

Full Length Research Paper

Challenges and opportunities of irrigated crop production in Gedeb river catchment: Machakel Woreda, East Gojjam Zone

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Accepted 22 July, 2013

This study has investigated the socioeconomic, institutional and biophysical constraints, opportunities, to what extent irrigation could improve the income of households and create employment opportunities in irrigated crop production. The river catchment has different agro-ecology and socioeconomic situations; thus, it was classified as upper, middle and lower catchments. From Laytemamagn, Yewela and Gotu irrigation areas 35, 70 and 35 households sampled randomly, and respectively. Survey, participatory rural appraisal tools and secondary sources were employed to collect primary and secondary data. For data analysis, one way ANOVA, T-test, Chi-square test, and mean were employed. The study revealed irrigated land holding size of farmers in Yewela was greater than lower and upper which cause to diversify livelihood strategy of farmers in Laytemamagn than Gotu. Crop intensity in Laytemamagn and Yewela was 200%. The extension service was inadequate and not packaged. Credit service bureaucracy like group collateral was constrained to improve irrigated crop production. Water governance was done by water users but interference by the government bodies aggravated water use conflicts. Streams drying, percolation and seepage of water determined water availability. Irrigation created employment opportunity for household members and the rural community, and also improved income. Therefore, policy makers and development practitioners should develop policies and strategies based on the agroecology and socioeconomic settings of irrigation areas to alleviate the challenges, and consolidate the opportunities.

Key words: Socioeconomic, institutional, biophysical.

INTRODUCTION

Agriculture is the backbone of the Ethiopian economy which contributed 41.6% to GDP, 2009 (GTP, 2010). It also provides raw material to industrial sector, export items and is major source of employment for 84% Ethiopia population (PASDEP, 2005). Cognizant to this fact, the country focused its development policy, that is, Agricultural Development Led Industrialization (ADLI) on agriculture to transform the economy.

ADLI aims for boosting agricultural productivity and

improving the rural standard of living, which in turn increase the demand for goods and services and further lead to industrial development. One of the impetuses to achieve the agricultural policy objective is the promotion of irrigated agriculture and integrated water resource management (ADLI, 1994).

In Ethiopia, traditional irrigation had been practiced since the ancient times. However, modern irrigation development was started during imperial regime in 1950s

with large scale irrigation and hydroelectric power projects (Berhanu and Peden, 2002). The then large scale irrigation projects were intended to produce crops used for inputs of agro-industries. The Derge regime gave emphasis in development of large and medium irrigation schemes to mitigate drought and famine (ibid.). The Ethiopian People Democratic Front (EPRDF), the current regime, like its predecessors enthusiastic in developing irrigated agriculture. Thus, it has developed an irrigation policy that aims developing the huge irrigated agriculture potential for the production of food crops and raw materials needed for agro industries, in an efficient and sustainable basis and without degrading the fertility of the production fields and water resources base (MoWR, 1999).

Though such attempts have been done for the last 45 years, the country still used 5 to 10% of 3.7 million hectares of irrigated potential area (Teshome, 2006). Irrigated agriculture produces less than 3% of the total food production of the Country (Teshome, 2006). Hence, though successive regimes of Ethiopia have attempted to boost irrigated agricultural production through irrigation development, the country still could not exploit its irrigation potential efficiently and effectively. Instead, the country is highly dependent on rain fed agricultural production system.

Cognizant to this fact, Woledeab (2003), and Berhanu and Peden (2002) stated that the three successive regimes emphasized on technical aspect and less emphasis with social and institutional aspects. That means socioeconomic, institutional, market accessibility and input supply has given less weight (Berhanu and Peden, 2002) which constrain irrigation development especially small holding farmers, who are not able to practice intensive and extensive irrigation farming.

Gedeb River is one of the big tributaries of Blue Nile River and has the potential for small and medium scale irrigation development. The study site has three catchments with different water availability potential, agro climatic zones and socioeconomic situations. On the other hand, the production of irrigated crop production is influenced by socioeconomic, institutional, biophysical and market factors. Moreover, the previous studies were not focused on the influence of agro ecology, socioeconomic and institutional contexts to improve the production and productivity of irrigated agriculture in specific areas in an integrated approach. Therefore, it was imperative to study socioeconomic, institutional and biophysical influences on irrigated crop production and the impact of irrigation on income and employment of the community within the context of such different agro-ecology and socio-economic settings for academic and development purposes.

THE STUDY AREA AND METHODOLOGY

Gedeb River is located in the Blue Nile basin, started from the

Choke Mountain of Arat Mekeraker in Sinan Woreda pass through Machakel *woreda* to Debre Elias *woreda* and lastly joins Blue Nile in East Gojjam Zone of Amhara National Regional State (ANRS) (Figure 1). The River has big catchment area ranging from Chokie Mountains to the lowlands of Debre Elias. Nevertheless, the study tried to see the Catchment in the Machakel *woreda*. From upper, middle and lower catchment, three irrigation sites were selected, that is, Laytemamagn, Yewela and Gotu, respectively

Laytemamagn total households were 165 which include Aderabet, AdisAmba and Eyesus *goths*¹ households. The small stream found haphazardly, used as irrigation water to produce onion and potato. Irrigation had been started long time ago. The farmers plant small plots of land around their homesteads.

Yewela total population was 6487 who live in 847 households. The total beneficiaries were 650 households. Total irrigated area was 268 ha but 87 ha was given to the investors though they stop production before a year at the time of study.

Irrigation water diverted from the Gedeb River through diversion weir. It was started to function in 1997. The 90% of the irrigated land had been used for communal grazing land. The *woreda* Agriculture office distributed 0.25 ha of the grazing land to the households of the Yewela *kebele*. However, particularly, the Yewela *goth* farmers were highly resistant. In the first five years farming was difficult, but the *woreda* Agriculture office took measure of handed over the uncultivated land to the landless youth. Then after, irrigated agriculture production increases both intensively and extensively.

Gotu had total population of 243. The irrigation beneficiaries were 70 men headed households, one women headed household and one youth group. Irrigation water is diverted from Gedeb River traditionally with earth dam and furrow canals. Before 2002, the land was covered by bushes and trees .The irrigation water diverted from Gedeb was used for powering milling stone and there were around ten milling stones but at the moment only one milling stone. During 2002, 300 m² land covered by bushes and trees were distributed to each household. The milling stone owner constructs earth dam and furrow each year lonely. The owner of milling stone has the right to use the water at any time but the people have to get the willingness of the milling stone owner to use the water for irrigation. Hence, the farmers irrigate during non working days.

The sampled households were selected from each irrigation area that has used both rain fed and irrigation to cultivate crop on a specific plot of land. The sampled households were 35, 70 and 35 from Laytemamagn, Yewela and Gotu irrigation areas, respectively. The data collected were both primary and secondary. The primary data were collected using structured questionnaire through interviewing household heads selected randomly; key informants were deeply interviewed; focus group discussants which ranged from five to seven members were discussed using semi- structured questionnaire. The analysis of quantitative data were done using one way ANOVA, chi-square test, t-test, mean and percentages whereas the qualitative data were narrated to compare the three irrigation areas.

