

Ex Ante Economic and Nutrition Analysis of Alternative Small Scale Irrigation Systems in Dangeshta Kebele-Amhara Region of Ethiopia

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Introduction

Dangeshta kebele is located in Dangila woreda, Awi (Agew) zone in Amhara region. The general climate in Dangila is moist sub-tropical (*Weina-Dega*) characterized by moderate temperature and sufficient *kiremt* rainfall (Assefa, 2015). Average annual rainfall is about 1600 mm, but varies between 1180-2000 mm. Dangila woreda is located about 80 kilometers south west of Bahir Dar and has 27 rural kebeles among which 16 have access to perennial rivers (figure 1). Crop and livestock mixed subsistence farming is the basic source of livelihood for the people living both in Dangeshta kebele and Dangila woreda (Belay and Bewket, 2013). Some of the leading food crops in cultivated area and production output are finger millet (*Eleusine coracana*), maize (*Zea mays*) and *teff* (*Eragrostis tef*). Potato (*Solanum tuberosum*), oil seeds and pulses are as well among the crops grown in the woreda. Vegetables and fruits are important food crops cultivated using traditional irrigation around the family farm in Dangila. Presence of groundwater shows a potential for manual drilling of water and its use for domestic needs and small scale irrigation in a woreda where about 2281 hand-dug wells are recorded (Assefa, 2015).

Even though there has been an increase in fertilizer use in Ethiopia over the last few years, in general the level of agricultural and livestock input (seed, fertilizers, animal breed improvement) is relatively low for a typical rural poor farm in a developing country (Teshome et al. 2009; Endale, 2011). Besides the low level of animal improvement (crossbred animals are fewer), the use of agricultural inputs such as fertilizers, irrigation and improved seeds in Dangila, are lower compared to the government-recommended rates.

A farm level analysis model (FARMSIM) is used to simulate and identify the impact of new agricultural farming technologies on farm profit and nutrition for a typical farming household in Dangeshta kebele. FARMSIM is a Monte Carlo simulation model for quantitatively analyzing the economic and nutritional impacts of alternative farming technologies on small farms in developing countries. The model simulates the current crop and livestock farming system and an alternative farming system simultaneously. Risk for crop yields, livestock production (birth rates, death rates, weight gain, and milk production), and market prices is explicitly included in the model so the results can be presented in terms of probabilities. Stochastic annual crop yields are simulated from multivariate empirical probability distributions estimated using 32 years of crop yields generated by the APEX model (Agricultural Policy / Environmental eXtender) using the most recent 32 years of local weather data, soil conditions, and an internationally validated crop growth modeling algorithm.

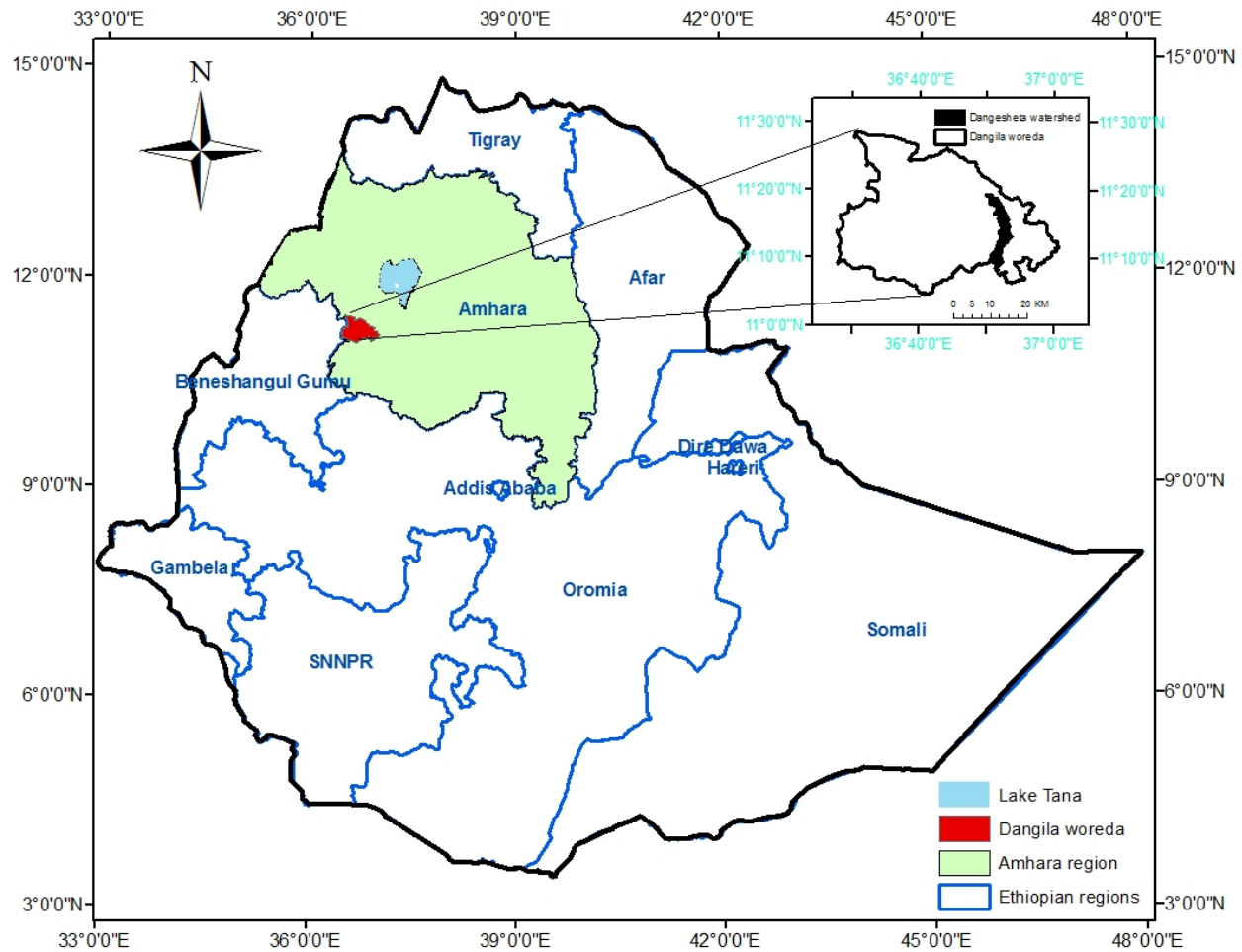


Figure 1. Location of Dangeshta watershed in Dangila woreda, Amhara region

Data

The model input information on crop and livestock was acquired from two surveys conducted by ILSSI-IFPRI and the ILRI-LIVES¹ projects respectively in 2015 and 2014. The survey shows that the major crops grown, by area, in Dangeshta are maize (874 Ha) and teff (456 Ha) on an estimated total cropland of 1766 Ha (rain-fed and irrigated). Irrigated onion was chosen for the irrigation study over tomato as the vegetable crop to study given its limited perishability. The pastureland occupies about 661 Ha. The main types of livestock are cattle, sheep and goats which generally graze freely in the pastureland or are fed with cut and carry grass. Sheep, cattle, chickens, and goats are sold at the market to generate revenue as well as livestock products such as butter, eggs, hides, and skins.

