Road Development Impacts on Agriculture in Ethiopia, the Case Studies of Weldiya-Mile, Gelagu-Gendewuha and Ginchi-Kachise Roads

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Abstract—Road transport provides better accessibility to markets for agricultural output and additional investments. Even though it plays a central role in rural development, yet little is known about the extent of the distribution of benefits that arises from the road developments particularly in lower developed countries. The main objective of this research is to assess the impacts of road infrastructure on agriculture and its productivity along Weldiya-Mille, Gelago-Gendewuha and Ginchi-Kachisi Roads in Ethiopia which are 165; 125; and 105 kms in length respectively. The study covers the influence zone of 10 kilometers each from the road center. The researcher has employed primary data of before and after the intervention by using mixed methods of data collection considering quasi experimental design (QED). The researcher had utilized two types of impact analyses for comparison: a) for each of the roads considered, there is comparison of current conditions with those before the intervention and, b) there is comparing conditions in the project road relative to a control zone which are not benefiting from improvements over the period of the study. The findings show that Ginchi-Kachisei Road is the first by utilization of chemical fertilizer as compared to other corridors under study. When we see maize productivity in all corridors the road intervention has strong significant impacts in the span of 1-5 kms than 5-10kms from the study road (at P value less than 0.001 and 0.05 respectively). In other side, the significant differences along Weldiya-Mille and in all corridors show negative road intervention impacts for sorghum. Therefore, keeping various variables constant, road intervention has plaid to bring changes in some agricultural outputs.

Index Terms— Access, change, corridor, COZ (control zone), highway, impacts, intervention, spatial, temporal, transport, ZOI (zone of inf.

1 Introduction

Ethiopia is predominantly an agricultural country. Per se, a majority (72.4%) of surveyed households of three corridors are engaged in farming as their first livelihood choice and 8.0 percent as the second livelihood choice.

This research presents the results of the household survey carried out in the influence zones (ZOI) and control zones (COZ) of three corridors: Weldiya-Mille, Gelago-Gendewuha, and Ginchi-Kachisi. The analysis had been made from 392 households of three regions in Ethiopia (Amhara, Afar and Oromiya).

2. Description of the Study Area

The Mille-Weldiya corridor is Federal road approximately 165 kilometers long and is located in north-eastern Ethiopia. About 102 kms (62%) of the length stretches through Afar Regional State and the remaining 63 kms (37%) falls in Amhara Regional State. The greater part of the line in Afar Regional States is situated in arid and semi arid climate, where the community is dominated by pastoral nomadic way of life. The gravel construction of Weldiya-Mille road was undertaken between 2006 and 2008.The Gelago-Gendewuha is located in Amhara region and has125kms is also located in Oromiya Region Climatically, Gelago Gendewuha road is located in semi arid area whereas Ginchi-Kachise road is located in moderately hot climate and populous area as compared to study lines selected. The construction of both routes was completed in 2007 and still gravels road type.

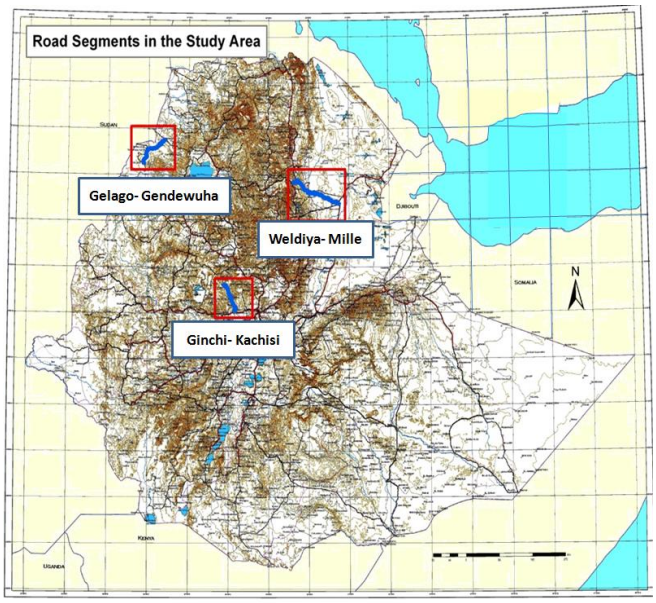

Figure 1 Location of the Study Area

Source: Developed by the author based on original map from [1]

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3. Literature Review

Impact of rural roads is commonly studied by using mixed methods [2]. They used 288 agricultural households and interviews in Delta State, Nigeria. They specified models in order to estimate factors that determine output and income among rural households. The OLS technique was used to estimate the relevant parameters. The findings indicated that rural roads had a significant positive effect on agricultural output, reduced transportation cost, stimulated demand for rural labour, improved rural income and promoted inter-sectoral linkages between the agricultural and non-farm sector that enhanced income diversification strategies among rural households. Road quality had also brought about a strong positive response on output and income as a 10% improvement in road quality caused a 12% and 2.2% increase in agricultural output and total household income respectively. However, the methodology they used did not consider the study influence zones from both side of the road line, the use of the base line (temporal scope considerations), the counterfactual factors as well as the control zones for the comparisons spatially.

