Retrospective Impact Assessment for Pilot Hydroponic Green Fodder Production in Sekota Woreda, Amhara Regional State, Ethiopia

Tariku Kidane1 · Alemu Dagnachew1

Received: 17 April 2021 / Revised: 26 July 2022 / Accepted: 2 August 2022 © The Author(s) 2022

Abstract
The objective of the study was to assess the impact of hydroponic green feed production on the milk production and household income of small-scale farmers in Sekota Woreda (District) of Waghimra zone in Ethiopia. Hydroponic feed production is not a common way of animal feed production. However, an NGO called Action For Hunger (ACF) designed a project and introduced it in two Peasant Associations (PAs) or Kebeles in Sekota Woreda. The technique employs non-soil fodder production with the application of specialized nutrient solutions which replace nutrients that plants can get from the soil. Sekota Woreda under Waghimra zone is found in Amhara region, Ethiopia, characterized by recurrent drought, degraded topography, and minimal amount of vegetation coverage. It is paramount in providing alternative production techniques to small holders in the area and the project introduced non-soil-based animal feed production technique. The project selected totally 50 households for piloting the project. All participating farmers have been included on the impact assessment study. Both descriptive and inferential statistics techniques were employed to characterize beneficiaries and analyze the impact brought about to their livelihood by the project. Descriptive statistics techniques implemented such as mean, frequency, standard deviation, and cross tabulation techniques. Two-sample t test with equal variance assumption is used to analyze the impact in retrospective way of analysis. The results include about 60% of beneficiaries are Female and the rest are Male and most of them are either Widowed or Divorced. Participation criteria for the program were restocking beneficiary, female-headed household, affected by recurrent drought and elderly farmer. When it comes to the impact of the hydroponic feed production activity, it has brought statistically significant improvement in both cattle and goat milk production and the income from the sale of the milk produced by the intervention. Hence, it is recommended that either the project itself or other development practitioners should take the lesson from this activity and think about scaling up the project to other farmers within the District or other Districts within the area.

Keywords Hydroponic · Retrospective · Impact · Sekota · Ethiopia

Introduction
Background
Waghimra zone is bordered on the east and north by Tigray, on the south by Semen Wollo (Lalibela), and on the west by Gondar. According to a 2016 population projection, this zone has a total population of 540,599, which is 91% rural and mixed farming (CSA 2018). Fodder availability is one of the main constraints affecting growth, health, milk production, and reproduction potential of livestock. In many instances, farmers in Waghimra do not possess or cannot access land that is productive enough for fodder production using classical agricultural technologies, and let animals graze open land; the average land holding size for crop production is 0.8 ha most of which is used for food crop production. The zone is suffering from chronic water shortages and poor irrigation infrastructure, and unlike other regions, Waghimra experiences only one rainy season—from June to August. Demand for pasture is high and farmers struggle with the scarce water and land to provide fodder for their livestock.

In Ethiopia, following recurrent droughts, there have been large livestock losses due to feed and water shortages. Drought has a direct impact on the growth of pasture,
leading to a decrease in livestock production and productivity. Waghimra is one of the most drought-prone zones. In this area, most livestock feed comes from communal pastures and crop residues, which depend on the availability of good rainfall. Hydroponic green fodder production may be a viable option in drought-prone areas like Waghimra to produce green fodder in large quantities with little water input and overcome issues of feed shortage. The zonal livestock office is currently piloting hydroponic green fodder production.