¹ We would like to thank both the IFPRI and ILRI-LIVES for providing the survey data we used to establish the farm baseline conditions in Dangeshta kebele. Our gratitude goes particularly to Drs. Dawit Mekonnen (IFPRI) and Berhanu Gebremedhin (ILRI-LIVES) for facilitating the data transfer and other related help.

Irrigation information from the surveys indicate that about 80% of farmers irrigate at least one plot in their farms with around 93% of them reporting to use groundwater from hand-dug well for irrigation (7% used river). Fertilizer use rates of DAP are about equal or higher compared to the recommended rates while the urea levels are low. Chemical use (herbicide and pesticide) is very low or non-existent in most of the surveyed farms in Dangeshta kebele. Also, the level of farm labor hiring for agricultural production is low since family members are expected to perform most of the agricultural tasks required for farming. It's worth noting that, the use of actual crops to feed animals is not common and most of the animal feed come from crop residues.

Scenarios description

Baseline scenario: current fertilizer + current tillage + no irrigation

In the baseline scenario, the major crops grown in the wet season are maize and teff in the food crops category while onion is considered in the vegetable category. With minimal agricultural inputs (fertilizer, irrigation, improved seeds), the crop yields are expected to be low. Water and nutrients are not limiting factors because teff and maize are grown during the main rainy season and receive optimum amounts of fertilizers close to the recommended rates, especially in the case of maize.

Alternative scenarios: recommended fertilizer + current tillage + irrigation

The type of tillage and fertilizer application do not change for the grain crops except the increase in fertilizer application rates for teff. Increases in yields are expected therefore for teff but also for onions since it is irrigated in the dry season (optimum fertilizers are applied to onions). The yield differences between the baseline and the alternative scenario for onions are due to irrigation and fertilizer. Five different water lifting technologies are evaluated in this study: pulley/bucket; rope and washer pump operated by hand, animal, motor, and solar (see pictures in Appendix A). Each tool is evaluated as to its capacity to provide the required water quantities needed to irrigate a maximum onion cropland of 856 ha in Dangeshta kebele.

Before analyzing the economic and nutritional impacts of farming technologies, a Soil and Water Assessment Tool (SWAT) model was used to assess soil and hydrological characteristics at the watershed level. SWAT helped assess the availability of irrigation water in the watershed as well the total potential irrigable land.

The combination of fertilizer level and five water lifting technologies for irrigated onions make a total of five alternative scenarios to compare with the current conditions or baseline scenario.

-Alt. scenarios 1-5: irrigated onions + recommended fertilizers + current tillage

The same major crops (teff and maize) are grown during the rainy season in addition to farming irrigated onions during the dry season. The five alternative irrigations systems, described above, are tested for this scenario.

Assessment of water lifting technologies

To evaluate the benefits and costs for alternative irrigation technologies (pulley vs. rope and washer operated by hand, animal power, motor and solar power) this analysis explicitly

considers the costs of the different technologies and the amount of land that can be irrigated without water stress to the crops. The assessment is based on costs (operating and capital) and capacity of the water lifting technology (pumping rate) to irrigate available land for a crop, given the crop's water needs. The following assumptions are needed for the analysis:

- 1) Number of active family members (adults) who will carry out the irrigation: 2
- 2) Number of irrigation hours per family member per irrigation day: 4
- 3) Number of days per season the farmers are irrigating if we assume 2 days per week of irrigation during a period of three and half months (January-mid April): 28
- 4) Total number of hours of irrigation per season: $2 \times 4 \times 28 = 224$ hours
- 5) Pumping rates (liter/min) for the different water lifting technologies:
 - Pulley/bucket: 8 liters/min
 - Rope operated by hand²: 20 liters/min
 - Rope operated by animal power³: 60 liters/min
 - Rope operated by motor power from gasoline⁴: 170 liters/min
 - Rope operated by motor power from solar⁵: 24 liters/min

SWAT model simulation results determined that enough groundwater was available to pump for irrigation (Bizimana et al., 2014). Crop yields are simulated by APEX for different levels of water stress. The irrigator's equation (see Martin, 2011) is used to estimate the total amount of water that can be delivered by a water lifting technology.

Irrigator's equation: $Q \times T = d \times A$

Q: flow or pumping rate (liters/min)

T: time (min) for irrigation

d: depth of irrigation water applied (mm)

A: area covered (m² or ha)

Knowing the total amount of water (mm) required to irrigate a crop for the entire dry season and the total amount of water delivered by each water lifting technology per hectare (based on pumping rate and irrigation hours), we compute the fraction of water supply provided by each technology. Given the total irrigable land available for a crop (e.g. onion) and its water requirements, we use the fraction of water supply by each technology to compute the fraction of available cropland that can be irrigated with minimal water stress for each water lifting technology.

For instance, due to its high pumping rate, the rope and washer pump operated by a gasoline motor would in most cases supply more than enough water to irrigate all available cropland. On the other hand, a rope and washer pump operated by hand, solar motor or the pulley system,

² Nederstigt and Van del Wal (2011)/PRATICA Foundation

³ <http://www.ropepumps.org/horse.html/> PRACTICA Foundation

⁴ IWMI field studies conducted in 2015 on behalf of ILSSI project

⁵ Mzuzu University in Malawi: http://old.solar-aid.org/project_water_pump/

assuming the same number of irrigation hours, do not provide sufficient water to irrigate all of the available cropland. Taking into account the initial investment and operating costs for motor and solar systems in the economic analysis, the use of a rope and washer pump operated by animal power could be the preferred options for an average farmer to be able to supply enough water to crops during the dry season and make the investment in irrigation worthwhile.

