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Impacts of Zero Grazing Techniques on the Livelihood of Rural Community of Tigrai

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ABSTRACT:

This paper was done to evaluate the impact of controlled grazing intervention (zero grazing) on household's livelihood (child education, milk and crop production and burden on women) that help policy and decision makers invest more on this policy reform to replicate widely and catch community ownership and leadership in land management easily in the region. 600 households from each policy villages and control villages were chosen using random sampling techniques where every household head was given equal chance of being included without bias which meets the study need. The impact of zero grazing was evaluated using selected crop, milk production, child education and women burden indicators that were analyzed in three different ways: comparison of means, regression, and IV-2sls. Overall, the study indicates that households living in zero grazing villages enjoy a better quality of life and most of the economic, social, and environmental outcomes are better in participant households than in non-participant households due to zero grazing. The impacts are quantifiable, statistically significant, positive and visible in all outcome indicators. However, most of the impacts are modest in magnitude due to low official and community involvement in its implementation, which seems largely limited to villages partially with access to irrigation, low ratio of grazing area and short distance to school. This is not surprising, as the flow of benefits from zero grazing is slowly emerging and will take time to translate into substantial impacts. Last but not the least, this study recommends, development impact of zero grazing is very material as it helps provide a better quality of life and potential for incremental crop production as well as child education. It should be noted that rural zero grazing is not only, of course, a necessary, but also a sufficient condition for expanding income opportunities, enhancing soil fertility, improving environmental and ecosystem service.

KEYWORDS: *zero grazing, IV-2sls, crop, milk production, child education and women burden*

INTRODUCTION

Background of the Study

In much of the world historically, and in much of the world today, enhancing agricultural productivity while ensuring environmental sustainability on which agriculture fundamentally based has been and is a difficult dual task for any country whatsoever policies and strategies it formulates and implements regardless of time reference. The argument is that growth in agricultural productivity should not come from an area expansion but from yield increment (Eicher 1994). Eicher also contends that for most sub Saharan African countries ,adoption of more efficient farming practices and technologies that enhance agricultural productivity while ensuring environmental sustainability remains the most practical option for achieving economic growth, food security and poverty alleviation. Ethiopia is amongsub-Saharan African countries that face this task given that Ethiopia is a country with high land degradation and environmental depletion (Lopeze et al 1992).

According to FAO (2001), Ethiopia faces the most pressing and difficult problems in feeding its population particularly because of erratic weather, endemic poverty, agricultural failure, population pressure and fragile ecosystems. Land degradation and over-exploitation of natural resources due to population pressure and poverty are widely spread phenomena in developing countries. Soil erosion, caused by erratic and intense rainfall aggravated by climate change, further exacerbates land degradation and increase the risk of production failures and food insecurity among smallholders. This in turn further increases vulnerability to climate change. The interlinked problems of land degradation, loss of biodiversity and climate change are therefore among the greatest challenges to many developing countries' efforts of poverty reduction, food security and sustainable development (Pary, M.et al 2009).

According to the WFP's prediction, energy consumption will rise worldwide over the next decades, and indeed should rise in order to meet the MDGs. Currently; about 2.5 billion people depend on biomass (essentially wood and

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animal dung) for cooking. Some 2 billion people depend almost entirely on wood for cooking and heating, half of which meet their demand by cutting wood at a rate faster than it is being replaced. Fire wood demand is between 0.6 kg and 2.8 kg per person per day. Multiplying even a 1.0 kg average by the 2 billion demonstrates that people consume an estimated 730 million metric tons of wood per year i.e. 10 percent of all wood harvested from world's forests (Pary, M.et al 2009).

In Ethiopia, rain fed agriculture is the dominant sector of the economy. It registered an annual growth rate of 8.4% and contributes 41.6% of GDP, 89 % export and absorbs 83% of labor force. Poverty head count and food poverty head count are estimated to be 29.2% and 28.2% respectively, during the last five period, i.e..1998-2002 E.C (MoFED 2010/11-2014/15).However production in Ethiopia has never been sufficient enough for the rural population to be food secured (Debebe, H. 1995).

The main causes of food in security problem and recurrent drought are not only complex but also diverse .Different scholars have suggested different factors among which poverty and liquidity constraint which tends to increase rate of time preferences, reduce the incentive for investment on natural resource management, low productivity, policy neglect of peasant association by the previous regime , unreliable weather condition and the drive for survival led to sever degradation of land reinforcing the negative environmental effect (Pender et al 2001).He also prove that drought and famine, land degradation, civil war, wrong economic policy, overdependence on erratic rain fed and under utilization of potential water resources have been responsible for food in security. Communal grazing lands are important sources of livestock feed in developing countries. Un restricted access to grazing land may result in overexploitation of resources .Each individual user of the resource enjoy the full benefit of his/her use right but bears only a fraction part of the cost. As a result, traditional free grazing system in LDCs has caused severe land degradation (IRLI 2000).In Ethiopia, it was estimated that loss of $106 m/n a year or 3% of agricultural GDP is due to land degradation which in turn include losses of $23 million a year due to deforestation and $10 million a year due to overgrazing (Bojo 1995).

Tigrai as the most northern region of the country provides the most recent example. It is considered as the most land degraded and nutrient-deficit land (Hurni 1988).The population census of 2007 for Tigrai estimated to be 4.3 million with an annual growth rate of 2.5% of which 19.5% lives in urban and 80.5% in rural areas. The average population density in the region is 80 people per km2. Average cultivated land holding is about 0.5 hectare in most highland parts of the region. Average annual rain fall ranges 400 to 600 mm and is characterized by subsistence farming .Free grazing is a dominant form of livestock rearing in the region1. Most of the grazing lands are grazed and trampled the whole year round without any resting period resulting in soil compaction and land degradation .In general, it has been estimated that about 20% of total soil erosion is caused by livestock density and overgrazing (Melese 1992). In addition to this negative effect, free grazing practice has a negative impact on the conservation efforts which are being under taken in the region. Physical conservation structure such as stone band, and soil band are highly damaged by free roaring livestock, biological conservation such as grass strip and tree plantation are also being destroyed, reducing the chance for rehabilitation and regeneration of soil fertility in the region (Tsigeweni 1997).

Statement of the Problem

Much has been done to enhance agricultural productivity and ensure environmental sustainability but much more still needs to be changed in the world particularly in LDC including Ethiopia. Farming system that successfully integrates crop and livestock production stands to gain more possible synergy that directly impact productivity and agro-ecological conservation efficiently (Sanchez 1995). Agricultural conservation practices require a certain level of crop residue and cover crops to maintain soil chemical, physical and biological properties and prevent land degradation (FAO 1995). In many areas of the world, crop and livestock production compete each other for the same resource, and require a proper management to meet conservational agriculture objective. Thus, synergetic integration according Sanchez (1995) offers numerous advantages; diversification of income through animal products (milk, meat, fiber, hide and manure etc.), soil erosion control, wood control, and increased yield. Furthermore, crop residue has a long run value as soil amendment in one way and meet animal feed requirement in the other way (ibid).