In Waghimra, farmers have limited space to grow feed for their animals, water resources are limited, fodder prices are high, tools are unavailable, and grazing land is limited. Hydroponic farming practices provide farmers with a low-cost, high quality, sustainable source of fodder, which can be available year-round. Hydroponic fodder production decreases the problem of land for fodder production because it requires little land. All work in a hydroponic production can be performed by unskilled labor, elderly, or partially disabled individuals. Feeding of quality green fodder to animals can play an important role in sustainable and economical milk production. Hydroponic fodder production also means farmers can grow animal feed with lower resource requirements than would be needed for traditional fodder production—namely, without the need for large tracts of land or a lengthy cultivation period. Unlike field production systems that use run-to-waste irrigation practices, the hydroponic fodder system uses recirculation, thus reducing waste of water and increasing water efficiency. It has been reported that hydroponic fodder production requires only about 2–3% of the water used under field conditions to produce the same amount of fodder. Fodder produced hydroponically grows in only 7–10 days. It is of a high feed quality, rich with proteins, fiber, vitamins, and minerals. All these special features of hydroponic system, in addition to others make it one of the most important agricultural techniques available, particularly in resource-scarce parts of Ethiopia. The production system employs non-soil production technique which uses artificial nutrient solution to grow plant tissues for animal feed purposes. In doing so, farmers are able to take advantage of the production system for better animal feed production and hence more household income to the family. Hence, this project aimed at improving the production and productivity of livestock in Sekota Woreda of Waghimra zone. Sequentially, this impact assessment was done to assess whether the project fulfilled its initial objective or not by looking at different variables like household perception or feeling toward the activity, physical production units like change in the amount of milk production before and after the project and household income improvements expected to happen after the project.

Objective

General Objective

The general objective of the impact assessment was to find out the impact of the hydroponic green feed production activity done by Action For Hunger, AAH in Sekota Woreda, Amhara regional state, Ethiopia.

Specific Objectives

(1) To characterize beneficiaries of the hydroponic green feed production project in their household holdings and other characteristics.
(2) To assess beneficiaries attitude toward the hydroponic green feed production for future scaling up works.
(3) To assess the impact of the hydroponic green feed production on the livestock productivity of beneficiaries and their household income.

Methodology

Sampling Technique

The common sample size determination formula for random selection of units was used, which is given below, but since beneficiaries of the project are relatively small for statistical analysis it gave the population size as a sample size for a minimum number of sample size for analysis. And the survey was conducted on all of the beneficiaries of the project.

\[ n = \frac{N}{1 + N(e^2)} \]  

where \( n \) is the sample size that should be collected for reasonable representation of the population, \( N \) is the population size under consideration for the study, and \( e \) is the statistical error that should be set in advance and usually it is 0.05.

Data Collection Tools

Structured questionnaire was the main data collection tool for the assessment study. The questionnaire was designed to assess the impact of the project on retrospective bases; in that asking respondents what their income was before feeding the green feed and how much they are getting now at the time of the interview. It has demographic characteristics segregated based on sex and household dependency and vulnerability. The questionnaire also assesses the implementation
process of the project, beneficiary, and community perceptions toward the hydroponic green feed production.

### Data Entry and Analysis

The data collected from the field were entered in to Microsoft Excel and transferred to SPSS software version 16 for easy data management and finally the analysis was made using STATA software version 12. Methods of analysis are mainly descriptive like frequency, mean, standard deviation, and cross tabulation techniques. For statistical analysis, a two-sample t test with equal variances assumption was used. This statistical analysis manages to compare the variables under consideration before and after the project calculating the mean of each group. The equal variance assumption was considered because the data were taken from the same household: before and after the project.

### Results and Discussion

This part of the assessment document first presents the descriptive analysis results and to be followed then by the statistical analysis results. The beneficiaries were selected using criteria such as Restocking beneficiary (farmers with new stock purchases), female-headed household, affected by recurrent drought and elderly farmer as they mentioned why they were picked for the program over other households. Other results of the assessment are presented below.

### Descriptive Statistics

The project as a pilot involved 49 farm households from two Kebeles (PAs) of Sekota Woreda from Waghimra zone: namely, Hamusit and Lay sida. 24 Participants involved in the hydroponic green feed production from Hamusit Kebele and 25 from Lay sida Kebele. Table 1 shows the results.