Simulation results and scenario analysis

A typical farm in Dangeshta kebele is simulated for 5 years to evaluate the adoption of new agricultural technologies (fertilizer and irrigation). Five water lifting technologies (pulley, rope pump operated by hand, animal, gasoline motor and solar motor) and the application of recommended fertilizers rates are evaluated to determine the most profitable and affordable technology for the farmer. The results presented below in the stoplight chart and CDF graphs (except for NPV) are developed from a 5-year simulation period (planning horizon). The six scenarios (baseline plus 5 alternatives) are defined below:

- ✓ Baseline: current fertilizer + current tillage + no irrigation
- ✓ Alt.1 (Pulley): irrigate onions with pulley + recommended fertilizers + current tillage
- ✓ Alt.2 (Rope Hand): irrigate onions with rope pump operated by hand + recommended fertilizers + current tillage
- ✓ Alt.3 (Rope Animal): irrigate onions with rope pump operated by animal + recommended fertilizers + current tillage
- ✓ Alt.4 (Rope Motor): irrigate onions with rope pump operated by gasoline motor + recommended fertilizers + current tillage
- ✓ Alt.5 (Rope Solar): irrigate onions with rope pump operated by solar motor + recommended fertilizers + current tillage

Note that, based on water needs to irrigate onions in the dry season, none of water lifting technologies is able to provide the required water quantity to onions (0% water stress level) for a total irrigable onion land of 856 ha. The pulley irrigation system covers only 2.7% of the total irrigable land to meet the needs, the rope pump operated by hand irrigation system covers about 7%, while the rope pump operated by animal power, gasoline and solar-powered motor can irrigate respectively 21%, 41.1% and 8% of the maximum irrigable onion land. Compared to onion water requirements in Robit kebele, the water requirement for onion is much higher in Dangeshta kebele, all other irrigation conditions (time, water lifting technology) remaining the same.

The farm level simulation results for the six scenarios showed differences not only between the baseline and the alternative scenarios but also among the alternative scenarios in terms of net cash farm income and ending cash reserves.

Other simulation assumptions

First, to show the full potential of adopting new technologies, we assumed that the alternative farming technologies (alternative scenarios) simulated for this study were adopted at 100%.

Second, the markets were assumed to be accessible and function at a competitive level with no distortion where the supply and demand determine the market prices. However, in the five-year economic forecast, market selling price in each of the five years was assumed to equal the average selling price of year 1 for each crop sold.

NPV (Net Present Value)

The net present value (NPV) results clearly indicate the importance of investing in irrigation and fertilizer application as shown by the cumulative distribution function or CDF (figure 2a). The use of recommended fertilizers on grain crops in combination with onion irrigation using the rope pump operated by animal power or a gasoline motor show outstanding performance (Alt. 3 and 4). Their CDF values lie completely to the right of the other scenarios for all 500 draws of the model. Regardless of producers' preference for income and risk alternative scenarios 3 and 4 are the most preferred. The second best options are scenarios two and five (Alt. 2 & 5) which consist of irrigating onions using the rope pump operated by hand and solar power. Alternative scenario one (Alt. 1) that used the pulley system to irrigate onions and the baseline scenario (no irrigation) had the lowest performance and are almost equal in NPV values (figure 2a).

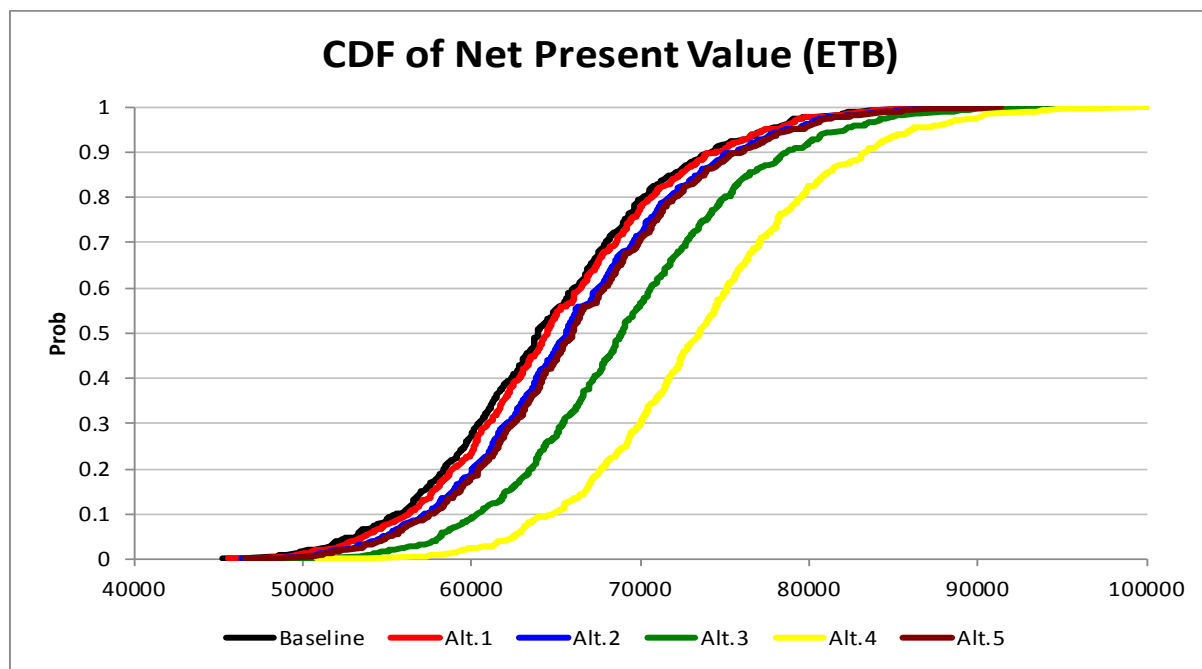


Figure 2a. Net present value for the six scenarios

Legend

Baseline: No irrigation + current tillage and fertilizer applications

Alt. 1: Use of pulley/RF

Alt. 2: Use of rope & washer pump operated by hand/RF

Alt. 3: Use of rope & washer pump operated by animal /RF

Alt. 4: Use of rope & washer pump operated by gasoline motor /RF

Alt. 5: Use of rope & washer pump operated by solar motor /RF

Note: RF=recommended fertilizer

The stoplight chart shows the year 3 probabilities of NPV being less than 64,000 ETB (Ethiopian Birr) (red), greater than 71,000 ETB (green) or being between the two target values (yellow) for the six scenarios. The target values are the averages of NPV for the baseline scenario (lower bound) and the best performing alternative scenario (Alt. 3 & 4) (upper bound). There is a 51% chance that NPV will be less than 64,000 ETB for a farmer who does not adopt the technology package (baseline scenario) and 17% chance that the NPV will exceed 71,000 ETB (figure 2b). A similar but slightly better outcome is expected for a farmer who uses a pulley to grow onions (Alt.1). As for farmers who use recommended fertilizer for the grain crops and grow irrigated onions in the dry season using a rope pump operated by animal power and gasoline motor, the probability that NPV will exceed 71,000 ETB are 39% and 64% respectively (Alt. 3 & 4). The main barrier for the best performing scenario (Alt. 4) is the initial investment in water lifting technology (motor-powered pump) which is two times higher for farmers using rope pump operated by solar and gasoline power than those using animal power. However, the NPV results strongly suggest that the investment in gasoline motor and animal power will pay large dividends by increasing income and wealth.