In the highlands of Ethiopia, excessive residue consumption by livestock or complete removal of crop residue is a common practice, leaving insufficient vegetable cover for soil enrichment and conservation purpose. The critical problem is in the absence of alternative feed source, farmers are usually unwilling to abandon grazing (Smil 1999). Excessive free grazing , wood clearing at an alarming rate of 62000 ha a year for agricultural use, population growth, unsustainable arable farming technology, removal of crop residue, periodic drought have forced the country as well as the region to pay high costs of land degradation and born many negative consequences. Accordingly, Sonnevel (2002) estimated that the loss of agricultural value due to land degradation is $106 million which in turn has a share of $23 million a year due to deforestation and $10 million a year due to free grazing. Forest in general has shrunk from covering 65% of the country and 90% of the highlands to 22% and 5.6% respectively and finally loss of 30000 ha annually due to erosion and nutrient depletion of 30 kg/ha of nitrogen (WB 2001).

In response to the mentioned drastic consequence, the government of Ethiopia including Tigrai has initiated many policy interventions based on win-win strategy that can reduce land degradation and poverty while enhancing productivity and resource sustainability by calling strong community ownership and leadership (FAO 2001). Because, it is unlikely that natural resource problem can be solved by the state alone. The transaction cost of imposing and enforcing use rule on the community is likely to be high due to the high incentive of individual users to shrink or collude against use rule (McCarthty 2001)

In addition to this to achieve sustainable agriculture and renewable resource use goals, the government of Ethiopia is working in the context of green economy in collaboration with WFP2. WFP is supporting governments in enabling food insecure communities to apply community- based watershed management in a number of countries, including Ethiopia.The natural resource and livelihood impacts of community-based watershed management addresses the intertwined problems of land degradation, biodiversity loss, declining agricultural productivity, food insecurity and climate change. These conservation and development activities include: SWC on farmlands, reforestation and development of woodlots, area closure, gully stabilization, rotational grazing, zero grazing, planting multipurpose trees and management of degraded communal lands, and water harvesting at household and community levels (TLP 2008). Communities where watershed management has been implemented have restored environmental services and conserved biodiversity and indigenous knowledge, leading to significant improvements in agricultural production, household food security and livelihoods (Parry, M.et al 2009).

Ethiopia's MERET (Managing Environmental Resources to Enable Transitions to more sustainable livelihoods) project, under the implementation of Ministry of Agriculture enables food-insecure communities to manage their natural resources effectively, in order to enhance their resilience to weather-related shocks through participation in labor-intensive soil and water conservation activities. As sustainable land management requires community ownership and leadership, the MERET approach includes capacity building of community selected management committee, to ensure that the community works together and manages together. Communities work with extension agents to identify their priorities, select and plan activities, and manage natural resources. Community plans for rehabilitating their micro watersheds consider environmental, social and economic needs (ibid).

The impact of influencing a system rather than just a community can also be seen in the Tigrai region where the NRD applied lessons from MERET to the entire region. Over the past 20 years, about 80 percent of cultivated land in Tigrai has been treated with soil and water conservation measures. This amount to about 960,000 ha, of which 300,000 ha is under livelihood improving. In general this intervention policy has brought multiple investment returns, ecologically; degraded land and depleted soil are regenerated, moisture retention capacity of soil is improved: In economic terms, water recharge, ecosystem services, horticulture, forage, fruit tree production, bee-keeping and yield production are improved. Overall, nearly 40 percent of Tigrai's land mass is treated, i.e. protected or reforested (FAO 2009).

Another unexpected positive aspect of changing the grazing management from traditional free grazing to restricted grazing has been the opportunity for children to go to school. Children who are, otherwise, required to stay out of school to herd animals are resent to school and it can cause division of laborer in families. That is, women and elderly may invest more time on cattle herding. But changing grazing management for families without children is also a major problem as the parents are often elderly and do not have the time or energy to cut and carry feed for their animals (Edwards et al 2006).

Although literatures that mainly focus on factors affecting environmental degradation and agricultural productivity as well as techniques of conservation are extensive in the region, the extent to which restricted grazing improves crop and milk productivity and its effect on the schooling of children still remains an open question. Empirical evidence based on farm household data is scarce in explaining the investment returns or benefits of restricted or zero grazing. Answering of these questions is of a great interest of this study. Hence, this paper focused on the economic effects associated with the adoption of sustainable agriculture with a particular emphasis on the adoption of controlled grazing (zero grazing) on livelihood improvement (milk and crop production, child education and its implication on women time burden) of households living in the zero grazing village (policy villages) in comparison to those who live in a free grazing village (control village) in Tigrai region.

OBJECTIVES OF THE STUDY

General objective

The main objective of this paper is to evaluate the impact of controlled grazing intervention (zero grazing) on household's livelihood (child education, milk and crop production and burden on women) that help policy and decision makers invest more on this policy reform to replicate widely and catch community ownership and leadership in land management easily in the region

Specific objectives

- To compare treated and control villages based on household characteristics
- To identify factors that affect participation decision in zero grazing practices
- To examine the impact of zero grazing land on crop and milk yield
- To assess the effect of zero grazing practice on child education and burden on women
- To examine the differential policy impact by gender and irrigation access

Research Questions

- **Are** controls and treated villages comparable in household characteristics?
- What determines participation decision or involvement in controlled or zero grazing?
- Does zero grazing affect milk production per cow per day or lactation period?
- Does a practice of zero grazing help enhance crop production and crop yield per hectare?
- Does this practices offer more chance for children' enrollment in schools at the expense of women by leaving much of children 'work in cattle keeping to woman at home?
- Dose the policy impact differ by sex and irrigation access?

METHODOLOGY AND DATA

Sample Size and Sampling Design

The Government of Tigrai in collaboration with WFP launched a policy reform in community- based watershed management in Tigrai districts with the aim of reducing land degradation, biodiversity loss, productivity decline, food insecurity and climate change using different interventions such as SWC, Reforestation, area closure, water harvesting and restricted grazing etc since 2005 (Edwards et al 2006). In principle every district is encouraged and instructed to follow restricted grazing practices but is currently active and operational only in few districts due to its difficulty for implementation. The research sites are among the leading districts to implement this out of the 46 districts of Tigrai (ibid). Thus, these districts are purposely selected from the districts putting its experience in zero grazing and ecological similarities with the other districts in to account.