The age of beneficiaries ranges from 22 to 65 years old and the median age group is from 31 to 39 years old. More than half of the beneficiaries for the hydroponic green feed production about (57%) are below 39 years old. It can be concluded from this fact that most of the farmers in these two Kebeles are relatively young. Table 2 shows this fact.

| Table 1 | Frequency table for number of beneficiaries across the two Kebeles |
|---------|------------------------------------------------------------------|
| Kebele  | Frequency | Percent | Cum     |
| Hamusit | 24        | 48.98   | 48.98   |
| Lay sida| 25        | 51.02   | 100     |
| Total   | 49        | 100     |         |

| Table 2 | Beneficiaries of the hydroponic green feed production across their age groups |
|---------|--------------------------------------------------------------------------------|
| Age     | Frequency | Percent | Cum     |
| 22–30   | 10        | 20.4    | 20.4    |
| 31–39   | 18        | 36.72   | 57.14   |
| 40–50   | 15        | 30.6    | 87.76   |
| 51–65   | 6         | 12.24   | 100     |
| Total   | 49        | 100     |         |

Table 3 segregates beneficiaries in the hydroponic green feed production in their sex across the two Kebeles. In Hamusit, almost half of the participants are female-headed households which are 11 in number, while male participants are accounted as 13. More than half of the participants in the Lay sida Kebele are Female-headed households which are 18 and the rest 7 participants in the Kebele are male headed.

In terms of Marital status of the beneficiaries of the project, out of the 29 Female participants 13 are Divorced, 9 Married, and 7 are widowed. In case of male participants, 1 is Divorced and the rest 19 are married. It can be taken from this fact that more than half of the beneficiaries are Female-headed households and out of them a significant proportion are either divorced or widowed heads. Table 4 shows these data.

As summarized in Table 5, the median family size is 4 as about 27% of the respondents replied it as their family size including the head. However, 70% of the beneficiaries of the program have a family size of 5 or below. The minimum family size is two and the maximum is nine.
About 78% of beneficiaries of the hydroponic green feed production consider both livestock rearing and crop production as their major livelihood; the rest include some petty trading, sole crop production, and sole livestock rearing at their reliable livelihood opportunities. Table 6 shows this result.

Livestock ownership is very important in the rural livelihood of Ethiopia at large and Waghimra zone in particular. Beneficiaries’ livestock endowments are asked before participating in the hydroponic green feed production. Table 7 presents the result and the median number of livestock (cattle, sheep, goat, and other animals) is 10 as 22% of the respondents replied as their stock size. However, about 76% of beneficiaries have a stock size of 11 or below.

Overall, farmers were asked if they were satisfied about the timing of the input distribution and how far they had to travel to collect. All of the beneficiaries were happy how the input distribution process was handled. Table 8 shows this result across the Kebeles; beneficiaries of both Kebeles are satisfied with the management.

Then, farmers were subjected to different ratings for the quality of inputs they received for the hydroponic green feed production process. 45% of beneficiaries rated the quality of the inputs as ‘Excellent’ and the rest of households (55%) rated it as ‘Good.’ It can be inferred from this fact that the project was able to deliver the right quality of inputs to the farmers and Table 9 shows the result.

It is necessary to assess the capacity building part of the project and farmers were asked some technical questions.
related to the hydroponic green feed production. One of these questions is if how much amount of green feed can be produced from 1 kg of barely grain and it was assessed if there is variation across the Kebeles. Accordingly, 16 out of 24 participants in Hamusit said it is 3 trays and the rest 8 said it is 4 trays. In Lay sida Kebele, out of the 25 beneficiaries. 16 said it is 4 trays and the rest 9 said it is 3 trays of green feed. Generally, it is minor difference observed may be related to individual inefficiencies but there was good understanding of the subject. Table 10 shows the result.

Beneficiaries were asked for how many shoats they fed from the hydroponic green feed they produced during the project’s life time. The median number of shoat they have fed was 8 which is almost 25% of the respondents replied. The other 23% of respondents also reported that they fed it to 7 shoats during the project’s life time. However, as linked to shoats ownership of beneficiaries, 80% of respondents fed the green feed to nine or less number of shoats. Table 11 shows the result.

When they were asked for how many trays of green feed they fed to the shoats, some variations have observed among individuals rather than location. However, the median number of trays they fed to their shoat animals is 3 about which 51% of respondents replied. 95% of beneficiaries of the project fed the green feed for 3 or below number of shoats. Table 12 shows the result.

