

Farmers' Perceptions on the Productivity of Water in Agriculture: A Case Study at Debre Kidane Watershed, Eastern Tigray, Ethiopia

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Abstract: Awareness of the knowledge of farmers on the productivity of water in agriculture (PWA) is the basis for all irrigation activities. This paper assesses the current knowledge level of farmers towards PWA in the Debre Kidane watershed which is located in eastern Tigray. It also identifies obstacles regarding the spread of knowledge of PWA and indicates the best knowledge-disseminating strategies and tools for raising awareness about PWA. Data for the study was obtained from a formal household questionnaire survey, key informant discussion and direct observations of farmers' fields. In the study area, the concept of PWA is new. All the farmers measure the crop harvested but not the volume of water used to produce it. Almost none of the irrigators know when their crop needs water and when to stop irrigating their crop. However, farmers are keen to discover methods which could help them to produce more crops per drops of water. Consequently, farmers indicated that training is the most suitable knowledge-sharing strategy for creating awareness about PWA, and its absence is the barrier that hinders them from recording PWA. Furthermore, they pointed out that training given through demonstration is their method of preference. Most of the farmers irrigate their farmland by checking the availability of the water in their shallow wells and irrigating their crop until the furrow holds up water. For better utilization of the groundwater resources in the area, the farmers have to be introduced to the concept of PWA.

Keywords: Groundwater; Knowledge; Productivity; Strategy; Tool.

1. Introduction

Producing enough food and generating adequate income in the developing world to feed the poor and reduce the number of those suffering is a great challenge. This challenge is likely to intensify, with a global population that is projected to increase to 7.8 billion in 2025, of which more than 80% of the population increase is expected to occur in developing countries (Kijne *et al.*, 2003). The picture for Ethiopia is more severe and serious as the country's food production per capita is below the average for Sub-Saharan African countries. Despite agriculture being the main sector of the economy, the performance of the sector has been unsatisfactory in Ethiopia since the problem of food security is still very serious (Lemma, 2004). In addition, the lack of adequate rainfall combined with the variability in the onset and duration of rain remains a major threat to agricultural production.

Irrigation development is an important means of achieving food self-sufficiency in many arid and semi arid countries, including Ethiopia, in order to address the main challenge caused by rainfall variability and moisture stress. However, irrigation has only been possible where there are adequately developed water resources. According to Rockström *et al.* (2003), irrigation accounts for about 72% of global and 90% of developing countries' water withdrawals and water availability for irrigation may have to be reduced in many regions in favor of rapidly increasing non-agricultural water use in industry and households, as well as for environmental purposes. They further stated that, with growing irrigation-water demand and increasing competition across water-using sectors, the world now faces a challenge to produce more food with less water. This goal

will be realistic only if appropriate strategies are found for saving water and for more efficient water use in agriculture. One important strategy for alleviating this problem is an increase in the productivity of water in agriculture.

Productivity of Water in Agriculture (PWA) varies greatly according to the specific conditions under which the crop is grown. Due to this, researchers define productivity of water in agriculture (PWA) differently, for example:

1. The ratio of benefits obtained to the amount of water that is quantitatively or qualitatively depleted during the process. The benefit may include biomass produced, the economic value of the produced or the value attached to the social benefits (Kijne *et al.*, 2003).
2. The ratio of the amount of water required for an intended purpose divided by the total amount of water diverted (Cai *et al.*, 2003). And,
3. The amount of crop harvested per unit volume of water used (Oweis *et al.*, 2003).

From all these definitions, in general PWA can be defined as the amount of crop produced per unit volume of water.

To increase the productivity of water in agriculture at farm level, improving the knowledge of farmers towards PWA through different means is essential. According to Kasele (2004), the preferred way of transferring information is face-to-face communication. However documents and others communication tools are also vital sources of knowledge acquisition. Knowledge-sharing among the farmers is also a means of improving and transferring the existing knowledge. A study conducted in Tanzania, Mkoji sub-catchment, by Kasele (2004) strengthens this idea that appropriate knowledge-sharing

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tools are needed to enhance the transferring of knowledge within different groups.