RESULTS AND DISCUSSION

Sampled households age, farming experience and family size

Age can influence the production and productivity of irrigated crop production and might create production difference among the irrigation areas. The analysis

¹ *Kebele* is the lowest Administration hierarchy under which there are *goths* which have boundaries.

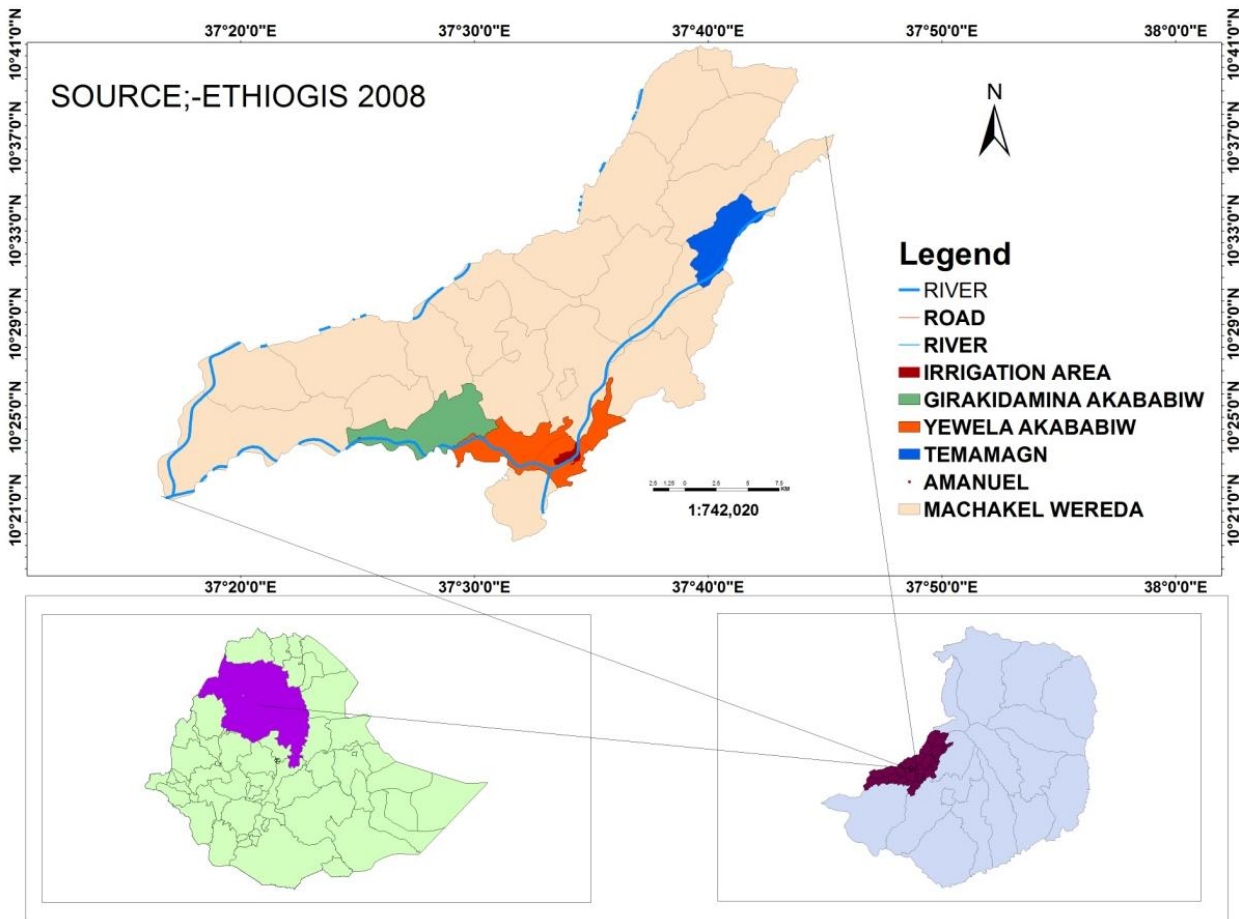


Figure 1. Location map of the study area.

showed that Laytemamagn, Yewela and Gotu farmers do not have significant age difference ($p>0.05$) able to create difference in irrigated crop production.

Regarding farming experience, it is an informal education on agricultural practices and production patterns from their surrounding environment, that is, households and community. According to Beyene (2002) and Bediru (2004) farmers in Ethiopia start doing agricultural activities from their 12 ages and stop when they reach 75 ages. The mean comparison of the farming experience of the three irrigation areas could not show significant difference ($p>0.05$).

However, the experience related to irrigation had difference among the three areas. Laytemamagn irrigation was started a long time ago; Yewela irrigation has been started since 1995 and Gotu irrigated agricultural production started since 2002. Hence, the farming experience of farmers on irrigation crop production among the three irrigation areas is different but farmers in Yewela and Gotu have more or less similar experience. Therefore, the experience might create difference in search of markets to sell their production. Family size is used as source of labour for the household

irrigated crop production. Average family size of Laytemamagn, Yewela and Gotu were 5.49, 5.43 and 5.74 respectively. The average family size for the three areas was 5.52. There is no significant difference in family size among the three areas ($p>0.05$). That shows the family size could not cause any possible influence on irrigated crop production difference among the three irrigation areas.

Household respondents' Ox, donkey and livestock (TLU) holding size

The oxen, donkey and livestock (TLU) holding size of respondents are analyzed independently because these socioeconomic characteristics of respondents have influence on the production and productivity of irrigated crop production and livelihood strategies of each irrigation areas.

The average ox holding of the respondents was 1.314, 2.686 and 3 for Laytemamagn, Yewela and Gotu, respectively. Oxen holding size variation among irrigation schemes is highly significant ($p<0.05$).

Though such a difference was occurred among the irrigation areas, it could not influence the crop production because the number of oxen holding is enough to cultivate the land. Donkey used as a packing animal to collect the harvested crop products and to market the production. The average holding in Laytemamagn was 0.657, Yewela 0.571 and Gotu 0.857. In addition, average holding size in the Gedeb River Catchment was 0.664. Donkey holding size among the three irrigation areas revealed similar ($p>0.05$). This is because the Laytemamagn farmers trade either their produced agricultural products such as potato, onion and basket and/or buy from the nearby market areas and sell and/or exchange in kind to Deberemarkos, Gira-kedamin and the Damot District². Hence, each trader has donkey for transportation purpose. The Yewela and Gotu farmers need donkey to transport their agricultural products during thrashing from their farm land and to sell their products to their respective nearby markets.

The average livestock size of each irrigation areas shows that 3.438, 7.27 and 7.74 for Laytemamagn, Yewela and Gotu respectively. In addition, The Gedeb River Catchment average livestock size was 6.43. The average livestock holding size among the irrigation schemes are highly different ($p<0.05$). This is because of livelihood and economic variations among the upper, middle and lower catchments; especially in the upper catchment (that is, Laytemamagn). This could create farmers economic performance variation to buy inputs such as fertilizer and improved high yielding varieties thereby influence production and productivity of irrigated crop.

Land holding size and arrangements

Land is vital resource for production of crops for farmers who rely their livelihood on it. Besides the holding size, land arrangement is crucial to cultivate, manage and produce agricultural products and also it has influence on net income gain from each plot of land. Land arrangement is a kind of consensus made between the land owner and the renter either in cash or as share cropping. The land arrangement is made when the farmer; who owns the land face short of labour or lack of oxen used to plough; rent to his fellow farmer who faces shortage of land to cultivate.

