grass herbaceous layer called medicago sativa and dolichos lablab showed that 37 to 44 tone of fresh biomass has been obtained from single harvest. Dolichos lablab showed statistically significantly better biomass yield as compared to Medics. Past research result indicated that species like Medics are naturally perennials and they can produce much more biomass than Dolichos lablab due to the possibility of multiple harvest. Data obtained from WARC and summarized at table 2 indicated that up to 68 tone dry matter can be obtained from 8harvest per year per hectar for medics without any new seed sowing which is statistically significant. However dolichos lablab needs sowing seeds after harvest and maximum of three

harvest per year is possible. Plant height measurement result indicated that dolichos is superior in height than medics. Date to first physiological maturity indicated that dolichos needs less date to attain physiological maturity than medics.

Table 2: Agronomic Characteristics of Forage Crops (Herbaceous legumes)

Variety	Plant Height	Date to first physiological maturity	Fresh biomass yield (ton/ha/harvest)	DM yield ton/ha/harvest	DM yield ton/ha/year	Remark
Medicago sativa	69.3b	67b	37.29b	8.5b	68a	8*8.5=68
Dolichos Lablab	183.2a	61a	44.12a	15.2a	60.8b	4*15.2=60.8
LSD 0.05	80.5	4.2	4.8	5.7	6.7	

LSD= least significant difference, DM= dry matter, kg= kilogram, ha= hectar
Note= values assigned with the same letter will be statistically not different from each other

b) Seed yield and Germination Rate of collected seeds

Quality seed is the base for successful adoption of any agricultural crop technology. Various survey result indicated that quality seed as well in quantity is the major drawback for the low adoption rate of forage technologies. During this participatory variety evaluation and demonstration, forage seed production was demonstrated successfully to agro-pastoralists result summarized at table 3 indicated that maximum seed of 491kg per hectare was obtained from panicum antidotale followed by chloris gayyana, cenchrus cilliaris and medics which is 362.9, 279 and 167kg/ha respectively. Seed germinability is the major variable in measuring quality seed, most of forage grasses needs some time to break dormancy. Previous research conducted at werer research centre indicated that storage of grass seeds for 12 month will result in better germination than using immediately after harvest. In this participatory evaluation seeds collected and stored for six month tested for germinability and its found that 42 to 87 percent germination of seeds has been obtained. Panicum and medics registered better germination percentage than chloris gayana and cinchrus cilliaris which is 87, 63.3, 47.5 and 42.2 respectively for medics, panicum, chloris and cinchrus. Herbage yield after seed harvest collected indicated that there is a significant decline in yield except chloris gayana as compared to the herbage yield collected at optimum physiological stage summarized at table 1. Various research so far undertaken indicated that the quality of feeds will decline with the increase in the age of the crop and panicum antidotale and cinchrus cilliaris affected significantly since the new tillering from established crop is uncommon. Whereas other forage crops chloris gayana and medics will produce new tillers the biomass yield doesn't affected significantly. From this result its understood that integrating seed and herbage production is possible for chloris gayana and medicago sativa without compromising the biomass yield than other crops. The seed yield data for chloris gayana was not produced due to the photo periodic nature of the crop during the experimental period.

Table 3: Seed related characteristics of forage crops

Variety	Number of plant per quadrant (1m*1m)	Harvesting date after flowering	Seed Yield kg/ha/harvest	Germination percentage at 6 month	DM Yd ton/ha/year during seed harvest	Remark
Chloris gayana	178	40	362.9	47.5	48	
Cenchrus cilliaris	287	29	279	42.2	42.14	
Panicum Antidotale	213	33	491	63.3	57.23	
Medicago sativa	472	52	167	87	62	
Mean	**287.5**	**38.5**	**324.9**	**60**	**52.3**	