In Tigray there are 35 districts with a total population of four million, out of which 75% of the population are food insecure and seriously threatened by drought, which hit the region every 3 to 4 years (Hugo, 2003). A major climatic limitation for agricultural production in the region is erratic rainfall, often combined with intermittent dry spells that regularly have an adverse effect on the survival of crops. The study area is one of the food insecure and drought affected areas of the region. In the area, on average households harvest enough food for about 4.79 months of the year. The remaining food gap is supplemented by a combination of activities including: food purchased from the market, earning food from work and food relief. This is mainly due to the erratic and unreliable nature of rainfall. The watershed also has significant problems regarding the distribution of rainfall throughout the rainy season. According to the rainfall data record only, 5 % of the mean annual rainfall takes place in September. However, this month is the ripening period for most of the dominant crops. This is considered to be the main cause for the recurrent crop failure the area is facing. In addition, there is uneven rain distribution throughout the month on average for 5 -10 days between each rainstorm at some critical times. This uneven distribution of rain also has a negative impact on the normal growth of crops.

Currently, in the study area, the farmers are carrying out irrigation to cope with this problem. The source of water for the irrigation is groundwater. In the Debre Kidane watershed, around 361 hand-dug shallow wells were constructed from 2003 to 2005 for the purpose of irrigation as well as domestic and livestock use. The households are nowadays benefiting from the intervention by producing different high-value crops two to three times per year. In the study area, almost all the farmers measure the crop harvested but not the volume of water used to produce it. None of the irrigators knows when his/her crop needs water and when to stop irrigating their crop. They usually wait until the crop starts to wilt or the soil dries and irrigate their crop either until the furrow holds up water or the water in the shallow wells runs out. This exposes the groundwater of the area to high risk and mismanagement. Consequently, the farmers fail to utilize the groundwater resource more efficiently and in a sustainable manner. To avoid this unwise use of water and to properly utilize the groundwater to increase agricultural production, increasing the knowledge of farmers of PWA is crucial. The main objective of this research work was to assess the current knowledge level of the farmers towards PWA, identify the constraints related to it and offer a solution.

The specific objectives of this research are to assess the current knowledge levels of the farmers on productivity

of water in agriculture, to identify obstacles regarding the spread of knowledge of PWA, to identify the best knowledge-disseminating strategies and to identify the best tools for raising awareness about PWA.

2. Methods

2.1. Description of the Study Area

The Debre Kidane watershed is located at about 106 km northeast of Mekelle in the Eastern Zone of Tigray National Regional State. Geographically, it is located between 39° 25' to 39° 30' E and 13° 52' to 13° 57' N (Figure 1). It has an aerial coverage of about 45.09 square kilometers, with a mean altitude of 2200 meters above sea level.

The mean annual rainfall of the area is 524.08 mm. Monthly rainfall distribution in the area is concentrated mostly from mid-June to mid-September. The mean annual temperature is 18.1 °c, and the yearly average maximum and minimum temperatures are 25.1 °c and 10.8 °c respectively. The annual range of temperatures is 3.7 °c.

The watershed comprises of two 'Tabias', which are the smallest administrative units: Debre Birhan and Selam. The total population is 13, 279 with a percentage of 50.3% for females and 49.7 for males. The number of households is 3761 from which about 35% are headed by females and 65% by males.

2.2. Data Sources

The data for the study was collected from both primary and secondary sources. Primary data was obtained from a formal household questionnaire survey, key informant discussions and direct observations of fields. The farmers' questionnaires generally included questions about current levels of knowledge of productivity of water in agriculture, the existence of obstacles to knowledge flow, the best mechanisms for dissemination of knowledge and appropriate knowledge-sharing tools for raising awareness about PWA. Questions to generate data about personal household resources were also included in the questionnaires. Moreover, some general information about the major problems of the farmers regarding the efficient utilization of groundwater for irrigation and the socio-economic conditions in the community were obtained from key informant group discussions at site level. In the focus-group discussions, experts from the extension service, individuals who were believed to be knowledgeable about the past and present history of the watershed, irrigation water users and rain-fed agriculture practicing farmers,, committee members of the irrigation water users' association, executive members of peasant associations and development agents were questioned.