The average farm land size in the Gedeb River Catchment was 1.336. Laytemamagn, Yewela and Gotu average farm land holding was 0.783, 1.445 and 1.658 ha respectively. Farm land holding size have variations among the irrigation areas ($p<0.05$). The average land holding size in Machakel *woreda* was 1.66 ha (WARDO, 2010) but the Laytemamagn land holding size is less than

half of the *woreda* average holding size. According to the key informant³ this is due to the fact that Laytemamagn is densely populated than the lowlands of the *woreda*.

The average irrigated farm size, in Yewela, was the largest irrigated farm size 0.318 ha and the least which was Laytemamagn 0.067 ha. Gotu irrigation area average holding size is almost equal to Laytemamagn. The variation of irrigated land is highly significant ($p<0.05$).

The average irrigated rented land size was 0.078 ha. The average largest irrigated rented land was found in Yewela (0.127 ha). The analysis T-test ($p=0.035$) revealed there is variation between Yewela and Laytemamagn irrigation areas' rented irrigated farm land size at 5% significance level. However, Gotu do not involve in renting of irrigation farm land. According to the focus group discussants, the farmers' plant perennial crops like sugarcane, mango, coffee, avocado etc. That does not need oxen to plough the land every year and other assets to buy inputs like fertilizer. Thus, since the resources needed to cultivate was negligible thereby everybody cultivate by himself /herself.

Hussain (2007) stated land size determine the amount of production per year. According to key informants and focus group discussants, Laytemamagn irrigated crop production could not constrained by smaller size of irrigated land because the irrigated farm land could be large if there was available sufficient irrigation water. Whereas, Gotu irrigated crop production was constrained by the small size of irrigated land.

Livelihood strategies

Agriculture is the main livelihood base of the farming community. The total respondents relied their livelihood on agriculture which includes crop production and livestock rearing. In addition, the respondents do activities to generate income. For instance, farmers trade basket, potato and onion from highlands to lowlands.

In Laytemamagn 42.9% respondents involved in crop production and livestock rearing while 57.1% engaged in crop production, livestock production and petty trade. Yewela respondents 91.4% involved in crop production and livestock rearing; and 8.6% in crop production, livestock rearing and petty trade. Gotu respondents 97.1% involved in crop production and livestock rearing and 2.9% involved in crop production, livestock rearing and on farm employment. Chi-square analysis ($p<0.05$) revealed that there is highly significant variation among each irrigation areas in their livelihood strategies.

Though the farmers had such livelihood strategies within their circumstances, they had different reasons to have such livelihood strategies. For instance, Laytemamagn focus group discussants and key informant interviewees

² Damot district is a place where Laytemamagn traders market which includes Finoteselam, Jiga and Burie towns and the surrounding rural areas

³ Anonymous is from Machakel *Woreda* Agriculture Office land administration department interviewed on June 6, 2011

Table 1. Laytemamagn and Yewla cropping intensity and productivity.

Irrigation area	Crop type	Period of production	Fertilizer		Land(ha)	Production (kg)	Productivity (kg/ha)
			DAP(kg)	Urea(kg)			
Laytemamagn	Potato	October-January	-	-	114	1036000	9000
	Onion	September- January	-	-	23	813000	6000
Yewela	Maize	February-August	31800	250	318.375	13371500	4500
	Potato	October-January	17425	3900	174.25	788000	16000
	Barely	October –February	3700	-	37	59800	1616

said people involved in trade activity because they have small and infertile land. Tefera (2011) also stated livelihood diversification in Lytemamagn is due to land degradation. Consequently, they do not sell their agricultural products in the local market. In addition, they bought potato and onion from the local market and sold or/and exchange walking long distance in Damot district, Debere-Markos town, and Gira-kedamin town. The product types they exchange in kind or buy were *bereberie* (hot pepper), maize etc. which is not produced in their locality used for selling in Degasegnen or home consumption. Whereas, in Yewela and Gotu the farmers main cash source was highly depend on agricultural products as they produce more than their home consumption. Some farmers in Yewela involved in trade activity. For instance, Source of cash income among each irrigation area is significant ($p < 0.05$). Therefore, one can conclude that Laytemamagn farmers' livelihood strategies differ from the other two irrigation areas because of the variety of existing situations within their respective irrigated areas. The livelihood strategy in Laytemamagn is an opportunity for irrigated agriculture to sale the commodities in better price and exchange or buys other commodities from other areas.

Crop pattern

Cropping pattern in Laytemamagn was similar in the last three years with average irrigated land coverage of 90.45 and 9.55% for potato and onion production respectively. Yewela in the last three consecutive years (2008, 2009 and 2010) the irrigated land covered by maize was 49.02%, tef 34.85%, potato 13.52% and barely 2.59%. Gotu irrigation area intercropped perennial horticultural crops such as sugarcane, coffee, *gesho*⁴, mango, avocado, peach, orange, and guava. This shows Laytemamagn irrigated potato production took the lion's share where as Yewela was dominated by maize production than the other crop types. This made to

conclude the cropping pattern differ with in the River catchment.

Crop intensity and productivity

The cropping intensity of Laytemamagn was 200% (Table 1). The farmers plant and produce irrigated crops from September to February, that is, either potato or onion. During the summer season plant and produce maize, tef or any other rain fed crop type. Yewela mainly produces two times annually. The farmers produce maize from February to August with irrigation. Tef is produced from August to January with rain fed but barely and potatoes are produced from October to early February with irrigation. A few farmers produce three times per year. In Gotu irrigation area perennial crops are planted hence, relatively speaking the production may range from two to three years. Therefore, the researcher concludes irrigation in Laytemamagn and Yewela helps to increase land productivity through increasing crop intensity. This argument coincide with Shah et al. (2004) who reflected that irrigation improve crop intensity thereby improves land productivity; but not for the case of Gotu.

Productivity of potato and onion in Laytemamagn was 9000 and 6000 kg per acreage respectively. The crop productivity in Yewela irrigated crops, that is, maize, potato and barely was 7549, 16000 and 1616 kg per acreage, respectively. Yewela potato productivity was greater than Laytemamagn by 56.25%.

Agricultural extension service

Agricultural extension service is vital for the development of irrigated agriculture through adapting and introducing improved technologies, providing training, accessing and supplying inputs timely and giving different information that ranges from production to marketing to the farmers. The survey result reveals that development agents contact of farmers per month in Laytemamagn, Yewela and Gotu 1.44, 1.58 and 1.16 times respectively. One way ANOVA ($p > 0.05$) revealed that contact of

⁴ *Gesho* is a kind of plant used to prepare local beer

development agents among the three irrigation areas do not vary significantly.

According to the discussion made with the farmers, DAs involvement in agricultural advices increases in seasonal works especially during sowing, harvesting and constructing water and soil conservation practices. The development agents divide their mandate area in to three and each development agent work on its mandate area on every aspects of agriculture such as livestock production, crop production, natural resource management, irrigated agriculture, and rain fed agriculture etc.