c) Agro-pastoralists forage evaluation and selection

i. *Grasses*

As indicated at table 4 agro-pastoralists identified 11 criteria for evaluation and ranking of forage crops. Accordingly date to maturity Panicum Antidotale is found to be early in attaining maturity followed by cinchrus cilliaris and chloris gayana. Agro-pastoralists indicated that less maturity date will help them to get biomass with less irrigation frequency which can help them to save irrigated water. Interms of biomass productivity panicum antidole selected as best yielder against other forage crops but the result obtained and summarized on ***Table 1*** indicated that rhodes grass is superior in biomass productivity than cinchrus cilliaris

but participants selected cinchrus as superior to chloris, probabily this may related to the growth nature of those crops. Purpose of the crop is the other evaluation criteria agro-pastoralists used for ranking the forage crops in addition to feeding animals thachability of the grass is used as an additional benefit for this Panicum Antidotale and cinchrus cilliaris is found to be better than chloris gayana. Interms of seed production capacity participants percieve that panicum yields high seed and chloris gayana and cinchrus cilliaris is found to be similar. But the data collected and summarized at table 3 indicated that chloris superior to cinchrus interms of seed yield, this might be related with the seed production nature of both species since chloris produces seed gradually as compared to cinchrus cilliaris. panicum is found to be better in estabilishment, number of harvest per year, seed benefit, and storage space requirement and but cinchrus is better in resistance to stress than other crops and finaly agro-pastoralists identified that by various selection criteria panicum antidotale is found superior followed by cinchrus cilliaris and chloris gayana. Previous onstation experiment result indicated that panicum and chloris are among the high ranking by various measurement variables against cinchrus cilliaris.

Table 4: Agro-pastoralists preference towards the performance of forage grasses

Variety Selection Criteria	Variety		
	Chloris gayana (Rhodes grass)	Cenchrus cilliaris (Buffle grass)	Panicum Antidotale (Blue panic)
Early maturing	3rd	2nd	1st
Biomass yield	3rd	2nd	1st
Purpose (Dual or mono purpose)	2nd	1st	1st
Seed yield	2nd	2nd	1st
Ease of establishment	3rd	2nd	1st
Intake by animals	1st	3rd	2nd
Repeated harvest (no of harvest/year)	3rd	2nd	1st
Leaf to stem ratio	1st	3rd	2nd
Benefit from seed	2nd	3rd	1st
Resistance to stress	3rd	1st	2nd
Storability	2nd	3rd	1st
Rank	3rd	2nd	1st

ii. *Herbaceous legumes*

Agro-pastoralists late to evaluate forage legumes developed various selection criteria's. based on the selection criteria interms of biomass productivity, multiple purpose, livestock preference, possibility of multiple harvest and leafyness, medicago sativa is found to be superior to dolichos lablab. whereas due to early maturing nature and ease of establishment doclichos lablab is found to be superior to medicago sativa. Agro-pastoralists decided to evaluate the leguminous forage crops for the storability, resistance to stress as very good, good and bad based on this dolichos lablab storability is found to be poor whereas resistance to stress and disease dolichos is found better than medics. Based on this agro-pastoralists identified that medicago sativa is superior to dolichos lablab by various evaluation criteria.

Table 5: Agro-pastoralists preference towards the performance of herbaceous legumes

Variety Selection Criteria	Variety	
	Medicago Sativa Alfalfa)	Dolichos Lablab (Lablab)
Early maturing	2nd	1st
Biomass yield	1st	2nd
Purpose (Dual or mono purpose)	1st	2nd
Ease of establishment	2nd	1st
Intake by animals	1st	2nd
Repeated harvest (no of harvest/year)	1st	2nd
Leafy nature	1st	2nd
Storability	Good	Poor
Resistance to disease stress	Good	V. good
Resistance to water stress	V. good	V. good
Rank	1st	2nd

IV. Conclusion

The following lessons were drawn from the experience with forage technology participatory evaluation using PRGs:

- Improved research-extension-agro-pastoralists linkage at the grass root level
- Improved stakeholders' participation in research and extension activities
- The approach was found best for identification of adaptable, high yielder and disease tolerant or resistant varieties by the clients themselves using indigenous variety selection criteria
- The approach was found efficient and effective in addressing research and technology extension issues since it utilizes both scientific and indigenous knowledge systems
- The approach helped in developing sense of ownership technology development activities
- The approach provided the means for feedback on technologies generated and disseminated

It's found that the PRG are effective and efficient approaches in generating, evaluating and disseminating forage technologies. Werer agricultural research centre used this approaches as means to address the week technology adoption of the various forage technologies so far developed. The valuable contribution of these approaches towards the realization of the goals of the centre is well acknowledged and appreciated.