Regarding number of cattle that beneficiaries fed from the hydroponic green feed introduced by the project, almost half of the beneficiaries did not use it for cattle since they have little or no cattle to feed to. However, the rest half of the beneficiaries fed the feed to one or two cattle and two respondents reported that they have fed it to three cattle. Table 13 shows the result.

Regarding the number of trays of green feed beneficiaries allocated to cattle, 57% said that they have given 1 tray to their cattle. The rest (43%) of households reported ‘nothing’ for number of trays which were fed to cattle. Table 14 shows the result.

As Table 15 puts it, when farmers were asked if they have fed the green feed to other animals other than cattle and shoat which include equines and poultry, 84% reported ‘nothing’ at all. However, the rest (16%) of households

| Kebele      | With 1 kg of barley seed how much trays produced? | Total |
|-------------|-----------------------------------------------|-------|
| Hamusit     | 16 8 24                                       |       |
| Lay sida    | 9 16 25                                       |       |
| Total       | 25 24 49                                      |       |

| Shoats fed | Frequency | Percent | Cum |
|------------|-----------|---------|-----|
| 0–5        | 5         | 10.2    | 28.56 |
| 6–10       | 40        | 81.63   | 91.84 |
| 11–22      | 4         | 8.16    | 100  |
| Total      | 49        | 100     |      |

| Cattle fed | Frequency | Percent | Cum |
|------------|-----------|---------|-----|
| 0          | 22        | 44.9    | 44.9 |
| 1          | 11        | 22.45   | 67.35 |
| 2          | 14        | 28.57   | 95.92 |
| 3          | 2         | 4.08    | 100  |
| Total      | 49        | 100     |      |

| Other animals fed | Frequency | Percent | Cum |
|-------------------|-----------|---------|-----|
| 0                 | 41        | 83.67   | 83.67 |
| 1                 | 2         | 4.08    | 87.76 |
| 2                 | 4         | 8.16    | 95.92 |
| 4                 | 1         | 2.04    | 97.96 |
| 5                 | 1         | 2.04    | 100  |
| Total             | 49        | 100     |      |
reported that they have fed the green feed to one or more animals other than cattle and shoats.

When it comes to the number of trays respondents fed to other animals outside of cattle and shoat, 88% respondents reported nothing or less than 1 tray of the green feed. However, the rest of households reported one or more of the trays of green feed they have given to other animals specified earlier. And Table 16 shows the result.

According to Table 17, beneficiaries rated the body performance of their livestock before feeding and sequentially after feeding for the result to follow in Table 18. Only 2% of the respondents rated their livestock’s body condition as good before feeding and the rest 98% rated as weak or very weak. After feeding the hydroponic green feed produced, all of the beneficiaries rated the physical performance of their livestock body condition either it is high or very high during the project period.

In terms of the mortality or the morbidity of new born kids as rated by the beneficiaries before feeding, in Hamusit, 23 out of the 24 beneficiaries rated it high and 1 respondent rated it very high. It shows how feeding is very important in the survival of livestock kids so that to add value in the production and productivity of the stock. All of respondents in Lay sida Kebele rated the mortality rate as high before feeding. The result is listed below in Table 19, across the two Kebeles. The similarity of rating of the Kebeles shows how the background status of the two Kebeles was somehow similar.

Similarly, beneficiaries were made to rate the mortality/morbidity rate of their livestock after benefiting from the project and the rating rests in the low, very low level of the rating. In Hamusit Kebele, 16 out of 24 beneficiaries rated it very low and the rest low level of mortality/morbidity in their livestock. All of Lay sida Kebele beneficiaries rated Low level after feeding green feed. Table 20 shows the result.