In the research sites, 42 sub-districts (tabias) exist, of which half of the Tabias are found in an areas where policy intervention for controlled grazing (zero grazing) is already active in some of their villages in different phases since 1998 E.C (BoARD 2010). This survey is based on three stage stratified sample design. In the first stage, policy Tabias were selected after actual visit and discussion with DA and local leaders considering their relative degree of experience, accessibility to transport and their strong initiative to maintain sustainability of zero grazing. In the second stage, policy villages and comparable control villages were randomly selected using similar geographical, ecological and socio-economic indicators after actual visit and discussion with the responsible district development agent was held. In the third stage, in order to select 600 households, a list of household heads for each village was supplied by respective tabia leaders. Using this list, 600 households from each policy villages and control villages were chosen using random sampling techniques where every household head was given equal chance of being included without bias which meets the study need. Since participation is voluntary and open to all, a slow scaling up of the policy intervention within the district also offers a chance of constructing control villages that are highly similar to the policy villages, thereby providing a good counterfactual. In summary, the following table presents the villages and number of households selected in this study.

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Region	Zone	District	Population	Category	Sample
Tigrai	Central	Tahtay machew	99,122	treated	76
				controlled	74
		Laelay Machew	72,625	treated	76
				controlled	74
	South	Endamekoni	84,739	treated	76
				controlled	74
		Ofla	126,889	treated	76
				controlled	74
	Total				600

Data Source and Data Collection Method

Prior to the actual field survey, visit survey was made in the districts. During this course of survey, meeting with concerned bodies, recruiting, training enumerators and questionnaire test was undertaken. In this study, mainly primary data was utilized and collected using questionnaire, interview with key informants, field observation, A secondary data sources from documents of district plan and finance and agricultural office were also supportive to supplement the primary data for its accuracy and validity .The sources and methods employed in this study are outlined below.

DATA ANALYSIS METHOD

The advantage of employing qualitative and quantitative methods in research is getting increasing recognition among researchers. It enables to benefit from the insights that the two methods provide when used in combination. Moreover, the most effective evaluation research is one that combines these methods (Babbie 2003).Thus; the research strategy employed in this study combine both methods. Descriptive analysis was employed to address the first objective and followed by estimation of participation model (2) using exogenous explanatory and instrumental variables to deal with the second objective whereas the remaining objectives were answered by estimating the outcome model(1) using 2SLS method depending on the nature of the dependent variable. A further detail explanation of the analysis method is outlined as under.

RESULTS AND DISCUSSIONS

Crop Production between Policy and Control Villages

In measuring the impact of zero grazing practice, the first interest of this study is to focus on the effect of this practice on crop productivity of participants and non-participants in the study area. In particular the effect on wheat and teff production since these are the most popular crops in the districts. The main idea of this argument starts with its inception that if crop residue and stubble are left standing in crop field and not destroyed by animal, nature absorbs and converts it in to natural organic fertilizer that have a residual effect on the next crop production by maintaining soil fertility. Thus, this sub section takes the full responsibility to examine the effect of zero grazing on crop outcome using plot level household data for teff and wheat crop types for policy versus control villages. In the wheat and teff household data sets, an information regarding plot ownership, location, soil characteristics and main inputs used in that plot were collected and used here for comparison between policy and control villages.

Not surprisingly, the dominant source of income in the districts is still cereal crop production mainly teff and wheat, which are the popular crop types of sample households. The report from the areas shows that average teff and wheat output per tsimdi in the district level is 5.1q and 10q respectively.

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As expected, policy villages could register a higher mean value of 4.473q wheat harvest, 13.21 donkey load straw harvest, 9.01q total harvest and 5.07qt-1wheat yield as compared to control villages with mean value of 3.5q wheat harvest, 11.8 donkey load straw harvest, 7.8q total harvest and finally 4.04qt-1 wheat yield .The difference is not only sizable but also statistically significant atp-value of less than 0.05 at 5% level of significance referring in to table 4.2.The maximum mean wheat output in the control village reaches beyond district annual mean harvest and this could be due to over recording plot harvest record since farmers were asked three months later than crop harvest season in the districts. But the maximum mean harvest in the policy villages almost falls to the mean wheat crop of the districts.

Overall the policy villages are showing a promising output than control villages in wheat production and the F-test result in the same panel is another witness that there is a statistical difference between the two villages at a p-value of less than .05 at 5% level of significance presented in the last column of panel B of table 4.2.

As expected, policy villages score a higher mean value of 5.5q teff harvest with maximum value of 12q, 18 donkey load straw harvest, 3.4qt-1 teff yield as compared to control villages with slightly lower mean value of 3.5q teff harvest, 12.donkey load straw harvest and 3.1qt-1 teff yield. If one puts the duration of starting time for the practice of zero grazing (since 2001E.C for most 61% participants) into consideration. The difference is not only sizable but also significantly remarkable at ap-value of less than 0.05 at 5% level of significance for teff grain and straw harvest variable and 10% level of significance for teff yield variable. The comparison at village level in panel B of table 4.2 also provides extra detail insight for all villages.

The general message is that crop residue left standing in crop field plays a significant role in enhancing crop yield in addition to chemical fertilizer and organic compost in the study areas even in the short time period as compared to areas whose crop field is annually freely grazed and depleted. Hence, the first hypothesis that zero grazing has a positive impact on improving crop production in zero grazing villages is fulfilled given the T-test result by participation and F-test by village.

Milk Production between Control and Policy Villages

Another parameter of interest in this evaluation is to look at the effect of zero grazing practice or home confining cattle on milk productivity of these cattle as compared to cattle which freely graze in the controlled villages. The researcher is interested in evaluating the effect of a binary treatment (closed or not) on a continuous outcome milk harvest and binary calf death.

Child Enrollment, Class Attendance and Achievement

One major intention of this study is to explore the impact of zero grazing on child enrollment, absenteeism and class achievement for children whose households are participants versus non participants in the study area. The idea that zero grazing improves child enrollment and performance emanates from the argument that closing cattle home provides more chance for children to go to school or household in the policy villages are supposed to resend their children to school when children are ready to school.

One of the outcome variables in this study is child enrollment which assumes a value of 1 if a child of 5-13 years old is enrolled in a formal class and 0 if this child is out of school in the same age category for both policy and control villages. The choice of this age category is highly subjective to the knowledge and interest of the researcher. The second indicator in this sub section is student class absence in the last semester measured by numbers only for those who are enrolled and follow their class regularly and yet another parameter taken in this subject is the average performance of a child out of 100 in the last semester. The underlying assumption is that differences in child performance in different grades is neglected since children of 5-13 years old will not be above grade 9 and all have average result of all subjects from 100.