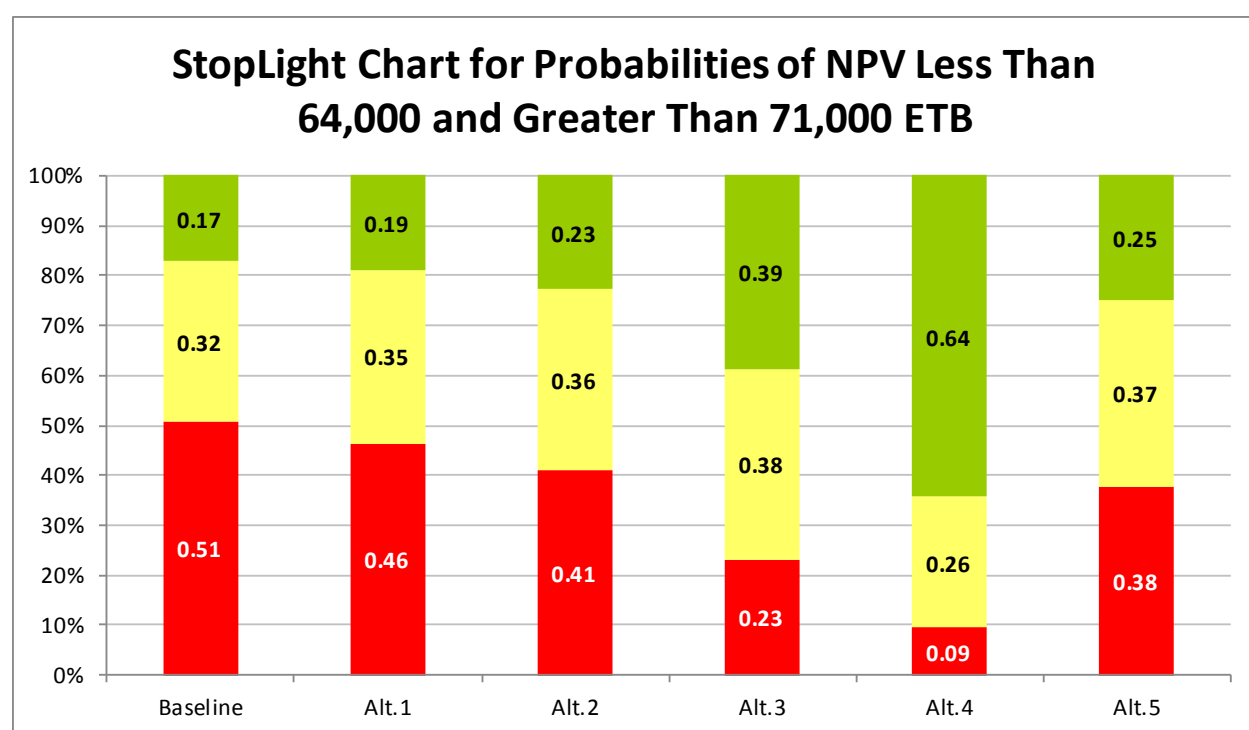


Figure 2b. Stoplight chart of the NPV for the six scenarios

NCFI (Net cash farm income)

The annual net cash farm income (NCFI) simulation results represent in figure 3a the profit of a farm production evaluated under a baseline and five alternative scenarios in year 3. The CDF graph for the NCFI shows a higher income for the alternative scenarios three and four (Alt. 3 and 4) compared to the rest of the scenarios. It should be noted that the baseline scenario performed

slightly better than the alternative scenario one (Alt.1). Alternative 1 results suggest that investing in the pulley system to irrigate more onion land will cost more than growing non-irrigated onions. Alternatives scenarios 3 and 4 involving the use of rope and washer pump operated by animal power and gasoline motor generate higher levels of NCFI at all probability levels which makes them the preferred scenarios for decision makers. The rest of the scenarios (baseline, Alt. 1, Alt. 2 and 5) do not show a significant difference among them as their CDF graphs are close to each other and sometime cross. Note a few instances where there are very slim probabilities of having a zero or negative net cash income.