Input supply and utilization

Improved seed: Input supply and utilization includes fertilizer and seed. Seed varieties are needed to increase production and productivity. There are different varieties of a specific crop their production and productivity potential differs. Focus group discussion (FGD) and key informant interview (KII) in Laytemamagn showed irrigated agriculture produces potato and onion crop types. However, there is no improved varieties of such crops yet introduced to the locality. Yewela irrigated agriculture produce maize, potato and barely. FGD and KIIs showed that the farmers faced shortage of improved maize varieties. They complain improved seed varieties were available on the rainy season but not for irrigated crop production during the dry season so that, some farmers were forced to buy on the rainy season to plant on the next dry season for irrigated crop production. Improved barely and potato varieties were not yet introduced. Gotu farmers planted perennial horticultural crops such as sugarcane, mango, avocado, coffee, guava and the like. These crops were introduced by the agriculture office since 2002. Moreover, maize, wheat and triticale improved rain fed crops were introduced but not potato, onion and barely irrigated crop varieties. Therefore, this shows the *woreda* agriculture office pay less attention to irrigated crop production than rain fed crop production.

In Laytemamagn, according to the key informant interviewees and development agent of the *kebele*, the local onion and potato crop types were attacked by fungi disease. Consequently, onion production is decreased from time to time. The farmers were complaining on the failure of the *woreda* agriculture office to give a solution to the problem though they were telling the respected development agents of the *kebele*. The *kebele* agriculture office educates the farmers not to plant root crops for few years but the farmers were complaining that “we do not have land which can be fallowed”. Therefore, in Laytemamagn, irrigated crop production faced challenges such as lack of access to improved seeds, pesticides and insecticides; Yewela faced both shortage and lack of access to improved seeds which determine the crop production. Hussain (2007) also stated crop production

predominantly depends on application of improved seeds, chemical fertilizers and insecticides.

Fertilizer

Chemical fertilizer is one of the major inputs for crop production. The major chemical fertilizers employed are DAP and Urea. Laytemamagn respondents incurred on the average 1.8 United States Dollar (USD), Yewela respondents spend 24.65 USD. Gotu respondents did not use fertilizer because the irrigated land is “fertile”. Therefore, fertilizer utilization is different among the irrigation.

Regarding organic fertilizer, Laytemamagn farmers used manure and compost highly for the irrigated agriculture than the rain fed agriculture but Yewela farmers did not use manure and compost because their farm land is far from their home rather used for their homestead farming. Some farmers of Gotu used manure to fertile their irrigated land and increase production and productivity but most of the farmers used for their homestead farming like Yewela. This shows the distance between the farmers’ home and irrigation area could constrain application of organic fertilizer. Therefore, the analysis shows the extension service provided in the areas was inadequate and not organized in supply of inputs and market information. This finding coincides with (Bediru, 2004; Degene, 2005) argued supply of inputs and market information was inadequate in East Showa.

Credit service

Access to credit for financing investment and farm operations is crucial for the commercialization of small holder agriculture. In line with this, it provides the facility of accessing inputs to the farmers and produce good and sufficient production without constrain by shortage of money. It can be provided in kind or cash based on the type of institutions and their rules and regulations. The survey result revealed that 88.6 and 11.4% of the respondents of Laytemamagn faced scarcity of money and not faced scarcity of money in irrigated crop production respectively. Yewela respondents 37.1 and 62.9% faced scarcity and not faced scarcity of money respectively. Gotu respondents 25.7 and 74.3% faced and not faced scarcity of money while cultivating irrigated agriculture respectively. Chi-square analysis ($p < 0.05$) revealed that there is significant variation among irrigation areas in facing and not facing scarcity of money. The analysis revealed that Laytemamagn irrigation cultivation of crops was challenged by scarcity of money than the other two irrigation cultivation.

There are formal and informal institutions which provide credit service in the study sites. The informal credit services gain from relatives, neighbors and the likes while the formal credit service is from Amhara Credit and

Saving Institute (ACSI). The survey result shows that Laytemamagn respondents 37.1% did not borrowed while the rest, more than 40, 11.4 and 22.8% borrowed from informal sources, ACSI and both from formal and informal sources respectively. Yewela respondents 80% did not borrowed and the rest, 5.8 and 14.3% borrowed from informal sources and ACSI respectively. Gotu respondents 77.1% did not borrow and the rest, 8.6 and 14.3% borrowed from informal source and ACSI respectively.

Farmers were used different sources of credit services to get credit for the cultivation of irrigated crop production. Almost all of Yewela and Gotu farmers did not need credit since they can finance their irrigated crop production. Therefore, the researcher argues the Laytemamagn, and Yewela and Gotu areas differ in the need to get credit. But, in all areas informal sources of credit are good opportunities for the farmers in addition to formal sources to intensify irrigated crop production. Moreover, the sampled households were asked whether they need formal credit service from ACSI or not to intensify and/or extensive irrigated crop farming. Laytemamagn respondents 68.6 and 31.4% need credit and not need credit service respectively. Yewela respondents 22.9, 77.1 needed credit and did not need credit service respectively. Gotu respondents 14.3 and 85.7% needed credit and did not need credit service respectively. The chi-square analysis ($p < 0.05$) also shows that there is significant variation among irrigation areas which need and did not need credit services to cultivate irrigation crops. Therefore, the Laytemamagn cultivation of irrigation crops needs formal credit from ACSI to intensify its production than Yewela and Gotu irrigation areas.

Meanwhile the respondents explained different constraints to get credit from ACSI. The survey result shows 25, 10.7 and 60.7% of Laytemamagn respondents said: faced complex bureaucracy; lack of collateral; fear of failed of the planted crop due to uncertain condition respectively. Yewela respondents 22.2, 7.4, 33.3, 11.1 and 18.5% said complex bureaucracy, short repayment period, high interest rate, lack of collateral and fear of failed of the planted crop due to uncertain condition respectively. Gotu respondents 8.3, 8.3, 54.2, 16.7 and 12.5% said complex bureaucracy, short repayment period, high interest rate, lack of collateral to get credit, fear of failed of the planted crop due to uncertain condition were constraints to get credit from ACSI.

The FGD and KIIs pointed out that the farmers fear to borrow many from ACSI because they perceived that if the borrowed money loses due to uncertain condition; for instance disease, ACSI would force them to pay back. Hence, they would sale either their oxen or iron sheet house. Consequently, they would force to migrate to other areas such as Welega⁵. In addition, the complex bureaucracy to get credit is tiresome that involves when

beneficiaries only come up in group. The group members' ranges from five to seven individual farmers each of them should have collateral to get credit otherwise not possible to access. In this case, if an individual failed to pay back, the group would be forced to pay the money to ACSI.

ACSI Credit services pass through complicated bureaucracy and need collaterals which made farmers to fear that if they would lose the credited asset they will force to pay back the money. Consequently, the farmers might decide not to borrow. But till now, the farmers' informal sources such as borrowing from their relatives without interest could make them beneficiaries. Therefore, the complicated bureaucracy and the need of collateral from ACSI create a real challenge to the development of irrigated crop production. Therefore, the researcher concludes the credit services provided either in kind or cash were inadequate to buy inputs for intensive and extensive farming.