Empirical Model Estimation

The descriptive statistics in the previous section give a first indication of the impact of zero grazing land management practices. Overall, members of the policy villages perform better on all crop as well as straw production, milk production, child education but slightly worse in time investment on animal rearing by women as compared to non-participants. Children of households that are participating themselves in the practices are more likely to be enrolled, less absent with higher class achievement and got a chance to go to school. Farmers in the policy village seems to be more successful not only to produce more grain and milk but also fodder output which is a good remedy to the main fear of many farmers not to close their animal at home .

These descriptive statistics results are merely indicative. First, participants in this studies may belong to the more advantaged villages in terms of access to irrigation, market, school, road, extension cervices and since these villages are also more likely to have high crop and milk yield, school outcomes without the policy intervention, controlling household characteristics in order not to overestimate the impact of the policy is required. Moreover, since participation is a voluntary decision, this could lead to a selection bias when comparing participants with non-participants. Participants might differ on additional unobservable characteristics such as awareness or motivation that could have a direct effect on the outcomes beyond participation in the policy villages. That is, without zero grazing, crop and milk yield, child education of participants might have been higher as well, due to unobserved characteristics (Blundell et al 2000). Thus, depending on the type of outcome variable, an econometrics model using IV-2SLS estimator was estimated so as to reconfirm the descriptive results in the preceding sections by controlling household, child, plot, cow characteristics.

The main target of this study is to estimate the causal impact of zero grazing on crop and milk production, child education and women time allocation outcomes. Ideally to identify the effect, we would conduct a randomized experiment where some plot, cow, children are placed into a treatment group that receives a treatment and others are placed in a control group. We would follow these treated groups over time and compare their crop and educational outcomes. The control group describes the counterfactual of what the treatment group's outcomes would have been had the intervention not occurred. This is a simple and convincing approach since at the outset of the experiment the treated and control were similar. In the absence of a randomized experiment, this study relies on a natural experiment where sample households are drawn from the universe using random sampling.

In this section, the researchers wishes to estimate the effect of participation (hereafter D) in all models so the parameter of interest is . Different estimated results are discussed below soon after this preliminary explanation is made and all estimated results are available in the appendix in table 4.3 through 4.10. In order to avoid tiresome of the reader with too many results, first model stage estimation results and some variable results which were included in order to avoid omission variable bias and ensure proper identification are not reported in the appendix but accessible up on request. For each estimation different or similar models and instruments are applied where they make a sense in applicability and reliability.

Crop Production Estimation

Table 4.3 in the appendix reports the full results of estimating equation (1) for wheat grain in quintal and straw harvests in donkey load per plot using OLS first and 2SLS instrumental variable estimator and table 4.3I below reports only the coefficient of interest for quick view where 4.3I indicates table 4.3I is a sub part of table 4.3 in the appendix. The main parameter of interest is the coefficient for the participation variable (D) which gives the average treatment effect. This parameter may underestimate the true effect of D for a couple of reasons. First, because treated and control villages are near neighbour villages, it is possible that animals from the control villages may encroach in to the crop fields of policy villages and benefit indirectly that reduces the true effect of D. Second, the policy villages are also villages which had longer leading history of implementing compost to improve their crop production .Due to its very low coverage rates and operated only in a few major households in the control village, it is unlikely to pose a significant problem. But it is quite likely that the policy areas got experienced, which means the treatment group is partially treated already on how to improve production. This would cause the impact to underestimate in the policy villages. Third, inter-village movement of households across villages may confound the estimated effect, but it is not much of a concern here. So, the researcher is not aware of any intervention that may contaminate the effect of the policy and the coefficient of D is interpreted under the assumption that the difference in outcome between policy and control villages would have been the same in the absence of this policy.

In this estimation, the dependent variables analyzed are wheat grain harvest (wgharv) measured in quintal per plot, wheat straw harvest (wsharv) in donkey load per plot and wheat yield (Wyield).The explanatory exogenous variable which are thought to have an effect on the outcome variables include household-level covariates (sex, age, education, total land, livestock in TLU, participation in farm association, distance to market ,family size etc) and plot-level covariates (plot area, plot location, plot biophysical characteristics (for example, soil type, soil fertility status),inputs used on the plot (such as draft power, fertilizers, purchased seeds), land management practices used on the plot (for example biological conservation), and land investments on the plot (for example, planting permanent fence and plot irrigation) and instrumental variables such as visit frequency by the development agent, grazing ratio, grazing ratio square and irrigation access of the household not in that plot .Because participation in zero grazing is suspected to be endogenous

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due voluntary self selection bias and unobserved heterogeneity characteristics of household for participation , participation was instrumented by the instrumental variables listed above in the first reduced form equation (2) or participation model on the top of other exogenous variables and the predicted endogenous variable was regressed as an exogenous variable in the outcome equation(1) or structural model.

After every estimation of IV-2SLS, an *endogeneity* test using ***Wu-Hausman* F test or Wu-*Hausmanchi-sq test,*** over identifying or validity test using ***Sargan chi2-test*** and exogeneity or relevance test using ***Stock and Yogo* (2005) F-test** were made and their results are reported in Table 4.4 of the appendix .In the IV-2SLS estimation, the reduced model or participation model is estimated using *probit* to identify the main determinants of participation so as to address the second objective of the research whereas the second estimates provides factors that affect the outcome variable including the coefficient of interest participation as predicted exogenous variable.

Column (1) of table 4.3 shows the ordinary estimates of the policy effect by estimating equation 1 and 2 parallely using OLS estimator. The coefficient participation suggests that participation in zero grazing has positive significant impact on wheat grain harvest rejecting its null hypothesis at 1% level of significance. The result suggests that the policy increases wheat harvest by 1.2q per tsimdi. On comparing the ordinary estimates with IV-2SLS estimates in column (2), it turns out that this naive estimate grossly underestimates the policy effect. This implies that estimating the model using ordinal OLS is not the correct approach because households may differ in unobserved characteristics which leads to *endogenity* problem and ignoring these differences would bias the program effect .This naive estimates highlights the danger of misleading causal effects of the policy when participation is not plausibly exogenous and this motivates the researcher to use IV-2SLS estimator and the preferred estimates are in column (2) in the same table. Results of this estimation suggests that zero grazing significantly improves wheat output, straw output and wheat yield .The policy increases wheat harvest by 1.7q per tsimdi given it is statistically significant at 1% level of significance, wheat yield by 2.1q per tsimdi being significant at 1% and straw production by 5.8 donkey load per tsimdi at 5%level of significance which seems below the official District report of 4-5 quintal per tsimdi. Thus, over a short period, zero grazing brings meaningfully sizable increment in productivity of wheat in the study area which the region took centuries to register this crop output level . In short, the following table presents the impact of zero grazing on wheat production only by taking the estimated coefficient of interest (participation).