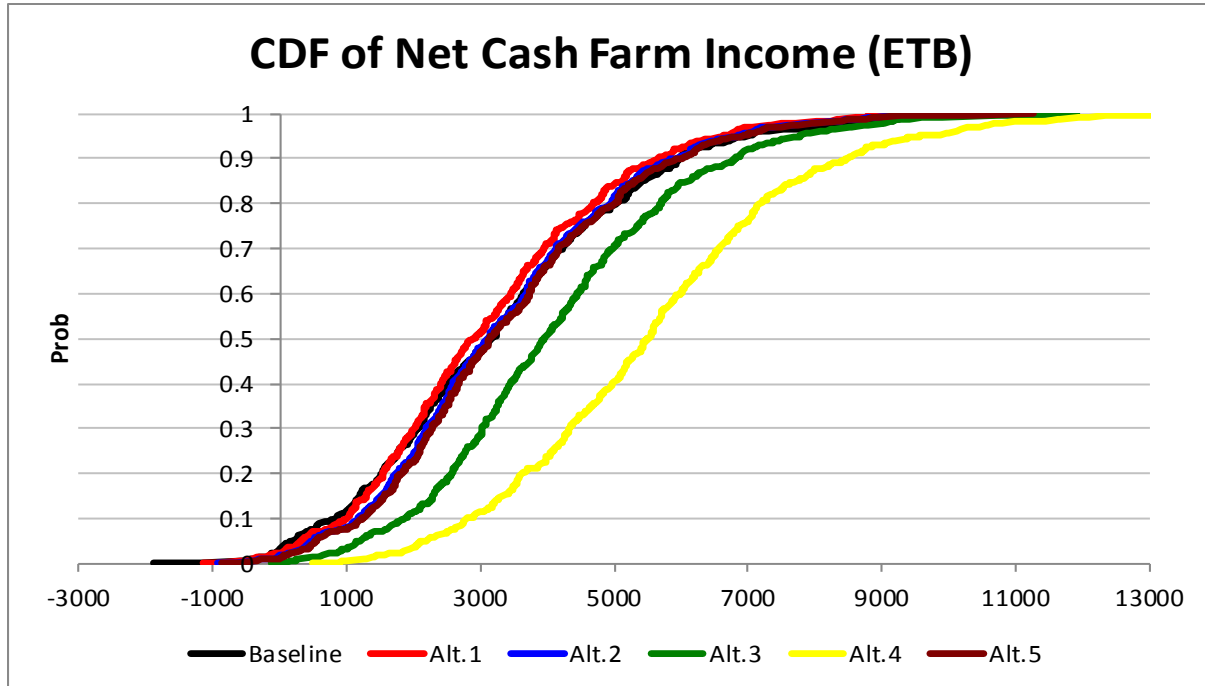


Figure 3a. Net cash farm income for the six scenarios

The spotlight chart for NCFI in year 3 of the planning horizon shows a 51% probability of NCFI being less than 3,200 ETB and a 20% chance that NCFI exceeds 5,000 ETB per year (figure 3b) for a farmer who does not adopt the technology package (Baseline scenario). However, there is a 59% chance that the annual NCFI will exceed 5,000 ETB for a farmer who uses a rope pump operated by a gasoline motor system to irrigate onions (Alt. 4). The farmer who adopts this technology package (Alt. 4) has about 14% probability of having a NCFI less than 3,200 ETB, which is superior to the other alternative scenarios and the baseline (their probabilities are between 34% and 55%). The second best alternative scenario is the one involving the use of a rope pump operated by animal power which generates a slightly higher NCFI than the rest of the scenarios. Note that the financial situation of a farmer who does adopt the pulley system to irrigate onions is less profitable than that of a farmer who does not irrigate due mainly to the costs involved in using the irrigation system. Also the simulation results show equal profitability for the baseline scenario (no irrigation) and alternative scenarios two and five (Alts. 2 & 5) that are associated with the use of a rope pump operated by hand and solar power.

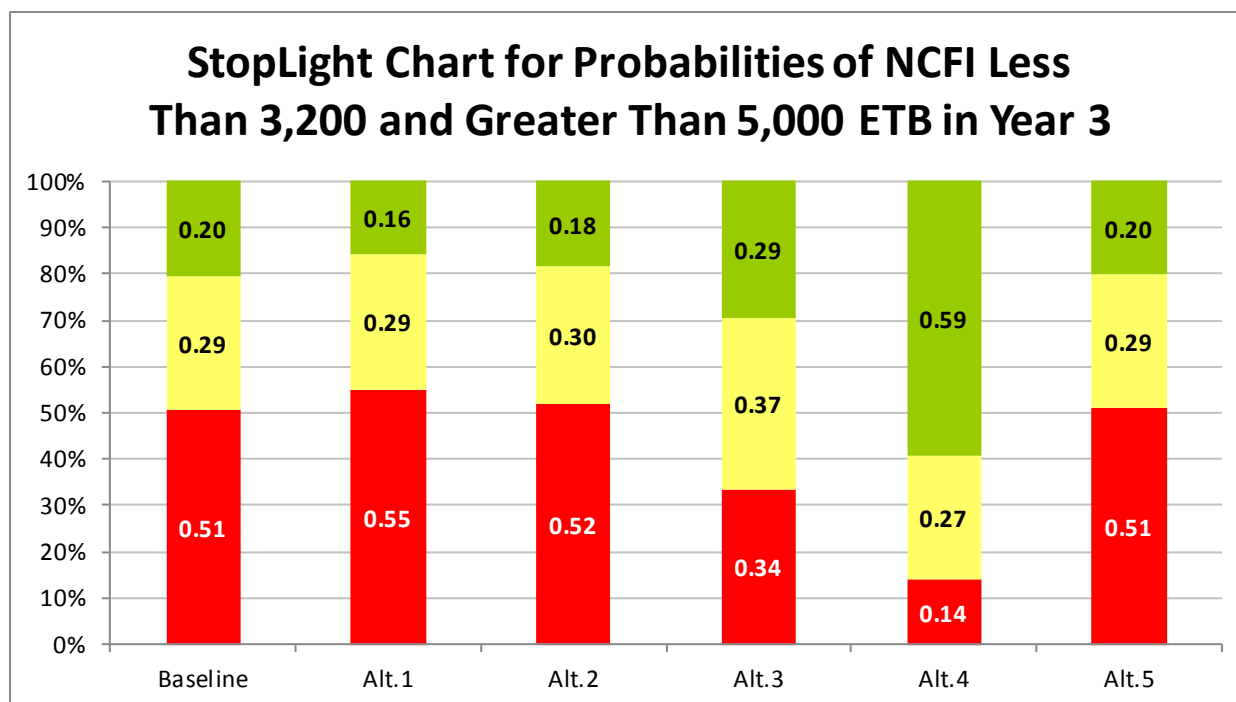


Figure 3b. Stoplight chart of the NCFI for the six scenarios

EC (Ending cash reserves)

The annual ending cash reserve shows the potential ending cash reserves a farmer can have in the fifth year of the five year planning horizon. The simulation results in figure 4a highlight once again the performance of the alternative scenarios 3 and 4 that involve the use of a rope pump operated by animal power and gasoline motor to irrigate onions. The CDF values for the alternative scenarios 3 and 4 lie entirely to the right of the other scenarios (baseline and alts. 1, 2 and 5). This is a strong suggestion that investing in these irrigation systems (rope pump operated by animal and motor) have the potential of increasing farmer's cash reserves. The alternative scenarios two and five (Alts. 2 and 5) in which rope pump operated by hand and solar power are used, have slightly higher ending cash reserves than the base scenario and alternative scenarios 1. Note that the baseline scenario with no irrigation performed as well as (or slightly better than) the alternative scenario 1 (Alt.1) which uses the pulley system to irrigate onions.