Market service

Market place

Market place is the vital socio-economic factor for marketing agricultural products and to buy inputs for agriculture. The three irrigation areas have different market places and market access. The researcher tried to classify market places as nearby, farm-get, distant towns, *kebele* farmers associations, and farm-get. Laytemamagn respondents 2.9, 2.9 and 80% said sold nearby market (that is, Degasegnen and Temamagn); in their farm-get; and distant towns (such as Deberemarkos, Amanuel, Gira-kedamin, Finoteselam, Jiga and Burie) respectively. Yewela respondents 2.9, 20, 71.4 and 5.7% said sold in nearby markets such as Yewela and Amanuel; their farm-get; and distant towns that is, Deberemarkos and Elias respectively. Gotu respondents 88.2 and 5.9% said that sold in nearby market (that is, Gira-Kedamin), and distant towns (Elias and Amanuel). Moreover, discussion with farmers of Laytemamagn showed they sale in Degasegnen, Erobu Gebeya, Deberemarkos and Amanuel. They walk on foot long distance for three to six days went in Finoteselam, Jiga and Burie towns to sell in better price. They argued that they do not worry about the distance, but their main concern is the price of their products. Yewela farmers' sold maize in the farm-get, potato in Debre- Markos and barely in Amanuel town. Gotu farmers sold their products in Girakedamin only.

Both the quantitative and qualitative analysis shows Laytemamagn farmers are good in search of markets than the other areas especially Gotu which is due to the fact that the irrigation farming experience and livelihood strategy of Laytemamagn is better than Gotu. Moreover, the livelihood strategy of Laytemamagn is more diversified, that is, involved on petty trade than the other areas.

⁵ Welega is a place found in Oromia Region of Ethiopia

Transport

To sell their agricultural products, farmers transport their irrigated crop products by car, cart, pack animals and human loading according to their accessibility and affordability. Laytemamagn respondents 88.9, 6.1 and 6.1% used donkey, horse and human loading respectively. Yewela respondents 85.3, 5.9, 2.9 and 2.9% used car, car and carts, car and donkey, carts and donkey respectively. Gotu respondents 12.5, 56.3, 28.1%, used carts, donkey, human loading and donkey respectively. The Pearson chi-square analysis ($p < 0.05$) revealed there is difference among each irrigation areas used to transport their irrigated crop commodities. FGD discussants also said that the Laytemamagn farmers are partial traders unlike the other two irrigation areas. Farmers use donkey because the area is located far from the weather road, and hence could not have transport access. In addition, production potential in the area as compared to middle and lower catchments is less which could not be transported by car rather donkey is the vital pack animal to transport products from place to place while engaged on marketing activities from highland⁶ to lowland areas⁷. Meanwhile 90.9 and 9.1% of Laytemamagn respondents said that the reason not used car was lack of transport services; and due to shortage of production respectively. 18.8, 31.3 and 34.4% of Gotu respondents said high cost of car service, lack of car transportation, shortage of production and limited demand in the market were the reasons not to use car for transportation of market commodities respectively. Yewela farmers perceived that they do not have infrastructure problem with respect to roads and transport services whereas, Gotu farmers understood car service can get on dry season to market their irrigated crop commodities though it needs much money since they do not have access to weather road from Girakedamin to the farm land which is about five to six kilometers.

Market information

Regarding sources of information respondents used to know market price of irrigated crop products before going to market places, farmers got information from their neighbor, agricultural development agents of the *Kebele*, merchants and sell their products without any information gained before. Laytemamagn respondents 97.1 and 2.9% used their neighbor who had gone before as source of information of market prices and sale their commodity unfortunately without getting any market information prior to marketing respectively. Yewela respondents 60, 14.3 and 25.7% gained information from their neighbor who

had gone marketing of its commodities before; sold their products without getting any information before and sold their products getting information from merchants through communicating individual merchants with cell phone respectively. Gotu respondents 48.5, 3, 17.7 and 33.3% had got information before from their neighbor; the *kebele* development agents; sale their products unfortunately without getting any market price information of the commodity prior to selling; and merchants prior to selling respectively. The Pearson chi-square analysis ($p < 0.05$) revealed there was difference among each irrigation areas sources of market price information.

Regarding constraints of marketing, the respondents of each irrigation area responded the faced problems while marketing their irrigated crops. Laytemamagn respondents 28.1, 6.3, 40.6, 3.1 and 21.9% said lack of road, lack of market information, lack of road and transport service, lack of transport service, and faced no problem while marketing. Yewela respondents 3, 81.8, 3 and 12% said lack of road, lack of market information, lack of transport service, tax on market place respectively. Gotu respondents 28, 60 and 12% said lack of road, lack of information and limited demand respectively. The Pearson chi-square ($p < 0.05$) revealed that there is variation among the three irrigation areas farmers market constraints faced.

Market prices vary from time to time based on supply and demand principle. The researcher asked respondents to rank market prices of commodities during peak production time. Laytemamagn respondents 5.9, 61.8, 29.4 and 2.9% said very cheap, cheap, fair and expensive respectively. Yewela respondents 54.3 and 45.7% said very cheap and cheap respectively. Gotu respondents 33.3, 48.5, 9.1, 6.1 and 3.05 said very cheap, cheap, fair, expensive and very expensive.

In addition, FGD discussants in Laytemamagn said market price is obviously cheap but they argued that primary problem to them is decreasing of production and productivity of agriculture in general and irrigated agriculture in particular. Which means market price is not their major problem. However, Yewela discussants said potato and maize were very cheap during peak production. The farmers reasoned out it was due to the nature of the crop and production time, that is, Yewela farmers irrigated maize production matured on July and August, during this time, maize is sold on farm-get cutting and separating the fruit from its stem, but if the fruit left one day without selling then, it would be dried. Consequently, the merchants would not buy it with the price set a day before. The brokers negotiated with the farmers and the merchants with a price they could get better benefit. According to key informant interviewees, the farmers could not negotiate with merchants because the merchants did not come to the area rather send car through discussing and negotiate with brokers on the price of each fruit of maize with cell phone. And then, the brokers negotiate with the farmers to set the price but the lion's share was taken by the brokers while setting the

⁶ High land refers Laytemamagn and its surroundings

⁷ Lowlands includes Girakedamin and Damot districts such as Finoteselam, Jiga and Burie

price. Because, if the maize left for one day the price decreases, moreover, the next production would delay. Hence, the brokers are the major determinants of the market price of the commodity.

Discussion with farmers group shows that Laytemamagn main constraints were whether road and transport services and shortage of production, Yewela farmers raised the problem of taxation while they sell in Deberemarkos town. Discussants complained taxation was many times on a single crop which means if a farmer taxed today on the market area and could not sold due to cheap price on the day and then try to sell on the next day, he would be taxed on the next day also for the same commodity. Gotu key informant interviewees showed that market problem was the vital. For instance, "the youth group, the association, has three hectares of irrigated area and mainly planted sugarcane. The association faced lack of market because the production was much greater than the quantity demanded in Girakedamin. They negotiated and sold one truck before a year on the farm-get but the left were not sold. Hence, they tried to retail sugar cane in Girakedam in transport through carts each market day but it was tiresome and also elongates the next production period". KIIs and FGDs said the problem was due to new introduction of most commodities like *mango*, *avocado*, *guava*, which were not known to the area. Moreover, to search other market places, production was small and each individuals crops do not mature at the same time and hence difficult to rent car and use transport to market in other areas like Deberemarkos and Amanuel towns. The *kebele* officials and development agents also agreed with the farmers on market problem and they tried to search market and contacted fruit and vegetable sellers in Deberemarkos town however, they could not come because the area is far from the high way.