As stipulated in to the project document, beneficiaries were exposed to different rounds of production of the green feed. Half of the beneficiaries in Hamusit Kebele produced 12–13 rounds of the green feed production for 1 round to take only 8 days. The rest half (12) produced greater than 13 rounds of the production. In the Lay sida Keble, all 25 beneficiaries managed to produce more than 13 rounds of production. And this frequency data are presented in Table 21.
Apart from rounds of production, it was possible to produce a number of trays of green feed per round and hence production results as taken from the respondents are presented below in Table 22. About half beneficiaries (11) in the Hamusit Kebeles managed to produce 8–12 trays of green feed per round of production and all in Lay sida Kebele managed to produce this much number of trays on the same period. The rest of the beneficiaries in Hamusit produce 13–15 trays about nine beneficiaries, 16–18 trays of green feed about three beneficiaries, and 19–24 trays about one beneficiary in a single round of production.

Beneficiaries managed to produce from 1 to 2.9 kg of hydroponic greed feed from 1 tray of production in a single activity. In Hamusit Keble, 88% of respondents produced 1.5–2.5 kg of green feed from a single tray. Half of the rest of respondents replied that they have produced 1–1.5 kg of green feed and the other half managed to produce from 2.6 to 2.9 kg of green feed per tray. In Lay sida Kebele, all in all beneficiaries produced from 1 kg up to 1.5 kg of green feed per tray. The result is presented in Table 23.

Beneficiaries were asked for how many trays of green feed they fed to their livestock/day, Table 24. Beneficiaries all in all in Lay sida Kebele fed from 3 to 4 trays/day regardless of their livestock ownership. Having a variation in Hamusit Kebele most of the beneficiaries (16 out of the 24 beneficiaries) fed 5–6 trays of green feed to their livestock/day. Seven out of the 24 beneficiaries of the Kebele fed from 7 to 8 trays of green feed/day to their livestock and 1 respondent replied that he/she has fed 3–4 trays of green feed/day to his/her livestock.

### Inferential Statistics

Statistical analysis was made to identify the impact of the project in terms of cattle milk production, goat milk production, daily income from cattle products, and daily income from goat products. Sheep is not considered in this kind of analysis because it is not customary among beneficiaries to milk sheep. Beneficiaries were happy regarding the intervention of the project; that is the introduction of hydroponic feed production to their livelihood. However, this analysis takes a hypothesis that the project does not have any impact to the livelihood of the beneficiaries and test that hypothesis with a 95% degrees of confidence whether it is true or not. The data were taken from beneficiaries on retrospective basis, for example, how much money did you get per day from cattle milk production before participating in this project and how much money are you getting now after participation. Generally, the project has brought statistically significant impact on all four of the outcome variables considered here. And the results are presented below.

Table 25 shows the result from the two-sample t test analysis which was made to analyze the projects’ impact on the beneficiaries’ cattle milk production. Before the project beneficiaries had a mean daily cattle milk production of 0.06 l. After the projects’ intervention on the hydroponic feed production, they recorded a mean 0.26 l of cattle milk/day. The difference is evident which is about 0.2 l/day. This difference in cattle milk production of beneficiaries is statistically significant at 1% level using the initial hypothesis that the project has brought improvement in the mean milk production.

The analysis goes on understanding the projects’ impact on the goat milk production of beneficiaries. Before the projects’ involvement, beneficiaries had a mean 0.06 l milk production from their goats, and after the project, they managed to get 0.33 l/day. The difference is evident which is about 0.2 l/day. This difference in cattle milk production of beneficiaries is statistically significant at 1% level using the initial hypothesis that the project has brought improvement in the mean milk production.

The analysis goes on understanding the projects’ impact on the goat milk production of beneficiaries. Before the projects’ involvement, beneficiaries had a mean 0.06 l milk production from their goats, and after the project, they managed to get 0.33 l/day. The difference is evident which is about 0.2 l/day. This difference in cattle milk production of beneficiaries is statistically significant at 1% level using the initial hypothesis that the project has brought improvement in the mean milk production.