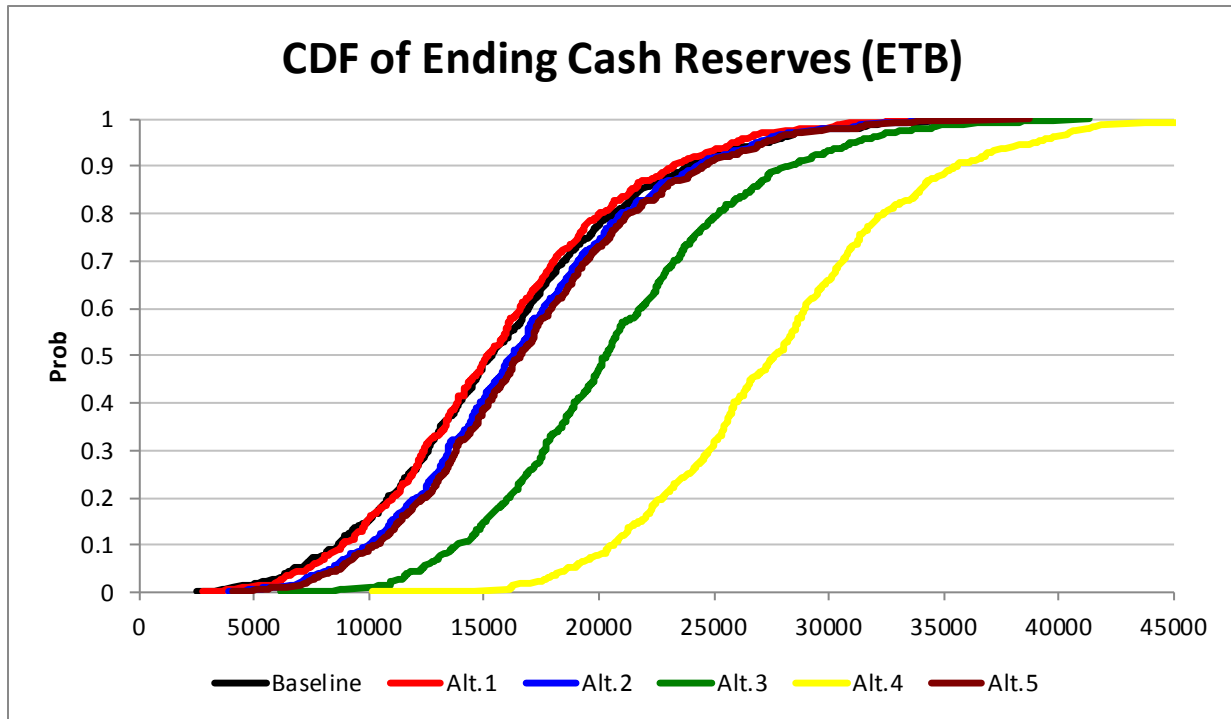


Figure 4a. Ending cash reserves for the six scenarios

The stoplight chart shows a 51% probability of having an ending cash reserve in year 5 of less than 15,500 ETB (baseline average) for a farmer who does not adopt the irrigation technology (baseline scenario) compared to 0% probability for a farmer who adopts an irrigation system using a rope pump operated by gasoline motor (figure 4b). Alternatively, there is a 75% probability of having ending cash reserves of more than 24,000 ETB for a farmer who adopts the rope pump operated by a gasoline motor to irrigate onions. Under the baseline there is 10% probability that the ending cash reserve would exceed 24,000 ETB in year 5, but in 39% of the cases the ending cash reserve will vary between 15,500 and 24,000 ETB. The alternative scenario one, in which a pulley system is used to irrigate onions (Alt. 1), showed lower performance than the baseline scenario with no irrigation (figure 4b) for mainly the reasons explained in previous sections. In general, the baseline scenario, alternative scenarios 1, 2 and 5 did not have significant differences in ending cash reserves in year 5 and generated less cash compared to alternative 3 and 4.

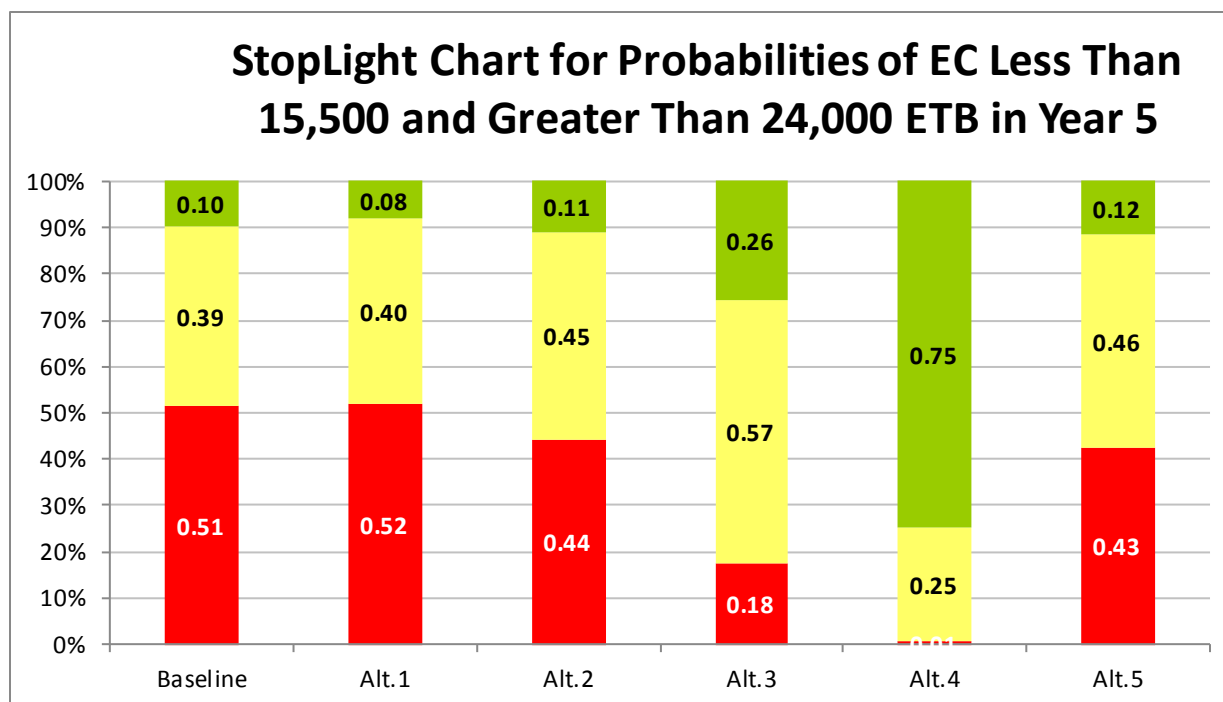


Figure 4b. Stoplight chart for the six scenarios

Since grain crops in Dangeshta are mainly used for family consumption, the increases in farm revenue in each of the alternative scenarios were due almost entirely to the sale of surplus onion. In alternative scenario 4, the forecasted sales of onions contribute, on average, 46% of the total crops receipts and 100% of the net cash (profit) for the five-year planning horizon. Maize contributed almost equally as onions at about 43% of crop receipts, but given its high costs of production, had a negative net cash contribution.

Scenario ranking

Decision makers rank risky alternatives based on their utility for income (or wealth) and risk. Many ranking procedures (e.g., mean, standard deviation, coefficient of variation, etc.) do not take into account utility but the best approaches use utility to rank scenarios. SIMETAR contains several functions to rank risky alternatives with some of them using a utility function such as stochastic dominance with respect to a function (SDRF), certainty equivalent (CE), stochastic efficiency with respect to a function (SERF) and risk premiums (RP). In the Dangeshta kebele study we use SERF to identify the preferred risky alternatives given its many advantages over the other ranking procedures.