It is economists' and geographers' philosophy that transport infrastructure is not productive by itself, but it is responsive to forces generated in the production and consumption sectors. The need for transport infrastructure is always a derived call for and the study of transport is perceived as a study of different sectoral activities in the economy. In this research, transport is approached from a geographic point of view which emphasizes that transport is an infrastructural element with powerful implications for overall development in general and agricultural development change in particular. Since impact study is a change study, the basis of this study is from theory of change perspectives. It is defined as "… an outcomes-based approach which applies critical thinking to the design, implementation and evaluation of initiatives and programmes intended to support change in their contexts"[3]. In other words theory of change is "The description of a sequence of events that is expected to lead to a particular desired outcome" [4].

4. Impacts of Road Development on Agricultural Productivity

Most commonly produced subsistence types of crops in the study areas are maize, sorghum and teff. Sesame and small amount of cotton as cash crops are produced particularly in climatically hot areas. Under this subtitle the discussion will focus on impacts on productivity for the first three types of crops with regard to temporal scope (between before and after road interventions) and spatial scope(between ZOI and COZs).

4.1Productivity of Maize

Table 1a illustrates that the average land productivity for maize has some differences temporally and spatially. Accordingly,

the average yearly yield of maize along the road of Ginchi-Kachsis takes a lion's share compared to the corridors under study. Its production in the ZOI and COZs is 33.17 and 22.21 Qt per hectare respectively after road intervention, but keeping the respective zones, the yield is 21.29 and 10.07 Qt per hectare before road intervention. The paired sample t-test confirms that there is strong significant change at p value less than 0.001. Even though insignificant difference, maize productivity in COZs of Galgo-Gendewuha and Weldiya-Mille has better figure during before intervention than after intervention. The influence is due to long distance from the road as well as land is depleting from time to time. When we see maize productivity in all corridors the road intervention has strong significant impact in the ZOI than COZs (at P value less than 0.001 and 0.05 respectively).

4.2Productivity of Sorghum

Like productivity of maize illustrated above, the output of sorghum has temporal and spatial disparities (Table 1b). Temporally, Road of Ginchi - Kachisi has better road intervention impacts than other corridors. The average yield per quintal is 14.35 and 15.87 before and after intervention respectively in the ZOI. But in the respective intervention periods the amount in COZ is 17.84 and 19.79 Qts per hectare which is greater than the amount in ZOI. Therefore, the road intervention has negative impacts on sorghum spatially along Ginchi - Kachisi corridor only. However, the impact is significant at p value less than 0.10 in ZOI and at less than 0.05 for both in this corridor. In other side, the significant differences along Gelago –Gendewuha corridor and in all corridors show negative road intervention impacts.

4.3Productivity of Teff

As illustrated in Table 1c Weldiya – Mille corridor is not comfortable climatically for some indigenous seed types of teff. That is why the data is not available in the table. But during after road intervention, some about six farmers have adopted improved seed types and chemical fertilizer. Due to this new innovation, the interviewed and FGD participants reported that the community in Gelago –Gendewuha corridor started to use teff as the main staple food.

Part of Weldiya – Mille corridor is also not comfortable for teff production too. Very wide part of Afar region is not producing teff but Hara study area in Amhara near Afar is cultivating teff, though the utilization of modern agricultural impute is poor. Because of this, the productivity per hectare is 1.64 and 4.42 times lower than the before intervention period in ZOI and COZs respectively. But spatially, the productivity is better in ZOI than COZs.

From the point view of Corridor 3, it has still a strong significant p value at less than 0.001 due to road intervention. Various reasons can be mentioned among which, Corridor 3 is the first by utilization of chemical fertilizer as compared to other corridors under study

TABLE 1
PRODUCTIVITY OF CEREALS IN THE STUDY CORRIDORS

(a)Maize Productivity(Qt/ha)

Corridors	Period	Mean value			Std. Deviation			T-value		
		ZOI	COZ	Both	ZOI	COZ	Both	ZOI	COZ	Both
1	Before	10.02	9.06	9.70	7.98	7.29	7.68	-0.92(NS)	-0.87(NS)	-1.19(NS)
	Now	11.12	8.88	10.65	9.68	5.72	8.23			
2	Before	15.97	14.45	18.37	14.73	22.25	19.93	0.65(NS)	0.84(NS)	0.85 (NS)
	Now	14.53	1378	15.29	11.39	9.78	10.62			
3	Before	21.29	10.07	19.79	32.85	10.25	28.05	-3.91*	-5.26*	-4.65*
	Now	33.17	22.21	29.84	56.70	12.68	48.03			
All	Before	18.26	14.74	17.09	28.22	13.20	23.99	-3.77*	-2.13***	-4.22*
	Now	26.49	17.64	23.40	48.39	11.95	39.61			