### Table 22 Number of trays of hydroponic green feed produced per round across the Kebeles

| Kebele   | Number of trays produced per round | Total |
|----------|------------------------------------|-------|
|          | 13–15 | 16–18 | 19–24 | 8–12 |
| Hamusit  | 9     | 3     | 1     | 11   | 24   |
| Lay sida | 0     | 0     | 0     | 25   | 25   |
| Total    | 9     | 3     | 1     | 36   | 49   |

### Table 23 Amount of Hydroponic green feed produced per tray in kilogram

| Kebele   | Amount of green feed produced per Tray (in kg) | Total |
|----------|-----------------------------------------------|-------|
|          | 1–1.5 | 1.5–2.5 | 2.6–2.9 |
| Hamusit  | 1     | 15      | 1       | 17    |
|          | 2      | 88.24   | 5.88    | 100   |
| Lay sida | 20     | 0       | 0       | 25    |
|          | 100.00 | 0.00    | 0       | 100   |
| Total    | 26     | 15      | 1       | 42    |

### Table 24 Number of trays beneficiaries feed their animals from the feed production per day

| Kebele   | Trays of green feed animals fed per day |
|----------|-----------------------------------------|
|          | 3–4 | 5–6 | 7–8 |
| Hamusit  | 1   | 16  | 7   | 24  |
| Lay sida | 25  | 0   | 0   | 25  |
| Total    | 26  | 16  | 7   | 49  |
The study also tries to figure out the project’s impact on the beneficiaries daily income gain. Livestock products are essential for day-to-day expenses of farm households, and if the project really has impact on its production and productivity, it should manifest itself on the daily income of those households. As Table 27 shows, the mean daily income of beneficiaries of the project is before and after the introduction of the project. The mean daily income of beneficiaries from cattle production before the project was 0.5 Birr/day but after the project it became 3.4 Birr/day. The difference in income before and after feeding is 2.8 Birr/day which is statistically significant at 1% significance level in both one- and two-way hypothesis of daily income improvement from the project.

Goat milk production is common in most locations of Waghimra zone but especially common in the lowlands of the area. In Table 26, it has shown that the hydroponic feed production and feeding have brought statistically significant improvement in the beneficiaries’ goat milk production. Table 28 presents the result for the hypothesis that the project does have impact on the daily income of beneficiaries from goat milk production. Before the introduction of the

| Table 25 | Two-sample t test with equal variances for cattle milk production |
|----------|---------------------------------------------------------------|
| Variable                  | Observations | Mean     | Standard error | Standard deviation | [95% Confidence interval] |
| Cattle milk before       | 49           | 0.059184 | 0.030011       | 0.210078           | −0.00116 0.119525       |
| Cattle milk after        | 49           | 0.255102 | 0.069195       | 0.484364           | 0.115976 0.394228       |
| Combined                 | 98           | 0.157143 | 0.038813       | 0.384225           | 0.080111 0.234175       |
| Difference               | −0.19592     | 0.075423 |                |                    | −0.34563 −0.04621       |

Diff = mean(Cattle milk before) − mean(Cattle milk after) t = −2.5976

Ho: diff = 0 degrees of freedom = 96
Ha: diff < 0 Ha: diff ≠ 0 Ha: diff > 0
Pr(T < t) = 0.0054 Pr(|T| > |t|) = 0.0109 Pr(T > t) = 0.9946

| Table 26 | Two-sample t test with equal variances for Goat milk production |
|----------|---------------------------------------------------------------|
| Variable                  | Observations | Mean     | Standard error | Standard deviation | [95% Confidence interval] |
| Goat milk before           | 49           | 0.059184 | 0.029439       | 0.206073           | −7.34E−6 0.118375       |
| Goat milk after            | 49           | 0.334694 | 0.063924       | 0.44747            | 0.206165 0.463222       |
| Combined                   | 98           | 0.196939 | 0.037698       | 0.373188           | 0.122119 0.271758       |
| Difference                 | −0.27551     | 0.070377 |                |                    | −0.41521 −0.13581       |