SERF assumes a utility function with a risk aversion range of $U(r_1(z), r_2(z))$ and evaluates the CEs over a range of risk aversion coefficients (RAC) between an LRAC (lower RAC) and an URAC (upper RAC). The range can vary from LRAC = 0 (risk neutral) to URAC = 1 (risk averse), allowing to evaluate the effects of different risk aversion levels of the decision makers. In ranking the risky alternatives, the SERF approach chooses as the most preferred the scenario with the highest CE at the decision maker's assumed RAC.

In this study, all six scenarios (a baseline and five alternative scenarios) were ranked based on the year 3 simulation results of NCFI. Results in figure 5a show that alternative scenario 4 which involves the use of recommended fertilizer rates and irrigation by a rope and washer pump operated by a gasoline motor (Alt. 4) is the most preferred scenario, ranking higher than any other scenario on the entire range of RAC represented by different levels of risk aversion (risk neutral to extremely risk averse). The next most preferred scenario is the alternative scenario three (Alt. 3). This scenario involves the application of recommended fertilizer rates and use of a rope and washer pump operated by animal power such as a horse or ox (Alt. 3). The two alternative scenarios (Alts. 4 & 3) are distinctively ranking higher than the rest of other scenarios with a clear edge of Alt. 4 over Alt.3. The remaining alternative and baseline scenarios are very close in ranking but show the alternative scenario one (Alt. 1) that uses a pulley system, to be the lowest ranking among all scenarios followed by the baseline scenario (Alt. 1). Notice that as the risk aversion level increases, the CE amount slightly decreases as well emphasizing the behavior of a risk aversion decision maker who is willing to get less money or wealth in return of reduced risk.

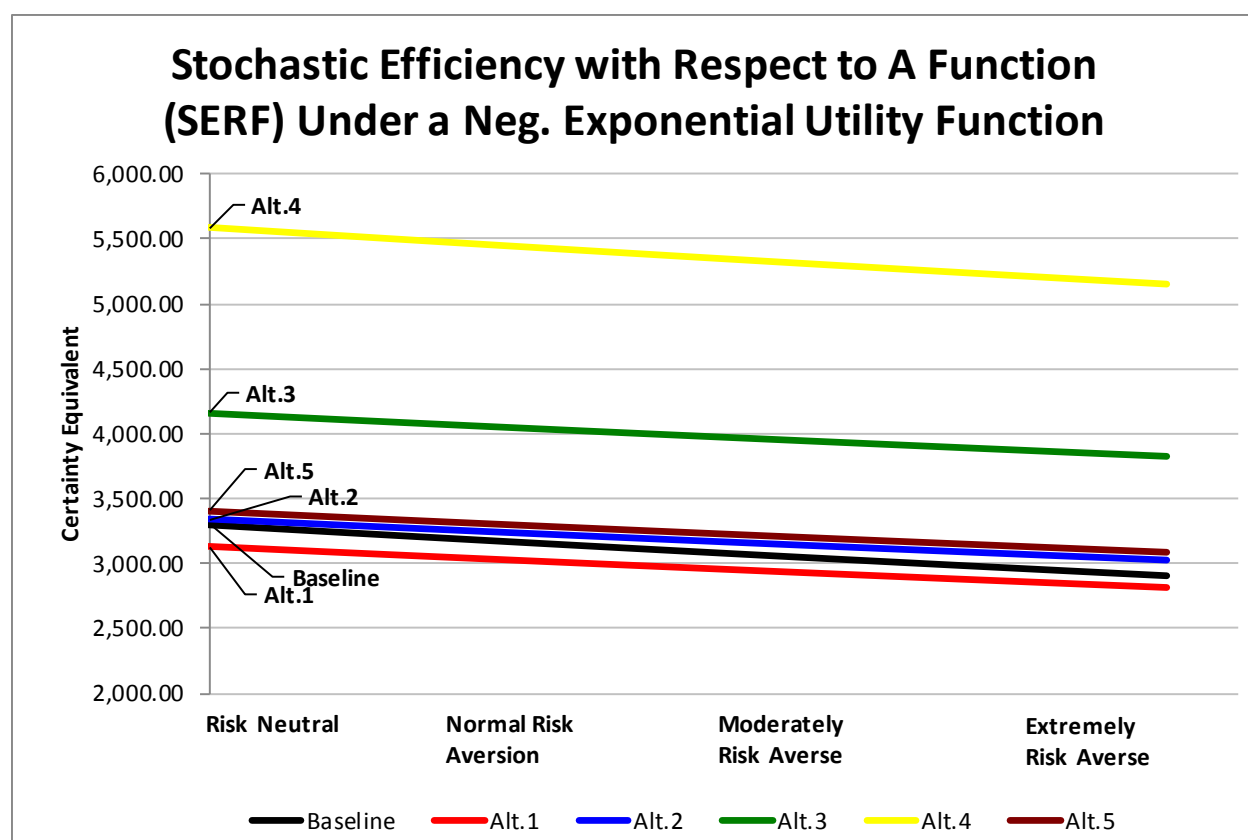


Figure 5a. SERF ranking of alternative farming systems in Dangeshta kebele

The SERF option in Simetar produces as well a risk premium (RP) chart (figure 5b). The chart shows the perceived premium that each risky scenario provides relative to the base scenario at different RAC values represented here by the risk aversion levels. A positive RP over the range of RAC for an alternative scenario means that the alternative scenario is preferred over the baseline while a negative RP would mean the preference of the baseline scenario over the alternative scenario. In this study the alternative scenario one (Alt. 1) that involves the use of pulley system has a negative RP meaning that the decision maker would be better off using the current level of irrigation and fertilizer application (baseline) than adopting the use of a pulley system. Also the difference in RP implies how much additional benefit in terms of wealth a decision maker can get by adopting a higher ranking alternative scenario (irrigation and fertilizer input) compared to a baseline scenario (non-irrigation). In this particular case however, the adoption of Alt. 1 that uses a pulley system would cause financial losses than profit to the decision maker or entrepreneur.