Therefore, though access to market is vital to market irrigated crop production, the study areas have difference in accessibility of markets, whether roads, transport services and crops produced and production potential. As a result, their marketing problems differ from place to place. Laytemamagn and Gotu lacked accessibility of market places, weather roads, transport services whereas Yewela has accessed to highway, market place better than the other areas but cheap market price is the constraint for irrigated crop production. Moreover, the types of crops produced also caused the marketing problem in Yewela and Gotu. The finding is coincided with (Hussain, 2007; Kennedy, 2001) stated that farmers access to market places in the nearby, infrastructures facilities such as road and telecommunications determine irrigation crop development.

Water governance

In order to alleviate irrigation water scarcity and conflict, each irrigation areas had water management bodies

though the organizational structures and acknowledgement by different formal and informal institutes varies. The water management bodies in the three irrigation areas were organized by the beneficiaries of each irrigation area though there was some difference in organizational structures and the responsibilities.

According to key KIIs and FGDs Laytemamagn water users of each stream have their own rule and regulation most of them were similar. The water users have irrigation schedule to irrigate their crop through sharing water equally and the schedule might be once per week or twice per week depending on the number of farmers who use the stream water. If a farmer violated the schedule which means use other individual water turn, he/she would be punished by the water users.

The punishment might differ in each stream water users but mostly denying the farmer from irrigating its crop on his/ her schedule for other time and/or pay money range from ten to fifty according to the agreement made before among the water users. If the farmer could not accept the punishment made by water users, the "Cell"⁸ would try to negotiate the water users. If still could not possible; the "cell" would take legal measure to settle the situation. Here, "the Cell" takes over the responsibility of water management from *Idir*⁹ before a year. *Idir* involved in water management based on the consensus among the members however, "Cell" did based on formal rules as court. People were respect *Idir* administration and hence everybody was responsible for each activity done by him / her. But, since cell take over *idir* responsibilities, as far as formal evidence was not there everybody did whatever he/she needs. As a result, social conflicts were rising every time especially irrigation water use conflict; this coincide with irrigation increases water use conflict Hussain and Hanjra (2004).

The key informant¹⁰ explained the complex issue in water scarcity and management faced and its implications in Laytemamagn.

Case

The priest said that small streams are the source of irrigated water. The farmers dig these streams and collect with in the hole through damming. The farmers who have farm land around this stream was requesting every time to share the water and produce vegetables especially onion and potato. The upstream farmers who shared the collected water before did not want to share to the lower stream users. However, the *kebele* officials forced them to share the water to the lower stream irrigation users. The priest explained he used the small streams to produce potato and onion before three years; and he sold

⁸ Cell is Ethiopian People's Revolutionary Democratic Front political party lowest organizational structure

⁹ *Idir* is social helping institute during death

¹⁰ Anonymous who is a priest living in Laytemamagn

onion 160 USD but currently stopped planting onion. Because, the number of farmers, used small stream to cultivate crop increased dramatically (from three to sixteen) though the stream remains constant. Therefore, they started to water their vegetables in turn once with in sixteen days. As a result, he stopped onion production and produces potato and even the farm land used is reducing every year”.

According to the key informant¹¹ Yewela irrigation users have formal Water Users Association unlike Laytemamagn, had rules and regulations under the Machakel *Woreda* Cooperative Office. The WUA management committee had five members responsible to manage and plan water schedule by *gote*; each *gote* have water father called “*Yeweha Abat*”¹² who manages water during its *got* watering schedule, mobilize beneficiaries during repairing, cleaning and digging of silted dam and canals, schedule water use turn, punish 2.67 USD while somebody violate the rule and use other individual watering turn, collect 3.2 USD as water fee per year per hectare. FGD discussants said that the WUA management committee has problems while implementing the rules and sometimes biased decisions made when punishing the accused farmers. But, the key informant¹³ said that the farmers themselves had created problems. “This means sometimes problems might occur while made decisions because the WUA management committee might not get sufficient evidence while making decisions to punish the accused individual”.

Nevertheless, the farmers themselves did not help the WUA management committee in informing or availing the actual evidence. As a result, at the moment the WUA management committee members were not volunteer to do and requesting the Machakel *Woreda* Cooperative Office to take over their responsibilities and assign other individuals. The beneficiaries need to change the management committee but the Machakel *Woreda* Cooperative Office was responsible to facilitate the selection of the committee by making general assembly of beneficiaries and approve the selected individuals.

According to the key informant¹⁴ and FGDs, Gotu irrigation users have water committee. The committee has five members responsible in management of water scheduling and mobilizing the community in constructing main canal each year. The irrigation area divided in to three sub divisions; each division has one *yeweha abat* who manages the water distribution within its mandate area. The committee was responsible to negotiate and punish if conflict occurred.

But, at the moment the committee negotiates between the quarreled individuals and if the individuals could not negotiate each other, the committee transfers the issue to

the *kebele* management bodies to punish the accused individual. The *kebele* administration punished the individual if there was evidence like formal court. However, the key informant said that the committee was responsible to see the problem physically while they were informed and punish the accused individual without the support of other evidence unlike the *kebele* administration. According to FGD discussants, Gotu irrigation users were not in favor of the water committee. Consequently, everybody tried to irrigate their crop by using other individuals watering schedule especially when elders and youngsters irrigate their area during their irrigation schedule.

The three irrigation areas beneficiaries had irrigation management bodies. Laytemamagn water users and *Idir* involvement in the management was influenced by the “*cell*” interference. This caused lack of solidarity among irrigation users to implement their own irrigation rule. Yewela WUA was formal organization, which had organizational structure but the beneficiaries and management members considered it as government institute. Thus, it caused lack of sense of ownership both from the management committee and from the members. Gotu water management committee lacked commitment to implement the rules and regulations set by the water users. Therefore, water governance causes a challenge on the efficient and equal utilization of irrigation water, thereby improves irrigated crop production.

Water availability and its constraints

Water for the irrigated agriculture is fundamental resource otherwise it could not be possible to cultivate crops. Gedeb River and its catchments is the source of water for each upper, middle and lower irrigation schemes. Laytemamagn farmers use water for irrigation from small streams which are the tributaries of Gedeb River in its upper catchment. Water scarcity was great problem in Laytemamagn, the respondents 2.9% said scarcity of water was minimum; 48.6% water scarcity was medium; and 48.6% said faced high water scarcity while they cultivate crops. Yewela respondents 31.4% said faced minimum water scarcity; 14.3% faced medium water scarcity and 40% faced high water scarcity 14.3% did not face water scarcity while they cultivate crops. Gotu irrigation area respondents 31.4% said faced minimum water scarcity; 17.1% said faced medium water scarcity; 28.6% said faced high water scarcity; and 22.9% did not face water scarcity. Pearson Chi-square analysis ($p < 0.05$) shows there is significant variation of water availability among the irrigation schemes. All of Laytemamagn respondents faced water scarcity but 60% of Yewela respondents faced medium, low and no water scarcity and 71.4% of Gotu respondents faced low water scarcity, medium water scarcity and did not face water scarcity.