(b)Sorghum Productivity(Qt/ha)

1	Before	17.29	8.90	13.79	29.17	5.79	22.87	1.31(NS)	-0.92(NS)	1.16(NS)
	Now	12.31	9.70	11.18	6.62	5.65	6.36			
2	Before	21.70	20.93	22.52	17.55	21.86	19.38	4.46*	2.16***	4.62*
	Now	13.52	12.18	13.54	8.48	9.54	9.03			
3	Before	14.35	17.84	15.37	9.60	15.50	11.98	-1.86****	-1.19(NS)	-2.37***
	Now	15.87	19.79	17.20	9.48	16.68	12.58			
All	Before	17.63	14.31	16.57	21.49	15.42	19.52	2.36***	0.68(NS)	2.55***
	Now	13.71	13.40	13.60	8.23	11.64	9.59			

(c)Teff Productivity(Qt/ha)

1	Before	-	-	-	-	-	-	-	-	-
	Now	-	-	-	-	-	-			
2	Before	15.10	12.08	14.65	11.42	13.21	12.28	4.43*	1.13(NS)	3.66**
	Now	9.19	8.50	9.31	7.35	7.03	7.35			
3	Before	10.05	9.02	9.78	8.40	5.81	7.65	-3.56**	-3.65**	-4.88*
	Now	12.86	12.30	12.77	8.49	7.68	8.22			
All	Before	11.68	10.18	11.25	9.74	9.10	9.52	-0.05(NS)	-1.12(NS)	-0.72(NS)
	Now	11.71	11.65	11.73	8.33	7.75	8.11			

*NB: NS: Not significant, ****: significant at p < 0.1, ***: significant at p < 0.05, **: significant at p < 0.01,*
**: significant at p < 0.001,*
1= Gelago – Gendawuha; 2= Weldiya – Mille; 3= Ginchi - Kachisi
Source: computed by the Author based on the field survey, 2014

4.4 Productivity of Major Cash Crops

Major cash crops cultivated in the study areas are cotton and sesame only along Gelago – Gendawuha corridor. All cash crops show greater productivity in ZOI than COZs. But the productivity is lower in the period of after intervention than before intervention. This shows that the road impact is negative. The p value significant at less than 0.10 is not due to road intervention. For instance, this Corridor does not use modern fertilizer as compared to Ginchi - Kachsi.

4.5 Level of the use of Agricultural Technology

To evaluate the level of agricultural technology used by the farmers, six variables have been selected. Namely: use of power tiller for plowing the use of improved seeds chemical fertilizers, herbicides /pesticides, thresher machine for harvesting, and irrigation. Accordingly, when a farmer uses all the six technologies stated above, he will be referred as level 1, when a farmer uses any five, four, three, two, one or if he does not use at all, the respective levels will be 2, 3,4,5,6 and 7. The measurement indicator is assumed to show that, if the mean value is approaching to 1 there will be a better use of agricultural technology, if the mean value is around 3.75 there will be moderate use of agricultural technology and if the result is

approaching to 7 the poor usage will increase.

Based on these criteria the computation has been done temporally and spatially as shown in the Table 2
The use of mentioned inputs Gelago - Gendewuha corridor is better after road intervention than before (5.73 and 6.62 in the ZOI) and 5.68 and 6.78 in COZs) respectively). Even though it shows a strongly significant change of P value less than 0.001, the agricultural technology use is at the infant stage. The information from the interview and FGD is that, many farmers do not use chemical fertilizer by stating that "*…the land is naturally fertile*", "*…the chemical fertilizer use does not agree with the land they have at harsh climate area and sometimes it is against the expectations".* Some of them also relate with their affordability and full of doubts thinking that they may not get output at the harvesting stage. None of them also use thresher and combiner due to economic reasons. The use of irrigation is also scantly due to non availability of water around.

Weldiya _Mille corridor also shows very low use of the technology than the rest corridors (P value of less than 0.10). The changes temporally happened are almost the same to Gelago - Gendewuha corridor. Generally the changes resulted after intervention is almost nearer to index 7 caused by backward use of modern agricultural use. Sharing the reasons mentioned for Gelago - Gendewuha corridor, the additional point here is that, more than 50% area is hot climate and promotes pastoral and semi pastoral activity which still need more innovations to use agricultural technology.