Difference = mean(Goat milk before) − mean(Goat milk after) t = −3.9148

Ho: diff = 0 degrees of freedom = 96
Ha: diff < 0 Ha: diff ≠ 0 Ha: diff > 0
Pr(T < t) = 0.0001 Pr(|T| > |t|) = 0.0002 Pr(T > t) = 0.9999

| Table 27 | Two-sample t test with equal variances for daily income from cattle |
|----------|---------------------------------------------------------------|
| Variable                  | Observations | Mean     | Standard error | Standard deviation | [95% Confidence interval] |
| Cattle daily income before | 49           | 0.510204 | 0.364359       | 2.55051            | −0.22239 1.242796       |
| Cattle daily income after  | 49           | 3.357143 | 0.784089       | 5.488625           | 1.780626 4.93366        |
| Combined                   | 98           | 1.933673 | 0.453708       | 4.49148            | 1.033189 2.834158       |
| Difference                 | −2.84694     | 0.864612 |                |                    | −4.56318 −1.1307        |

Difference = mean(Cattle daily income before) − mean(Cattle daily income after) t = −3.2927

Ho: diff = 0 degrees of freedom = 96
Ha: diff < 0 Ha: diff ≠ 0 Ha: diff > 0
Pr(T < t) = 0.0007 Pr(|T| > |t|) = 0.0014 Pr(T > t) = 0.9993
In those two target areas, no one was getting any income from goat milk production. However, after feeding the hydroponic feed, the mean daily income from goat milk production is 3.3 Birr/day and which is also the income difference between before and after feeding. This difference is statistically significant at 1% level meaning this result is not random in that it does not come by accident. The project really has brought practical impact on improvement of daily income from goat milk production on the beneficiary households keeping other factors constant.

Table 28  Two-sample $t$ test with equal variances for daily income from Goats

| Variable                  | Observations | Mean    | Standard error | Standard deviation | [95% Confidence interval] |
|---------------------------|--------------|---------|----------------|-------------------|---------------------------|
| Goat daily income before  | 49           | 0.00    | 0.00           | 0.00              | 0.00                      |
| Goat daily income after   | 49           | 3.27    | 0.55           | 3.82              | 2.18                      |
| Combined                  | 98           | 1.64    | 0.32           | 3.15              | 1.01                      |
| Difference                | -3.27        | 0.55    |                | -4.36             | -2.19                     |

Difference = mean(Goat daily income before) − mean(Goat daily income after) \( t = -6.0018 \)

H$_0$: diff = 0 degrees of freedom = 96
H$_a$: diff < 0 Ha: diff $! = 0$ Ha: diff > 0
Pr($T < t$) = 0.0000 Pr($|T| > |t|$) = 0.0000 Pr($T > t$) = 1.0000

Conclusions and Recommendations

Conclusion

The title of the project was piloting hydroponic green fodder production for the enhancement of milk production of small-scale farmers in Sekota Woreda, Waghimra zone of Amhara regional state, Ethiopia. Two Kebeles are selected for this purpose; namely Hamusit and Lay sida, located 30 km and 20 km from Sekota town, the Zonal capital.

It was discovered from this impact assessment study on the project that the project was planned, implemented, and handled very well. In terms of its objectives, the project observed to be well liked by its beneficiaries and impacted their lives accordingly. In terms of planning, all beneficiaries are satisfied about the timing of the input deliveries; it means it does not coincide with other agricultural practices like farming, sowing, weeding, and the like. Regarding inclusion of beneficiaries, the project included majorly female-headed households from the start most of which are either Widowed or Divorced. The other category of beneficiaries is households with limited number of household assets, and besides, it was necessary that the community participates in the selection process of beneficiaries since most of the beneficiaries mentioned the community as a selection entity for the project. In terms of implementation, beneficiaries received the inputs at a central location in the respective Kebeles and in that all are happy with it. Little variations have observed across the two target Kebeles in terms of input delivery and performance, otherwise they are similar.

In terms of capacity building for beneficiaries, little variations are observed across farmers in that how many rounds they produced, how many trays of green feed produced, and how much kilogram of green feed can be produced per tray and per day. More than 10 rounds of productions are undertaken by the beneficiaries and it made them aware of the amount and type of inputs needed for the production and the amount of green feed which can be produced. When beneficiaries were asked if the project is easily scalable or not, all of them agree that it is very easy to implement and it is scalable. According to beneficiaries, neighboring farmers are also happy about the technology for which it can be popularized easily with some initial capital. However, it was observed that the milk produced by the household is not being preferred from one household member to the other; that almost all of the respondents did not show any preferences across the family members.