¹¹ Anonymous the WUA management committee member

¹² *Yeweha Abat* is *Amharic* phrase means a farmer who manages water with in the *goth*

¹³ Anonymous is a development agent working in Yewela

¹⁴ Anonymous member of water committee

There are different causes of water scarcity. 80% of Laytemamagn respondents said scarcity of irrigation water occurred due to stream dry. 75% of Yewela respondents said transmission of water through cracked dam and canal water diversion in the upper near head dam. 54% of Gotu respondents said management problem means water seepage in the furrow canals and percolation in the soil. In addition, the land sliding and the nature of sandy loam soil causes soil erosion and gully formation. The chi-square analysis ($\chi^2=44.171$, $p=0.000$) revealed there is variation among the three irrigation areas in reason of water scarcity.

Gotu irrigation is unlike both Laytemamagn and Yewela. The owner of the irrigation water is an individual who initially divert Gedeb River and used to power milling stone. The individual used on working days to power its milling stone; and on non working days, the farmers used to irrigate their land. Water utilization in the area is difficult because of the water percolation and seepage since sandy clay type of soil and valleys the furrow canals passes over using locally available materials like *Bermeil*¹⁵, plastic, and mixing mud and *ched*¹⁶ which made inefficient water utilization. Therefore, Gotu main reason for scarcity of water is seepage and percolation of water through the furrow canals and soil respectively. Moreover, extent of seepage and percolation problems should be further studied by irrigation and soil scientists.

The main reason of water scarcity in Laytemamagn was stream drying; Yewela was head dam cracking and diversion of water near head canal; and Gotu nature of soil type and furrow canals.

The water scarcity constrains crop production however, Faulkner et al. (2008) in Ofosu et al. (2010) stated profit difference in irrigation is not due to water scarcity.

Employment opportunity

Regarding employment opportunity, irrigation creates employment opportunities to the households and the community. Laytemamagn respondents did not employ daily laborer both for irrigated and rain fed crop production. Yewela respondents employed 2.9143 and 6.0857 employees per year averagely to cultivate irrigated and rain fed crop production respectively. Gotu respondents employed 0.4412 and 6.2571 labourers per year averagely for irrigated and rain fed crop production respectively. Laytemamagn FGD discussants highlighted the household's farm land holding size is small therefore, everybody could cultivate easily himself/herself either irrigated or rain fed crop production. Most of the household have excess labour than the need to cultivate. The analysis one way ANOVA ($p < 0.05$ and $p < 0.05$) revealed there is significant variation among the three

irrigation areas in employment opportunities both for irrigated and rain fed crop production respectively. However, according to the FGDs, though rain fed agriculture employment opportunities were greater than irrigated agriculture employment opportunities at community level, irrigated agriculture activities were mostly done by the household members while they employed for the rain fed agriculture cultivation during harvesting and thrashing times. Therefore, irrigated crop production creates employment opportunities indirectly to the community besides create direct to household members and the community too.

Income

Regarding the income of farmers, farmers have different income sources either on farm or off farm. However, the major income source is agriculture which includes livestock and crop production. Crop production in the study areas is the major income source. Crop production divided in to two, that is, irrigated and rain fed crop production. The study tried to assess the average net income of households gained from both irrigated and rain fed crop production in year 2010. The survey result (Table 2) shows Laytemamagn farmers gained on the average 13.47 USD net income per year from irrigated crop production while they also gained on the average 22.51 USD net income per year from rain fed crop production. Yewela farmers gained average net income 128.93 USD and 170.74 USD from irrigated and rain fed crop production respectively. Gotu farmers average net income gained from irrigated crop production were not possible to calculate since the fruit crops were not harvested and sold.

The one way ANOVA ($P < 0.05$ and $p < 0.05$) between the irrigation areas show that the average net income gained from irrigated and rain fed agriculture was significantly vary respectively. Here, the irrigated crop production average net income per year was less than the rain fed agriculture net income per year due to the rain fed farm land is greater than the irrigated farm land. The irrigated area on the dry season is used to produce on the rainy season. Hence, the analysis considered the crops produced by rain fed during rainy season as rain fed crop while the crop produced by irrigation as irrigated crop on the same plot of land. In line with this, the average net income gained per year from irrigated crop production is an additional income to rain fed crop production average net income. Therefore, net income gained by the household's increases due to irrigation through increase in intensity of crop production.

Moreover, key informants and farmers discussants believed irrigation increases their revenue because before irrigation was employed especially in Yewela people were starved due to lack of money though enough production to household consumption but since irrigation starts people do during off season and on season. As a

¹⁵ *Bermeil* is a type of water storage material used to connect the furrow canal cut by the valley and irrigation water passes through

¹⁶ *Ched* is a residue of tef after thrashing used to make mud as glue

Table 2. Net income of households from rain fed and irrigated crop per year.

Irrigation areas	N	Mean	p-value
Net income gained from Irrigated crop production			
Laytemamagn	33	13.44	0.000
Yewela	70	128.6	
Gotu	0	-	
Total	103	91.71	
Net income gained from rain fed crop production			
Laytemamagn	35	22.41	0.000
Yewela	68	170.31	
Gotu	35	272.81	
Total	138	158.81	

Source: Survey 2011, significant level 5%.

result, people of Yewela especially have got enough money and nowadays they are developing assets and open saving book account besides sending their children in school covering their expenses. Whereas, Laytemamagn farmers though got less than Yewela, the focus group discussants said their livelihood highly depend on irrigated crop production for their home consumption and generation of income through going far distant areas to sale and/ or buy or exchange it with maize, hot pepper etc. which is produced in the lowland areas. Gotu FGD participants highlighted they benefit from irrigated agriculture but they could not get possible benefit due to marketing problem.

Summary of challenges and opportunities

Farming experience

According to Beyene cited in Bediru (2004) agrarian society do agricultural activities from age of 12 to 75. Laytemamagn farmers have high experience of irrigated agricultural production; but Yewela farmers experience fifteen years, Gotu farmers experience is nine years. Gotu less farming experience especially in horticultural fruits affect production in search of market places.

Land size

Irrigated land size in Laytemamagn and Gotu is smaller than Yewela. But Laytemamagn irrigated land size is highly affected by the irrigation water scarcity because the farmers plant irrigated crop on small plot of land within large size farm land. Yewela farmers benefited since the farmers have better irrigation land than the others through increasing production and productivity.

Oxen

Yewela and Laytemamagn irrigation areas used oxen to plough but Gotu irrigation area do not use oxen because perennial cropping types are planted and also the hill nature of topography.

Livelihood strategies

Laytemamagn livelihood strategies changed to partial traders but Yewela and Gotu farmers' are dominantly based on agricultural production.

Agricultural extension service

The researcher concludes extension services provided are not focusing on identifying and organizing farmers' problems and support farmers in supplying and accessing inputs such as pesticides, improved seeds and fertilizers.

Credit services

High interest rate putted in place at cooperatives which might disfavor the farmers. Therefore, credit service provided is inadequate.

Market

Lack of market accessibility could be a threat to Gotu irrigation development. Similarly, Lack of access to road especially to Laytemamagn and Gotu irrigation areas is become a challenge for the development of irrigation. Unlike Laytemamagn, cheap price of crops during peak production is also created a challenge in Yewela.