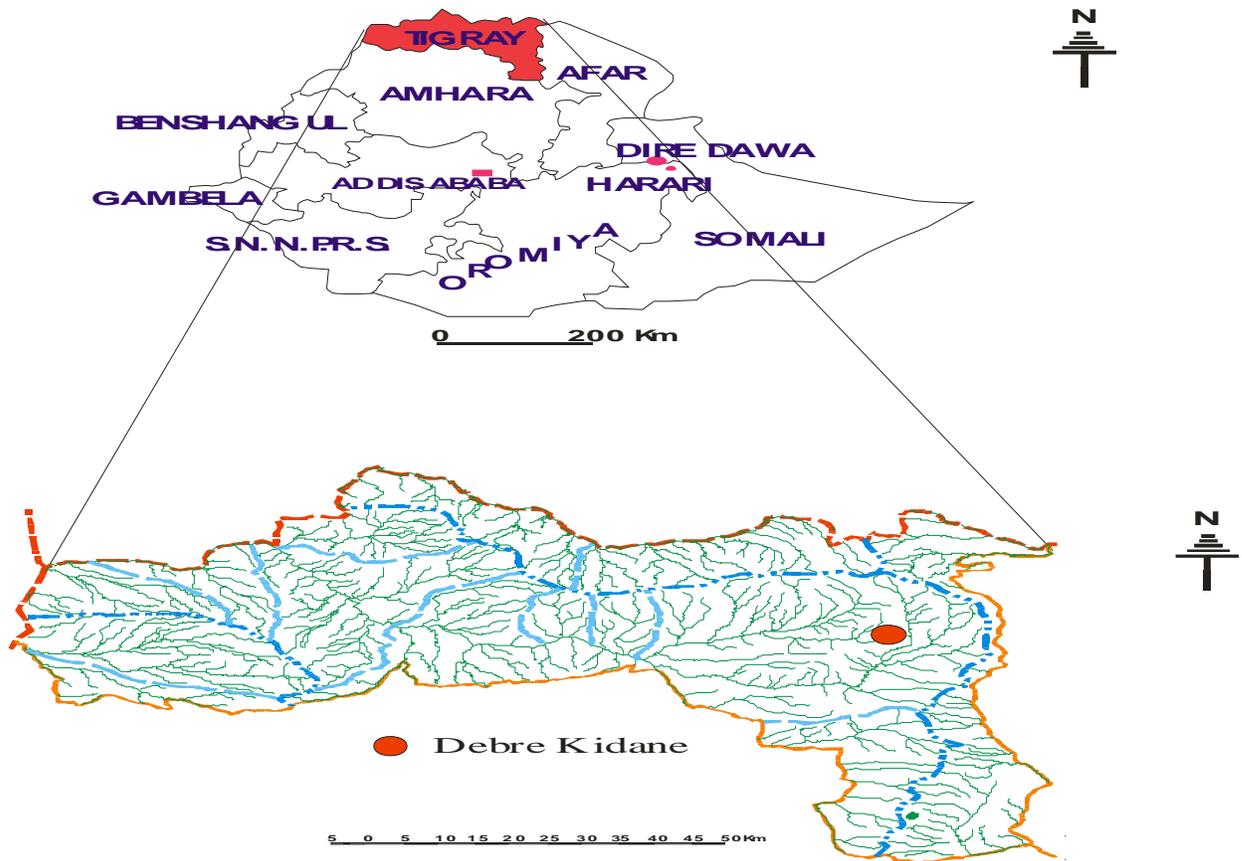


Figure 1. Location map of the study area.

The sample population for the study was drawn from the two ‘Tabias’ of the study area. By using stratified sampling, the sample populations were drawn both from farmers who practised irrigation and farmers who practised only rain-fed agriculture. The total number of households was obtained from the District Bureau of Agriculture (Table 1). From this number, systematic random sampling was used to select total sample

populations. Accordingly, 36 and 72 households were interviewed from a total of 361 irrigation users and 3400 households who did not practise irrigation respectively.

In addition to the primary data, secondary data which is relevant to the research was collected from different sources. The collected data was analyzed using SPSS software.

Table 1. Total number of households and sample size selected from each ‘Tabia’.

‘Tabias’	TT HHS SW	Sample Size	TT HHS	Sample Size
Debre Birhan	226	23	2200	44
Selam	135	13	1400	28
Total	361	36	3600	72

Source: District Bureau of Agriculture.