Table 4.3I Impact of Zero Grazing On Wheat Production

Estimates	Variable	OLS	IV-2SLS	IVTREG
WHEAT GRAIN	hhpar	**1.215*** **	**1.708*** **	1.376909**
WHEAT YIELD	hhpart	.8899587*	**2.116*** **	1.084***
Wheat straw	hhpart	-.1142017	**5.672** **	7.10444*

Source: own estimate, 2012* shows significance at 10-percent level, ** at 5-percent level and *** at 1-percent level.

Although the main coefficient of interest in this study is the coefficient of participation, the results of other exogenous variables are also reported in the same table. An increase in one *tsimdi* of plot size increases wheat harvest by 2.3q and wheat straw by 3.7 dl but reduces wheat yield by 2.59quintal per *tsimdi*. While plot irrigation, plot ownership, household sex and age have positive significant effect on both wheat harvest and yield outcomes, soil colour, ox draft power and house hold age square significantly reduces the outcome value by their respective coefficients given they are statistically significant in the indicated level of significance.

Table 4.5 shows results from estimating equations1and 2 where the effect of the policy on wheat harvest outcomes vary by gender (column 1), by irrigation access in the

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village (column2). Column (1) of Table 4.5 suggests that the policy did not have differential effect for male and female headed households in wheat production i.e. ,wheat harvest increases by about the same amount for both male and female due to zero grazing (though the point estimate is positive for male household , suggesting that male households have benefited a little more). Column (2) suggests that the policy had a zero effect on households residing in free grazing areas in terms of access to irrigation in the village not in the plot (the point estimate is 1.16q and is statistically insignificant) and did not have differential effect for household whose village has access to irrigation not necessarily for crop production and those whose village does not have any access to irrigation.

Glancing into the result of first stage estimation which is not reported in the table due to space saving and avoiding burden of readers with too many results, plot size, plot location, plot slop ,access to irrigation, grazing ratio , household readiness indicator, being member of farmer association, total household land size have a significant and positive effect on participation in zero grazing and variables such as fertilizer use ,plot fence, total livestock , school distance reduces participation given they are significant at 10% or 5% level of significance. The interesting point is that farmers whose plot is fenced permanently have lower tendencies to close their animal home. Moreover, farmers with high livestock unit seems be reluctant to participate in zero grazing and this is surprisingly consistent with the main reason of farmers and development agents as why zero grazing is not implemented in *tabias* in the study areas in particular, and in the region in general. As a complementary, villages with longer distance to school are found to have lower interest to participate in the practice and finally the sign of the instruments is as expected .Villages with access to irrigation particularly used for fruits and vegetables show a positive and significant probability of participation as compared to villages with no access to irrigation. The coefficient of grazing ratio also suggests that lower grazing area relative to the total area of the village encourages participation in the study area.

This sub section is completed by testing and discussing about the instruments used in the above mentioned models of wheat harvest, wheat yield and wheat straw harvest. Soon after IV-2SLSestimation of models, a test of *endogeneity* was conducted and the Wu-hausman F-test with p- value of 0.0089 in table 4.4 rejected the null hypothesis that OLS estimation is consistent or treatment is exogenous. Table 4.4 of Panel A depicts the list of potential candidate instruments accompanied by their *endogeneity*, validity and relevance tests .In the wheat grain model, participation was instrumented by frequency of contact with development agents, grazing ratio and its square value of grazing ratio and household readiness indicator .According to the Sargan Chi2 –test, the null hypothesis that all instruments are uncorrelated with the error term in the structural model or all instruments are valid is below the conventional rejection rule given its p- value of 0.09 at 5% level of significance and this helps conclude that the instruments pass the over identification requirement. finally instruments were also tested if they could pass the second most important criteria that the instrument should be correlated or relevant to the endogenous variable participation, Even if there are a plenty of options to test this, the Watson and Yogo (2005) F-test was employed here and rejected the null hypothesis of instruments are weak at F statistics which is extremely higher than the rule of thumb of at least greater than 10. In the same fashion, the instruments in the wheat yield and wheat straw also pass the conventional requirements.

Table 4.6 in the appendix reports the full estimated results from estimating equation (1) and (2) for*teff* grain, straw harvest and *teff* yield in the same fashion as the estimation of wheat in the previous section using OLS in column (1), IV-2SLS in column 2, 4, 5 and IV- Generalized Method of Moments in column (3). Column (1) suggests that the policy has no significant effect on teff grain suggesting that estimating the model by ignoring the unobserved heterogonous characteristics of participants would bias the policy effect. Hence cognizant of this problem, the model was once more estimated using IV- 2SLS and IV-GMM for efficiency and consistent comparison .After controlling the unobserved heterogonous factors, columns (2-5) suggests that the policy has a positive and pronounced effect on all grain, yield and straw harvest outcomes, The policy significantly increases teff grain by 3.6q, teff yield by 2.2q and Teff straw by 12.7dl in zero grazing areas as compared to free grazing areas given coefficients are significant at the specified level of significance. The policy effect on teff crop is more pronounced than the effect on wheat for all outcomes putting the duration of time since implementation into considerations (3 years for 61% of participants) .The third column reports about 0.03quintal higher impact of the policy on teff grain harvest by estimating the same equation with the same dependent and independent variables using IV and GMM estimator. In short, table 4.6I below as part of table 4.6 in the appendix offers the summary of the impact of participation as follows.

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Table 4.6I Impact of Zero Grazing On Teff Production

Estimates	variable	OLS	IV-2SLS	IVTREG
TEFF GRAIN	hhpart	0.304	3.565**	1.94558***
TEF YIELD	hhpart	-.3244265	2.180**	1.88220***
TEFF STRAW	hhpart	-.1094097	12.67*	3.849131***

Source: own estimate, 2012* shows significance at 10-percent level, ** at 5-percent level and *** at 1-percent level.

Variables such as plot size, plot ownership, dummy soil depth, labour used, household age and dummy household membership in farmer association are also found to have a positive and significant effect on grain outcome given they are statistically significant at the given level of significance in table 4.6. The coefficient estimates of the interaction variables "*hhsexpart*" and "*irrigpart*" show that the intervention impact did not vary neither by gender nor by irrigation access in the village saying that the policy have the same effect on *teff* production regardless of male or female household and village with access to irrigation or not .Estimated results from the first stage also show that total land holding, fertilizer use, household ethical indicator encourages participation positively while school distance, household sex and plot size discourages probability of participation negatively.