Water governance

In Laytemamagn the interference of cell could aggravate water use conflict. Yewela the Machakel *Woreda* Cooperative office has more power to assign water management committee than the beneficiaries. This made the beneficiaries lack of trust to WUA. In Gotu the milling stone owner has the right to use the water but the irrigation users get through willingness of the owner on non working days. Moreover, the water committee is less committed and leaves its responsibilities to the *kebele* officials.

Water availability constraints

Water scarcity is a serious problem in Laytemamagn than the other two areas due to drying of small streams from January to April. Though water scarcity is there with in the Yewela and Gotu areas, transmission of water through the cracked dam is a problem in Yewela. Whereas, management problem related to seepage in the furrow canals and percolation due to soil type is a problem in Gotu.

Income

The net income gained from irrigation is an additional income gained. Because, farmers cultivate their plot of land on dry season by irrigation in addition to main season cultivation by rain fed. Therefore, irrigation improves the income of farmers through crop intensification and change of crop pattern. However, lack of market access due to new introduction of the crop types will disfavor Gotu irrigation beneficiaries.

Employment

Employment opportunity to the household members and the community are created either directly or indirectly. In Laytemamagn, the household members get job opportunities while in Yewela and Gotu both the household members and community are beneficiaries.

Conclusions

1. Irrigated crop production in Gedeb River Catchment of Machakel *Woreda* has been practiced in different times. Which were started long times as the case of Laytemamagn while others were started recently as the case of Yewela and Gotu that were started in 1995 and 2002 respectively.

2. The economical and biophysical circumstances of irrigated crop production in the three irrigation areas are different but the institutional factor is more or less similar.

3. Regarding irrigation crop farming experience, Laytemamagn farmers experience was much greater than Yewela and Gotu farmers which benefits Laytemamagn farmers how and where to sale their irrigated crop products.

4. Livelihood strategies in Laytemamagn was more diversified, that is, they are more of partial traders than Gotu and Yewela, though still some differences between the two were there. It helped to search market areas for better market prices of commodities than Gotu farmers.

5. The livestock and oxen holding size were different in the three areas especially Laytemamagn farmers have smaller in size than the other two irrigation areas. Whereas, donkey holding size of the three irrigation areas was almost equal which was due to donkey is necessary for transportation of market commodities in Laytemamagn and also in Gotu and Yewela which helped for the intensive irrigated crop production and to get better income saleing in good market price.

6. Irrigated Land holding size in Yewela was more than Laytemamagn and Gotu which was an opportunity for increasing irrigated crop production. The land arrangement to solve land shortage in Yewela and Laytemamagn were positively contribute for the irrigation crop production.

7. Cropping pattern and intensity differ in each irrigation area; agricultural extension services were inadequate; market service was constrained by different factors such as lack of weather roads; transport services; lack of information; cheap market prices during production and these factors differ from place to place.

8. The need of credit services in each irrigation area was different; the main constraints of ACSI credit service was fear of lose of the credited asset, lack of collateral and complex bureaucracy therefore, it might hinder the production and productivity potential of irrigated crop production.

9. The water governance in the three areas was done majorly by the water users which have management bodies especially in Yewela and Gotu that have rules and regulations but their function was influenced by the interference of the government and degree of water scarcity vary from place to place within the catchment and the reasons of scarcity such as stream drying in Laytemamagn; cracking of head dam and diversion of water near the head dam in Yewela; and percolation and seepage problems in Gotu.

10. The soil fertility status among the three areas was different, that Gotu irrigated land was more fertile than Yewela; and Yewela irrigated land was more fertile than Laytemamagn.

RECOMMENDATIONS

The researcher recommends the following socioeconomic, institutional and biophysical conditions to be made by the respective offices or stakeholders to

improve the irrigated crop production in each specific area that again improves the living standards of the irrigation farming community.

1. In Laytemamagn, the people diversified their livelihood strategies as partial traders in addition to crop production and livestock rearing. The farmers sale or exchange the irrigated crop products in the lowlands however, in Gotu, farmers livelihood strategies based on only crop and livestock production and had less experience in marketing of their irrigated crop products in better prices going far distance. Therefore, the Machakel *Woreda* Economy and Finance office and Machakel *Woreda* Agriculture Office should design strategies to expand livelihood strategies of Laytemamagn farmers to Gotu farmers.

2. Agricultural extension service provided by Machakel *Woreda* Agriculture office lacks packaging for instance; there was lack of improved technologies especially in Laytemamagn and Yewela. Whereas there were improved crop technologies in Gotu though marketing problem faced. This shows extension service provided by Machakel *woreda* lack coordinating and organizing agricultural research centre and marketing institutions. Therefore, Machakel *woreda* Agriculture Office should try to identify, prioritize and solve problems from production to marketing with research centre, marketing institutions, farmers and improved seed supply institutes. Therefore, Machakel *woreda* agriculture office should organize platforms for improving linkage among stakeholders.

3. ACSI is a formal institute which provides credit for intensive and extensive irrigation nevertheless, the accessibility of credit service to the farmers constrained by lack of collaterals especially land less youths and complex bureaucracy. Thus, ACSI credit service should be accessed in simple and easy way to intensive and extensive irrigation farming. Therefore, the collateral and complex bureaucracy should be revised and find other options.

4. The constraints of marketing of irrigated agricultural products were different in the three irrigation areas. Lack of weather road in Laytemamagn and Gotu was the major constraint. Therefore, in order to increase the farmers benefit Amhara Rural Road Enterprise should construct weather road from Laytemamagn to Amanuel and from Gotu to Yewela.

5. The farmers got market price information from their neighbor who had gone to the market before and no other means of getting updated market information. As a result, farmers' sale their irrigated crop products with the price they get without considering their benefit. Therefore, updated market price information of each commodity should be posted to the farmers by development agents or cooperatives on information desks of each site.

6. Agricultural extension service should give training to the farmers in every aspect of agriculture from production to marketing. As the study revealed the Gotu farmers faced marketing problems which was due to lack of road

and marketing information. Therefore, Machakel *Woreda* Agriculture Office should give training to Gotu farmers on how to market their irrigated crop products.

7. The marketing problem in Gotu irrigation areas was due to limited demand of the crop products in the markets which in turn was due to new introduction of the crop types in the area and most of the consumers were not aware how to feed. Therefore, the Machakel *Woreda* Agriculture Office should make promotion in Gotu on how to feed such crop types and their benefits especially on market days.

8. In the three irrigation areas there were water management bodies which have rules and regulation set by the water users to manage the water but sometimes the interference of the government bodies made some confusion among the water management bodies to implement the rules effectively. Therefore, the government bodies should leave the issue to the water users associations because they are more powerful than government bodies to solve water conflict.

9. The water scarcity problem in Gotu was caused by seepage of water in the furrow canals. And the local materials used to pass the water were not efficient to transfer water without seepage. Such problem can be solved by concrete canal construction. Therefore, Gotu irrigation furrow canals should be rehabilitated to modern irrigation scheme by Amhara Water Design and Supervision Works Enterprise so as to use water efficiently and reduce water conflict.

ABBREVIATIONS

ACSI, Amhara Credit and Saving Institute; **USD**, United States dollar; **KII**, key informant interview; **FGD**, focus group discussion.

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