NOTE: TT HHS SW: Total households that have shallow wells.

TT HHS: Total households that don’t have shallow wells

3. Results and Discussions

3.1 Perspectives of Farmers on PWA

3.1.1 Rain-Fed Agriculture

The main rainy season is from mid-June to September. According to the responses of the farmers, this is their only season for crop production. The major crops grown under rain-fed agriculture are barley, wheat, mixed crops

(wheat and barley), teff, finger millet, maize, peas and beans.

Out of the 72 respondents, all of them gave r responses about PWA. Seventy six per cent of the respondents indicated that the concept of PWA is new to them. Twenty four per cent of the respondents indicated that they understand PWA and relate PWA with good yield in a good year and poor yield in a bad year. According to the farmers, a good year is the time when a sufficient amount

of rainfall is recorded throughout the growing season and a bad year is characterized by both low and high rainfall that results in moisture stress and water-logging problems respectively.

In general, there is an understanding that water is an important input in agricultural production and farmers relate production from rain-fed agriculture to the frequency, intensity and duration of rainfall that has a direct influence on the yield of crops.

3.1.2 Irrigated Agriculture

The main irrigation season is from November to June. The major crops grown using irrigation are onion, tomato, cabbage, potato and maize. Those farmers who have neither a motor pump nor a treadle pump usually irrigate their farmland at 15-day intervals, whereas those farmers who have either a motor pump or a treadle pump normally irrigate their farmlands at 5 or 10 day intervals.

The timing of different irrigated crops varies according to the types of crops and their growing stages. According to the farmers' responses, vegetables are the ones that take the longest time to irrigate.

Out of the total 36 respondents, all of them gave their responses about their understanding of PWA. Eighty one per cent of the farmers indicated that the concept of PWA is new to them. Nineteen per cent of the farmers claimed to know the meaning of PWA. These farmers who claimed to know the meaning of PWA were farmers who had taken related training when they were in Eritrea. When asked what PWA means, those who claimed to understand its concept gave different definitions. The first definition given by four of the farmers is "the amount of water that is put onto the farm when needed by the plant". A further two farmers said that PWA is "the amount of water that is put onto the plant at each irrigation time" and one of the farmers explained PWA as "the amount of water that is used for irrigation purposes throughout the plant-growing time". Apparently, even those farmers who said they knew the meaning of PWA did not appear to have grasped the concept. None of the farmers in the study area measured the amount of water that they applied during each irrigation period. From the sample population, all of them reported that they put water on their farmland after checking the availability of the water in their shallow wells. Farmers also put water onto the farmland when the plants showed signs of wilting and irrigated their crop until the furrow held water. However, some of the farmers who took training organized by the District Agricultural Bureau and other nongovernmental organizations are aware that the amount of water that should be added to the farmland is different depending on the conditions. As shown in Figure 2, the respondents are well-informed about the fact that crop type, plot size and soil type are the most influential factors for determining the frequency and amount of irrigation water used on the farm plot. Nevertheless, according to the farmers, due to limited availability of groundwater in their shallow wells and, in some cases, labor, they are unable to take such factors into consideration.

3.2 Obstacles to the Spread of the Knowledge of PWA

The concept of PWA is new in the study area. Almost all the farmers measure the crop harvested but not the volume of water used to produce it. Out of the total 36 respondents, all of them gave their responses regarding the obstacles to the spread of knowledge of PWA. All of them indicated that there are obstacles to the spread of knowledge of PWA.

Fifty three per cent of the respondents indicated that absence of training is a barrier regarding the spread of knowledge of PWA. Thirty one per cent and sixteen per cent of the respondents indicated that absence of appropriate training (i.e., training related to water) and absence of adequate training respectively are the barriers regarding the spread of knowledge of PWA. The implication may be that farmers fail to use irrigation water properly due to lack of knowledge about how to use the groundwater properly.

3.3 Knowledge-Sharing Strategies for Creating Awareness on PWA

Sharing knowledge is a social activity that is useful to create awareness about different things. In a complete knowledge-sharing system, meeting the right person or group of people would be of great importance to equip oneself with sound information (Kasele, 2004).