In terms of the impact of the project, the assessment was made in physical impact and on household income. Apart from statistical tests, beneficiaries were made to rate the physical performance of their livestock and the mortality/morbidity rate of their animals before and after feeding. The two Kebeles are located in different direction from Sekota town. Hamusit Kebele is located to the North of the town and Lay sida Kebele is located to the West of Sekota town. Regardless of the Kebeles interviewed and their geographic disparity, beneficiaries are agreed that the body condition and physical performance of their livestock were weak and very weak before feeding. However, they rated the physical performance of their livestock after feeding high or very high. In terms of the mortality and morbidity rate or their animals, they rated it to be high and very high before feeding and dropped to be low and very low after feeding. It can be taken from this fact that farmers are satisfied with the project intervention in the green feed production and that it
impacted their livestock production significantly across the two target Kebeles.

The statistical tests also confirmed farmers’ impression about the impact of the project in their livestock production and income. In terms of the physical milk production using the retrospective analysis combining the two Kebeles, beneficiaries of the project managed to get a significantly higher milk production either from their cattle or goats. It can be inferred from this fact that we are statistically confident that the project has brought a real and tangible impact on beneficiaries’ household milk production making other variations across households constant. In tandem with the significant physical milk production, beneficiaries also got a higher income from the sale of the milk than before participating in to the project. It is customary in the area to milk goats but there was no any beneficiary in the project who was getting any income from the sale of goat milk. Afterward, we are confident that farmers are getting some income from the sale of the goat milk. In terms of cattle milk, the project has brought significant income difference across the beneficiaries due to its intervention.

In monetary terms, on average, the mean daily income of households from their household milk production before the project was only 50 cents or 0.5 Birr. However, after the project, this amount of mean daily milk income rose to 6.7 Birr which is significant for any household within the project.

**Recommendations**

The principal objective of the project was to improve fodder production and livestock productivity through the piloting of hydroponic green fodder production in the project area. The project was pilot and it planned to include only 50 farm households from two Kebeles. It is necessary in making a project mandate as manageable as possible. Considering that, the target households of the project are small and the project was handled by the project staff appropriately well so that to make everyone at stake satisfied.

In locations where there is limited amount of resource base, it is paramount for projects to support these communities but more paramount if the target group is the less privileged ones among these communities (like old, divorced, widowed, and drought affected farmers). Hence, other project implementations should consider the less privileged communities as this project gave lessons for noticeable impact on the daily livelihoods of these communities.

It was discovered in this assessment that the implementation process of the project is simple and easy for anyone to handle within the farming community. Without any segregation of farm households, it can be scaled up easily and

without much effort. Hence, it should be due considered by the project and its partners for scaling up of the project. In terms of capacity building for beneficiaries, frequent production activities can be considered as hands-on training in this project that everyone has equal knowledge about the subject. Hence, it should be considered in future activities that rather than a onetime intervention of oral training it is helpful to undertake such kind of hands-on practical project implementations.

The study confirmed that beneficiary households are producing higher milk due to the green feed production project and hence are getting a higher and significant daily income out of it. Hence, considering the simplicity of the project and the visible and significant household livelihood impact, it should be scaled up either by the project itself or its partners. Animal feed is essential not for the animal but for those who are entitled for the animal. Since the area is characterized by very small and degraded land holding, unpredictable rainfall, and large number of animal stock and as this project showed potential in improving the production and productivity of the animal stock, it should be considered seriously in scaling up of the project outcome in the location. In addition, there should be ways in availing the solution nearby to farmers to buy it by themselves and enhance their production. It should further be noted that the project or implementing agencies consider other seed grains other than barely for the green feed production which have a lower intrinsic value for them.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

**References**

Central Statistics Authority of Ethiopia (CSA) (2018) Report on area and production of major crops, private peasant holdings, Meher season. CSA, Addis Ababa

**Publisher’s Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.