The potential candidate instruments used in the above estimation were tested to check if they could pass the necessary requirements for instrument to be as an instrument. Table 4.4 of panel B reports test results for all estimations used in teff production. The Wu-hausman F-test with p- value of 0.056 in table 4.4 rejected the null hypothesis that OLS estimation is consistent or treatment is exogenous and motivates the use of instrument under 10% level of significance . In the teff grain model, participation was instrumented by square of frequency of contact, irrigation access, school distance and household "civicness" indicator .Accordingly, the Sargan chi2 –test fails to reject the null hypothesis that all instruments are uncorrelated with the error term in the structural model or all instruments are valid given its p-value of 0.8737 and this helps to conclude that the instruments pass the over identification requirement.

To ensure the relevance of instruments, the stock and Yogo (2005) F-test was employed and provides a warning that instruments are not strong enough at F statistics of (4.5) which is normally expected if small sample size is used for estimation (Staiger. D, et al 1997). But the rule of thumb of Staiger and Stock save the instrument from warning of weakness i.e. the F-statistics from the first stage estimation which is greater than 10 let the instrument pass the requirement. So the weakness is no more risky. In the same fashion, the instruments in the yield and straw estimations also pass the conventional requirements.

Milk Production

In the preceding section, it was found that the policy significantly and positively increases wheat and teff yield and is further speculated that it increases milk production too. In particular, sheltering milking cows may improve milk production conditional to sufficient fodder they get regularly. In this estimation the underlying assumption is that the milking cows in this study area are not considered as properly treated and fed well enough. The expected differences in milk production between cows of control and policy villages are only due sheltering or staying home.

Turning to the estimated results of milk harvest measured in terms of litter per day and probability of death of calves below two years old measured in binary value in table 4.7 in the appendix, column (1) presents estimated results of milk by estimating equation (1) using a simple OLS estimator which shows the program has no effect on milk. As argued earlier, the reason is that estimating a model using OLS under a suspicion of *endogeneity* violates the important assumption of OLS and leads to bias inferences. As a remedy column (2) reports the estimation outcome by estimating equation one and two in two steps. Accordingly, the coefficient of interest participation suggests that the policy intervention positively and significantly increases

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milk harvest by almost 1.3 liters per day given that the estimate is statistically significant at the specified level of significance. So after controlling *endogeneity*, the coefficient of participation correctly reflects the importance of zero grazing on improving milk production in addition to crop production improvement. Column (3) of the same table displays the result of linear probability model estimation suggesting that the treatment has no significant effect on death of new born calves but column (4) using a two stage IV estimator correctly presents the true impact of the policy and the probability of death for the newly born calves is significantly lower in the policy villages than in the control villages. Newly born calves in the policy village have 68% probability of surviving than calves in the control village at its marginal effect. This highlights that the policy has a remarkable multiple impacts in the study area in short period of time.

Notably the amount of milk consumed by the new calf before actual milking significantly affects milk harvest negatively and cows which lives in a permanent stable (local shell) provides more milk than cows living without shell. Milk harvest seems very conditional on season implying that milking cows can give 3.2L when milked in autumn, 1.4 L in summer and 0.8 in spring relative to winter season. While male households seem to harvest more milk than female headed households, household age, religious education and economic status reduces milk harvest significantly. The estimation of variables in the calf death model also show that calves from breed cows have less chance of dying than calves from local cow. Brewery residue consumption appears to play on reducing a calf death but milking frequency and distance to water source significantly increase the probability calf death in the study areas and interpretation of coefficients in the first stage estimation are deliberately ignored for the simple reason that participation was determined in the previous model estimation. For short view, the following table 4.7I as part of the main table 4.7 in the appendix presents the summary of the impact as under.

Table 4.7I Impact Of Zero Grazing On Milk Harvest And Calf Death

Estimates	Variable	OLS/LPM	IV-2SLS	IVTREG
MILK HARVES	hhpart	0.0311	1.259**	1.25393***
CALF DEATH	hhpart	-0.241	-0.677***	-.41897**

Source: own estimate, 2012* shows significance at 10-percent level, ** at 5-percent level and *** at 1-percent level.

In the milk model, the estimation used two instrumental variables named school distance measured in walking minutes for students and a binary variable membership of tabia council. Distance to school is supposed to have a negative effect on participation in zero grazing and council membership with positive impact on participation. Referring panel C in table 4.4, the *endogeneity* test withWU-hausman F-test at a p-value of 0.04 supports the use of IV estimation to be efficient and consistent, Moreover, the candidate instruments have also passed the over identification requirement at a Sargan p-value of 0.73 indicating that the first assumption that instruments should not be correlated to the error term in the structural model is fulfilled. Since application of instrument approach requires the instrument to meet the second assumption that the instrument is correlated to the endogenous variable (participation in this case), the F statistics from the first stage estimation ensures the strength of the instruments with its F statistics value of 42 .04 greater than the rule of thumb10. Following the same procedure and explanation, the instruments in the calf death model estimation proves to pass endogeneity test at p-value of 0.0096, over identifications test at p-value of 0.93 and F- statistics of 26 for relevance test

4.2.3 Child Enrollment, Class Attendance and Achievement

Another subject remaining unexamined in the preceding sections is to know the link between child education in terms of enrollment, class absenteeism, achievement and zero grazing practices

.But the link is highly subjective to empirical evidence of this research .Child education in this sub section is examined

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in terms of three indicators, The first outcome variable is simple enrollment which assumes a value of 1if a child of 5-13 years old in the household is enrolled and vale of 0 if the opposite is true. The second dependent variable class absence is a continuous variable derived from counting the number of absent days in class in the last semester and the last outcome variable class achievement the average result of only enrolled students in the last semester. On the top of household characteristics, child characteristic variables such as child sex, age, grade, rank and mother characteristic variable such as mother age, education level and divorce situation are included in the estimation. A study made by Sue Edward in 2005, even though it is not empirical causal relationship study, indicates that keeping animal home creates an opportunity for children to go to school and division of labor among wife of the household and elder man in the house. Quantifying this relationship based on the survey data remains unanswered question for this section. The education results which is based on children who are beyond age five and below age 13 years are presented in table 4.8 in the appendix.

As IV estimates are considered superior to OLS regression estimates, the results are discussed emphasizing IV, but regression results from *probit* or LPM are also presented for comparison purposes.Column (1) in table 4.8 shows lineal probability model estimations of the likelihood of enrolment for children of age 5 to 13 years when participation is not yet instrumented in these estimations while column (2) reports *probit* estimation. These first estimate results clearly show participation is highly significant for enrolment probabilities and the coefficients in these two estimates are similar in direction and significance except in magnitude. The magnitude is higher in the *probit*estimation than LPM. However, since IV is considered more consistent, the results of IV estimation are discussed in detail in comparison of results from *probit* or OLS.