Out of the total 36 respondents, all of them gave their responses regarding strategies for raising awareness about PWA. Seventy two per cent of the respondents indicated that training is the most suitable knowledge-sharing strategy for raising awareness about PWA, whereas eleven per cent respondents indicated that knowledge-sharing with different people is the best way. Seventeen per cent of the respondents indicated that both training and knowledge-sharing with different people are important ways to procure knowledge about PWA.

Although most of the respondents selected training as a more useful and suitable strategy to raise awareness about PWA, most of them had not participated in any training. Out of the total 36 respondents, fifty three per cent of respondents indicated that they had not attended any type of training. The remaining forty seven per cent of respondents indicated that they had taken training. Out of the respondents who claimed to have taken training, thirty one per cent said that the training conducted by the District Agricultural Bureau and other nongovernmental organizations was not related to water use, but focused on how to construct shallow wells and use different pumps. Only sixteen per cent of the respondents who attended the training said it was related to water productivity. During the interview, it was discovered that these farmers took the related training when they were in Eritrea where they lived before. It was also reported earlier that these farmers do not have sound knowledge about PWA and fail to apply the little "knowledge" they have due to several factors, such as shortage of water, labor force, etc.

During the interviews, the respondents who claimed the training was related to PWA said that trainers used

theoretical methods rather than practical ones. Consequently, they could not understand the intended output of the training. Focus group discussion sessions were also held to identify suitable knowledge-sharing strategies to raise awareness about PWA. From the results, training was preferred by the group.

3.4 Knowledge-Sharing Tools

Out of the total 36 respondents, all of them gave their responses on suitable tools or teaching methods during training to create awareness about PWA. Eighty three per cent of the respondents indicated that they prefer training

given through demonstration. Their reason for choosing demonstration as their number one choice is its potential to allow them to learn by observing and doing. The remaining seventeen per cent of respondents favor field visits as the most suitable teaching method for training to raise awareness about PWA. According to them, this will give them the opportunity to share experiences with others who are well-experienced.

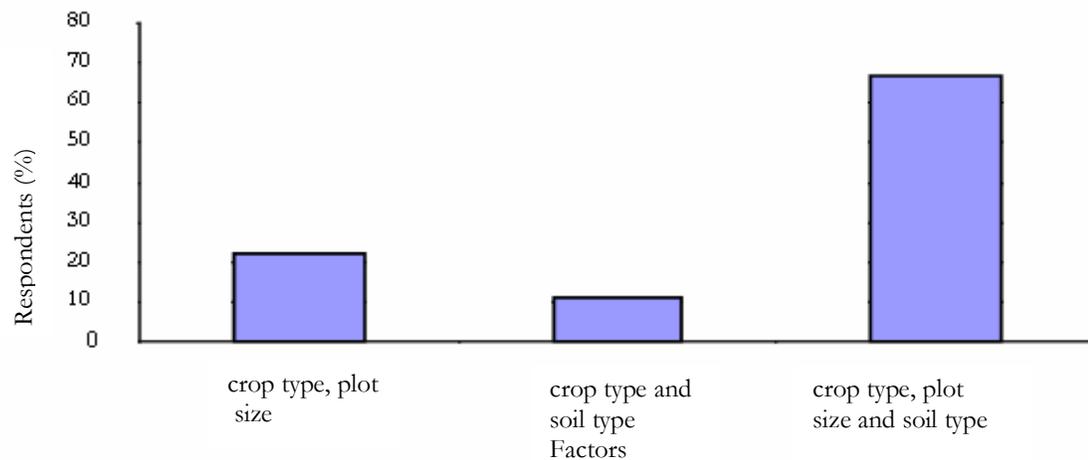


Figure 2. Factors influencing the frequency and amount of irrigation.

7. Conclusion

The introduction of water harvesting and its use for irrigation in the region is a recent phenomenon. So it is not surprising to learn that the majority of farmers practising irrigation are unaware of the concept of productivity of water in agriculture (PWA).

To make irrigation efficient and sustainable, coordinated intervention is required by all stake holders. Training on methods of irrigation and irrigation scheduling with the help of simple charts that can be easily understood by farmers is one of the areas that requires due emphasis. Similarly, when and how much to irrigate crops grown under irrigation, which is the basis for irrigation scheduling, should be calculated by professionals who are working in the field.

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