Acknowledgments

We are extremely thankful to the Pastoral Community Development Project(PCDP),for financial support and Werer Agricultural Research Center for Research material and vehicle support. Finally, we are grateful acknowledged the Amibara Woreda Pastoral and Agricultural Development Office and extension developmental agents for their continuous monitoring the experimental site and our pastoralists who donated their land and labour without restraint.

References Références Referencias

1. Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M. and Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], CSIRO, DPI&F(Qld), CIAT and ILRI, Brisbane, Australia.
2. Denbela Hidosa, Bizuayehu Ayele and Mesifin Mengistu (2015). Participatory On - Farm Evaluation and demonstration of improved Legume Forage Species in Benatsemay Woreda of South Omo Zone, Southern Agricultural Research Institute, Jinka Agricultural Research Center, P. O. Box 96 Jinka, Ethiopia.
3. Denbela Hidosa, Tekleyohanus Brehanu and Mesfin Mengitu (2016). On Farm Evaluation and Demonstration of Improved Legume forage Species in Irrigated Lowlands of Bena-Tsemay Woreda, SouthOmo Zone, International Journal of Research and Innovations in Earth Science Volume 3, Issue 2, ISSN (Online): 2394-1375.
4. ESGPIP (Ethiopia Sheep and Goat Productivity Improvement Program), 2008. Technical Bulletin No. 17. Fodder Establishment, Management and Utilization Techniques for the smallholder.
5. Funk, Rowland, Eilerts, Kebebe E, Biru et al. (2012) Climate trend analysis of Ethiopia. Climate change adaptation series. U.S. Geological survey famine early warning systems Network-Informing (FEWSNET) Fact sheet 3053. p. 6.
6. Ibrahim, Truong Tan Khanh and Heriyanto. 2000. Forage technologies for smallholders in grassland areas. In: Stür, W.W., Horne, P.M., Hacker, J.B. and Kerridge, P.C. ed. Working with Farmers: the Key to Adoption of Forage Technologies. These Proceedings, see Contents.
7. Norton (1982) Differences between species in forage quality. In: Hacker JB (eds), Nutritional limits to animal production from pastures. Farnham Royal: Commonwealth Agricultural Bureaux. pp 89–110.
8. Stür, W.W., Cameron, A.G. and Hacker, J.B. 1995. Forages for Smallholders – Proceedings of the Third Meeting of the Southeast Asian Forage Seeds Project, Samarinda, Indonesia, 23–28 October 1994. CIAT Working Document No. 143. Cali, Colombia, CIAT, 149 p.
9. Tessema Zewdu .2008. The Effect of Variable Seed Rate Proportions on Agronomic Attributes, Dry Matter Production, Biological Potential and Economic Viability of Some Grass-Legume Mixed Pastures.
10. Tollefson, L. and Wahab, 1. 1996. Better research-extension-farmer interaction can improve the impact of irrigation scheduling techniques. In: Irrigation Scheduling from Theory to Practice. Proceedings of the ICIDIFAO Workshop on Irrigation Scheduling. FAO Publication 8, Water Reports. Rome, Italy. pp. 227-234.
11. Vermillion, D. L. and Brewer, J.D. 1996. Participatory action research to improve irrigation operations: examples Jrom Indonesia and India. In: Irrigation Scheduling: From Theory to Practice. Proceedings of the ICIDIFAO Workshop on Irrigation Scheduling. FAO Publication 8, Water Reports. Rome, Italy. pp. 227-234

This page is intentionally left blank