Column (3) is responsible to report the estimates of child enrolment using IV or *biprobit* which almost have similar sign and magnitude except for standard errors and the coefficient of participation from this estimation indicates that children living in the policy villages have a positive and significantly higher probability of going to school than children in the controlled villages. The magnitude of the coefficient indicates the policy has considerably larger and positive impact on child ennoblement. Using its marginal effect estimation, participating households have almost 54% more chance to enrol their children in school than households in the free grazing villages and 25% more chance using marginal effect from *probit*. Child age, child health, mother age, household head literacy and religion education appears to have positive and significant effect for child enrolment. However, household head age and total land holding seems to play a significantly negative effect on child enrolment if other factors are held constant. This is very common in rural areas where children of elder and richer people often supply more labour time than children of poor and young family.

In column (4) school attendance from school is presented by estimating the model using tobit and the coefficient of interest was found unfortunately to be insignificant suggesting that the policy have negative and insignificant effect on child school attendance. Hence, estimating equation (1) using *Tobit* seems to be incorrect approach in the presence of *endogeneity*. To avoid this misleading effect, column (5) depicts results of the same model when participation is instrumented by irrigation access and square of contact frequency. The estimated coefficient displays that zero grazing reduces class absence significantly, children who live in the policy villages attended class 8 times more in the last semester than children who live in the control villages or children of free grazing villages miss class attendance 8 times more in a semester as compared to children in the zero grazing villages. This shows that the policy, if properly managed, seems to play significant role on improving child school enrolment in quantity aspect and child school attendance in quality aspect which is in line to the Ethiopian government policy agenda. Male children appear to have one more class absence than female children and household land size significantly increases class absence taking their significance at the given level of significance in the table.

The last column (6) presents results from estimating equation (1) for class performance measured in average result in the past semester using IV approach. Looking in to the coefficient of participation, the impact is significantly positive and higher in magnitude. It suggests that children of policy villages scores 8 points more than children of control villages given it is statistically significant at 5% level of significance. Educated households and members of farmer association show a positive role in increasing child school performance but children of male participants score lower performance than children female participants. In summary, the impact of the policy is highly positive for that it increases child enrolment by 54% at its marginal effect, class attendance by 8 times and average performance by 8

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score points .In summary, table 4.8I as sub part of table 4.8 in the appendix offers a quick view of the impact as follows.

Table4.8I Impact of Zero Grazing On Child Education

Estimates	Variable	LPM/TOBIT/OLS	IV-2SLS	IVTREG
Child Enrolment	hhpart	0.223*	**0.543****	.1990***
Class attendance	hhpar	**-1.213**	**-8.349***	-1.15212**
Class achievement	hhpart	1.895635	**7.827****	3.283579

Source: own estimate, 2012* shows significance at 10-percent level, ** at 5-percent level and *** at 1-percent level.

This inference is valid input for policy makers if all the instruments could pass the required criteria. The test results for instrument are still made available in table 4.4 panel D .the first instruments have a statistically significant effect on participation in the first stage estimation and were instrumented after the *exogeneity* hypothesis was rejected at Wu-hausman F-test of p-value 0.05 at 10% level of significance .The over identification criteria allowed them to be valid instruments at Sargan p-value of 0.67 .So zero correlation between instruments and error term from the structural model was met. The positive correlation between the instruments and endogenous variable participation was also checked and led to conclude that the two instruments are relevant in the model suggesting that they significantly affect participation positively or negatively directly and child enrolment, class attendance and performance indirectly via participation .The test results in the same table for the last two estimation also proves that instruments are found to be valid and relevant

Women Participation in Cattle Rearing and Time Investment

The assignment of this study is completed by examining the impact of zero grazing on women's time burden .In the last sections, it was found that zero grazing increases child enrolment and class attendance significantly and this could be blessing if it is not at the expense of women. The hypothesis is that zero grazing increases women's time load in animal rearing home when children are sent to school and husband go outside for farm or nonfarm activates. On the top of usual child rearing and house activity, a wife is expected to spend some more time to rear the cattle at home specially feeding, milking and taking to water source are the extra assignment for wife when animal are confined home. To validate this hypothesis, the impact of this practice was examined by taking two indicators or outcome variables. The first dependent variable which only assumes a binary value of 1if the wife in the household participates in animal rearing and 0 if the opposite is true is termed as wife participation and the second outcome is daily hours spent by wife as a continuous variable .In the second case, the time spent may take a value of 0 for some wives and continuous value for others. To handle this zero and positive value of the dependent variable, equation (1) was estimated using a *tobit* instrumental variable approach.

Table 4.9 shows the results of different estimations for wife participation and time investment on animal rearing. The third column shows the results of simple linear probability estimation without instrumentation. As expected, the coefficient for participation is highly significant. This coefficient reflects the tradeoff between improving child enrolment and class attendance in one way and increasing wife participation on the other way. To simply put using its marginal effect value, wife living in a policy village participates almost 20% more than a wife living in the control village who would have had participated equally had she been living in the policy village.

Since the estimation did not pass the *endogeneity* test at p-value of (0.6633) in table 4.4 panel E when instrumented with grazing ratio, square value of that variable and estimated using IV-2slscolumn(4). The estimated result

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from linear probability model is assumed more superior and emphasized for interpretation than the coefficient with IV estimation. Both have the same sign and almost similar magnitude indicating 20% probability of participation for wife living in the policy village taking its marginal effect. The results from both suggest that the policy significantly and positively increases probability of wife participation by 20% as compared to a wife whose village did not participate in zero grazing. If one prefers estimates from IV estimation, he would immediately find 22% probability of participation in the policy village given the instruments are valid at p-value of 0.444 and relevant at F-stat of 214.12 in table 4.4 panel E. Control variables such as mother age ,total livestock affects wife participation positively and family size is found to reduce participation significantly.

Column(1) of table 4.9 presents estimation of the model using tobit specification without instrument and suggests that wife in the policy villages spend two and half hours in a day as compared to a wife in a control village who saves 2.5 hours for other activity. Although estimates from IV *tobit* in column (2) depicts that the policy has a positive and considerable impact on women (3 hours in a day) , this result is not interpreted once again participation was found to be exogenous at p-value (0.471) where validity and relevance have almost satisfied at p-value of (0.94) and (9.10 which is less than 10) respectively. If one of these two conditions is not met, the correctness of IV estimation is may be questionable. For this reason, results of the first column are emphasized for interpretation .While total livestock and mother age still affects time investment positively, family size reduces daily hour spent by wife significantly. In short, the impact on women is presented using table 4.9I below as part of table 4.9 in the appendix.