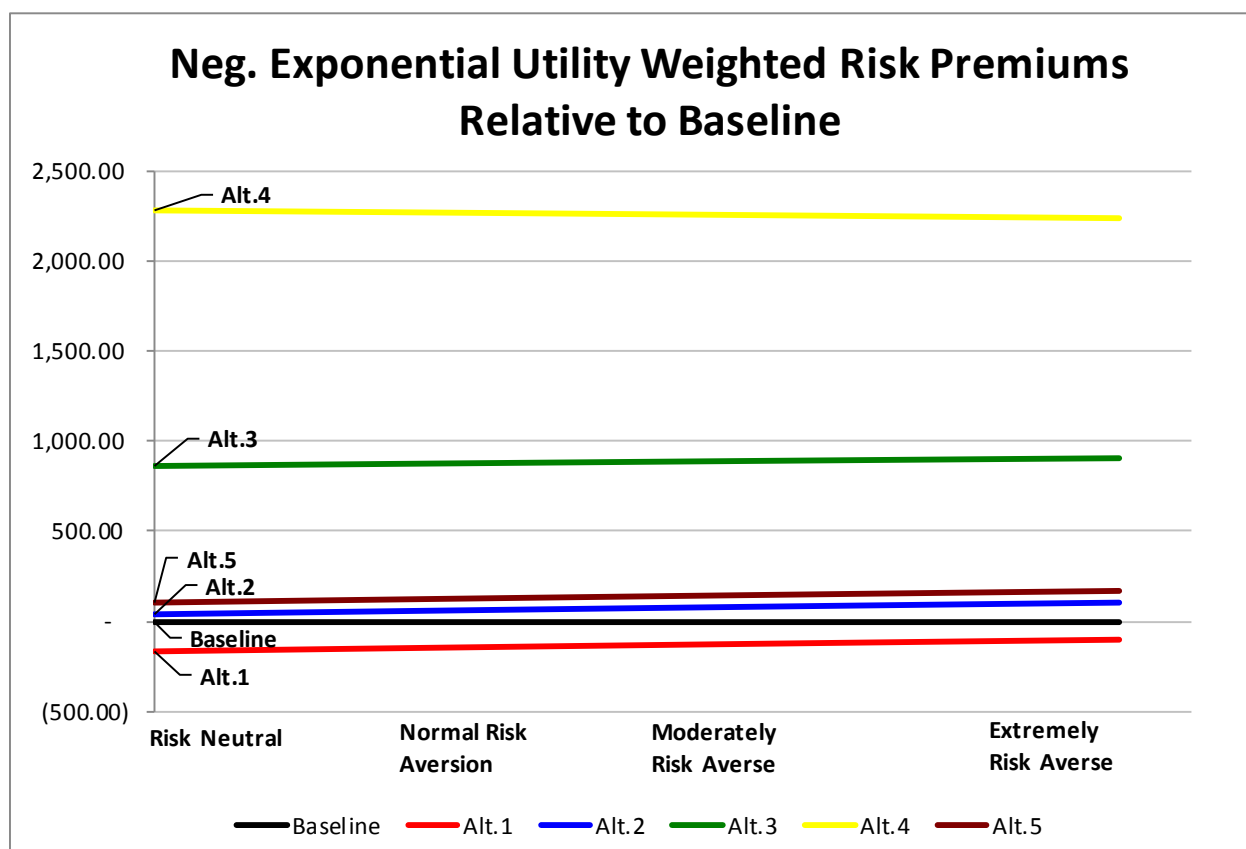


Figure 5b. Risk premiums ranking of alternative farming systems in Dangeshta kebele

Nutrition

Adoption of agricultural technologies when properly used leads to an increase in quantity and variety of crops produced. The implications on the nutrition however vary according to the type of crops grown and consumed. The increase in irrigable land following the adoption of some of the irrigation technologies (water lifting technologies) has increased the quantity of onions produced in Dangeshta Kebele. We assume that after meeting the household consumption needs,

the onion surplus can then be sold to the market and use the revenue to buy other food items needed to meet the nutrition minimum requirements.

The simulation results indicate that the quantities of crops produced under the alternative scenarios did not increase the levels of calories, proteins, fat, iron and vitamin A produced. Only calcium recorded an increase in quantity available under all five alternative scenarios. This can be explained by two factors. First there is a limited number of grains crops simulated (teff and maize) which reduces the variety of crops consumed and its nutritional contribution. Second, there is almost no new technology evaluation on grains crops except for fertilizers which had an impact only on teff yields. The results show that the minimum requirements per adult equivalent per day were met for calories, proteins and iron with nutritional deficiencies recorded for fat, calcium and vitamin A. Clearly food supplements (either through purchase or farming) to meet the minimum requirements for fat, calcium and vitamin A will be needed for families in Dangeshta Kebele to meet the nutritional requirements.

Conclusions

The objective of the study was to evaluate the impact of adopting agricultural technologies (specifically irrigation) on household nutrition and farm profitability in Dangeshta Kebele, Amhara region of Ethiopia. The baseline scenario, which represents the current farming conditions (no irrigation and current fertilizer), is compared to five alternative scenarios in which recommended fertilizers are applied to grow teff (rates for maize are kept constant) during the wet season and the application of irrigation of onions in dry season. The use of recommended fertilizers on grain crops in combination with onion irrigation using a rope pump operated by a gasoline motor was the best performing alternative scenario (Alt. 4). The second best performing alternative scenario was alternative scenario three (Alt.3) which involved the use of a rope pump operated by animal power to irrigate onions. The least performing scenarios were the baseline and alternative scenario one (Alt. 1). The alternative scenario one uses the pulley system to irrigate onions and applies the recommended fertilizer to grow grain crops.

Of the best performing scenarios (Alt. 3 and 4), alternative scenario four (rope pump operated by gasoline motor) generates higher profit for farmers compared to alternative scenario three (Alt. 3) that involves the use of rope pump operated by animal. While irrigating with a rope pump operated by a gasoline motor cannot cover all the available irrigable land, it can cover twice the land that a household would irrigate using a rope pump operated by animal power with a much higher operational and capital cost. However, the simulation results show that investing in both the gasoline motor and animal power irrigation systems will generate profit to the farmer.

Finally, despite its low pumping capacity and high capital cost, the solar system may be a more promising option for the future due not only to its low operating and maintenance cost but also its recognition of being environmental friendly.

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Appendix A

Water Lifting Technologies (WLT)

Pulley/bucket system



Photo 1&2: ILSSI site/Bahir Dar-Ethiopia-2015

Rope and washer pump operated by hand



Rope and washer pump operated by a horse



Note:

Photo 3: ILSSI site /Adami-Tulu Ethiopia, 2015

Photo 4: <http://www.ropepumps.org/horse.html>

Photo 5: <http://www.ropepumps.org/solar.html>

Photo 6: <http://www.ropepumps.org/motor.html>

Rope and washer operated by solar energy



Rope and washer operated by motor