Tabale 4.9I Impact of Zero Grazing on Women's Time Load

Estimates	variable	LMP/ TOBIT	IV-2SLS	IVTREG
Wife Participation	hhpart	**0.191****	**0.220****	.15724**
Time investment	hhpart	**2.517****	**3.070****	1.486658***

Source: own estimate, 2012* shows significance at 10-percent level, ** at 5-percent level and *** at 1-percent level.

Conclusion and Recommendation

CONCLUSION

The leading interest of the research paper is not only to tell readers how this research is done technically but it is to inform policy makers based on the empirical inference how this research contributes to rural households economically. The economic benefit is thought to be more superior to technical benefits. Many papers have been and are extensively made regarding causes, costs of land degradation in one way and land management conservations with its benefit in the other way. The extent to which theses conservations especially restricted grazing improves crop and milk productivity and its effect on the schooling of children remains an open question. What is striking in the policy debate of this region is the absence of empirical evidence of how much sustainable agriculture particularly zero grazing improves rural livelihood, especially empirical evidence based on data of farm house hold is scarce in explaining the investment returns of these conservation practices. This research, however, is intended to contribute to filling this research gap by exploring the causal impact of zero grazing on crop, milk production, child education and women time allocation.

While there is heterogeneity in factors influencing the choice of adopting zero grazing practices and/or conservation practices, the estimated results from participation model underscore that irrigation access, ratio of grazing area, distance to school were found statistically to be the leading factors to influence the adoption decision for zero grazing . In addition personal readiness to accept change in the household and strong participation in civic related issues have also significant and positive correlation on making decision for voluntary participation. Since active participants in development package and civic related issues are also active in social networking, accesses to information, these sources help promote adoption of zero grazing practices in the district.

The impact of zero grazing was evaluated using selected crop, milk production, child education and women burden indicators that were analyzed in three different ways:

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comparison of means, regression, and IV-2sls. A simple difference-in-means, however, does not establish the causality and, hence, recognizing this limitation of difference-in-means, the study also conducted multivariate analysis adequately controlling for confounding factors other than the participation in zero grazing. As most impact evaluation studies experience selection bias, this paper has been designed in such a way that this *endogenity* problem is solved using instrumental variable approach keeping the instrument to be valid and relevant. To check and supplement the regression results from IV-2sls, alternative methods such as propensity score matching and IV treatment regression were employed. Depending on the properties of the outcome variable, either a linear or nonlinear regression approach was adopted and produced the following statistical outputs of crop production, milk production, child education and women time allocation.

The impact evaluation study provides empirical evidence to suggest that the impact has beenmulti-fold. Economic benefits, in terms of increase in grain harvest, straw harvest and productivity in participant households are higher than in non-participant households, to a greater extent from teff cultivation activities and, to a lesser extent to wheat cultivation. The plausible causes are preserving crop residue or leaving stubble grazing and low soil compaction which are responsible to enrich soil fertility. The result also supports the argument that restricted grazing also substantially increases milk production, and incidences of calf death are less prevalent in participating villages than non-participating villages. The probability of newly born calf death is found to be less in policy villages than control villages. The magnitude of impact is, however, small due to early stage of implementation.

Children in zero grazing households enrolled more in primary schools compared to those in free grazing households with no pronounced differential impact on girl and boy child students. The results also depicts that participation substantially improves child school performance in the policy villages as compared to children of controlled villages by improving class attendance significantly and positively. This is due to time savings in cattle rearing and stubble keeping. However, the findings also confirm that time spent by wife on managing animal increases substantially in zero grazing households. In addition, women in zero grazing households seems to play more significant roles in household decision, particularly regarding the education of children, than their counterparts in free grazing areas by taking the highest share of responsibility in animal management activity at home. Women in zero grazing households tend to be better informed and more aware about child education than their male counterparts, partly from being member of social networking and closeness to extension training center.

Overall, the study indicates that households living in zero grazing villages enjoy a better quality of life and most of the economic, social, and environmental outcomes are better in participant households than in non-participant households due to zero grazing. The impacts are quantifiable, statistically significant, positive and visible in all outcome indicators. However, most of the impacts are modest in magnitude due to low official and community involvement in its implementation, which seems largely limited to villages partially with access to irrigation, low ratio of grazing area and short distance to school. This is not surprising, as the flow of benefits from zero grazing is slowly emerging and will take time to translate into substantial impacts.

Recommendation

The results of this paper have important policy implications for the design of optimal policy in the region. While the policy shows a remarkable significant economic benefits of increasing crop production, milk production and elementary child education given the time duration of implementation short, these result are only indicative, just beginning to be realized and now relatively small in magnitude. It might be that awareness creation and setting enforcement regulation is too limited to meet the full objectives of the intervention. A lesson may be that agricultural and environmental policies have to be considered jointly so that rural households not only improve their livelihood by enhancing agricultural productivity but also preserve environmental sustainability. Policymakers should provide additional focus to aware the rural society and help them perform better. Dissemination of extra information and awareness rising about its social and economic benefit would be a step forward to ensure its expansion and sustainability There is more potential to improve the productivity of crop and milk as well as child education by promoting and encouraging willingness for participation by the households through awareness creation, training exposure, model demonstration and setting village-based regulatory frame work which could be enforced by the local village leaders since information constraint took the highest rate of reasoning for being non participants. At the same time, migrating from free grazing to zero grazing will take some time, and its space coverage will depend on an enabling prudent policy environment and effectiveness of awareness campaign that ensures community ownership and leadership in the region, otherwise this impact is likely to remain unsustainable.

Development impact of zero grazing is very material as it helps provide a better quality of life and potential for incremental crop production as well as child education. It should be noted that rural zero grazing is not only, of course, a necessary, but also a sufficient condition for expanding income opportunities, enhancing soil fertility, improving environmental and ecosystem service. Unless substantive complementary investments in improving complementary fodder are made by planting *sesbaniasesban*, improving feeing home system, reducing livestock size to few quantity of better quality etc, the willingness for closing animal at home is likely to remain below lifeline in the foreseeable future for most of the households in the region.. Farming system that successfully integrates crop and livestock production can create substantial multiplier effects, thus promoting and stimulating growth in local economy.

Although a simple mean comparison test and regression using confounding factors ensures internal validity, the external validity using only small sample size may limit its application and replication to the other parts of the region. Its output, therefore, cannot be regarded as a decision-making criteria but as a supportive evidence to design zero grazing policies and allocate resources for its sustainability. Hence, this study can be only taken as a proxy to the other areas of the region and a further impact evaluation using more representative sample size is not only a necessary condition but also a sufficient condition to come up with rigorous inferences based on which a decision can be made.

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