TABLE 2
LEVEL OF AGRICULTURAL TECHNOLOGY USED IN THE STUDY CORRIDORS

Corridors	Period	Mean value			Std. Deviation			T-value		
		ZOI	COZ	Both	ZOI	COZ	Both	ZOI	COZ	Both
1	Before	6.62	6.78	6.69	1.02	0.52	0.86	4.66*	6.07*	7.09*
	Now	5.73	5.68	5.72	1.34	1.19	1.28			
2	Before	6.56	6.33	6.41	0.85	0.92	0.92	2.39***	0.00(NS)	2.11***
	Now	6.28	6.33	6.23	1.12	0.92	1.07			
3	Before	5.74	5.66	5.73	1.43	1.48	1.43	7.16*	5.75*	9.12*
	Now	4.65	4.45	4.59	1.35	1.09	1.28			
All	Before	6.22	6.22	6.21	1.26	1.18	1.23	8.60*	7.43*	11.24*
	Now	5.37	5.33	5.35	1.46	1.32	1.41			

*NB: NS: Not significant, ***: significant at p < 0.05, *: significant at p < 0.001.*
1= Gelago – Gendawuha; 2= Weldiya – Mille; 3= Ginchi - Kachisi
Source: computed by the Author based on the field survey, 2014

In terms of Ginchi – Kachsis corridor , the mean value of agricultural technology used is above half of the index value. This Corridor takes the first rank in using agricultural technology. There is a strongly significant change temporally due to road intervention (P value less than 0.001), but the changes are almost similar spatially. This may be due to the fact that URAP road accesses had created new opportunity sharing almost the same service facility in ZOI and COZs.

4.6 Changes on Marketable Surplus from Major Cereals and Cash Crops

Table 3 is about temporal and spatial variations of marketable surpluses from agricultural products. Temporally, it illustrates that households during before road intervention were producing better than after road intervention except in Ginchi – Kachsis corridor for cereals. The mean value of surplus production has been increased by 64.82, 70.62 and66.48 percent for ZOI, COZS and for both zones of Corridor Ginchi – Kachsis respectively. In other words keeping the respective zones, the P value is significant at less than 0.001, 0.01 and 0.001. But spatially COZ has more agricultural surplus than ZOI. The main reason here is that households in ZOI are engaged in other non agricultural activities. Temporal impacts in Corridor 2 and 1 are negative at P value less than 0.01 and with no significant impact respectively for cereals. With this end deterioration of the arable land due to overuse should not be forgotten.

In terms of cash crops, there are no significant cash crops produced in Corridor 2 and 3, but Corridor 1 is a sole producer of sesame and cotton. In this regard, the p value for the later shows negative impact at less than 0.01. This shows that the road intervention has no positive impact. But even though the yield is in the decreasing trends, as FGD and interviewed information, the road intervention has created better market and paved the opportunities to construct warehouses at road access centers like at Gelago and Shinfa towns. They suggested that it is after road intervention that much sesame is loaded and sold at better price. Due to this opportunity households in Corridor 1 have the highest yearly income than other Corridors. By forming association or individually, some farmers are selling cash crops at Gendewuha where well organized market facility has been opened. Various farmers speak about crucial importance of Gendewuha – Gelago road because of it facilitated to transport cash crops easily as well as the importing and accessing laborers for agricultural activities, seasonally.

TABLE 3
MARKETABLE SURPLUS FROM MAJOR CEREALS AND CASH CROPS (Qt)

Corridors	Peri-od	Mean value			Std. Deviation			T-value		
		ZOI	COZ	Both	ZOI	COZ	Both	ZOI	COZ	Both
Marketable Surplus from Cereals										
1	Before	34.75	28.89	32.27	-7.86	-14.75	-10.6	0.83(NS)	1.79***	1.62(NS)
	Now	32.02	24.63	28.85						
2	Before	14.65	16.96	14.32	-60.68	-65.21	-59.92	3.780**	3.21**	4.22*
	Now	5.76	5.90	5.74						
3	Before	9.75	12.83	10.74	64.82	70.62	66.48	-5.346*	-3.41**	-6.05*
	Now	16.07	21.89	17.88						
All	Before	18.69	19.63	19.08	2.35	1.58	2.36	-0.33(NS)	-0.17(NS)	-0.42(NS)
	Now	19.13	19.94	19.53						
Marketable Surplus from Cash Crops										
1	Before	28.84	19.49	25.35	25.56	29.86	26.9	1.49(NS)	2.62***	2.18***
	Now	21.47	13.67	18.53						

*NB: NS: Not significant, ****: significant at p < 0.1, ***: significant at p < 0.05, **: significant at p < 0.01,*
**: significant at p < 0.001.*
1= Gelago – Gendawuha; 2= Weldiya – Mille; 3= Ginchi - Kachisi
Source: Computed by the Author based on the field survey, 2014

From Corridor 3 point of view, particularly Jeldu *wereda* has implanted new technology for potato production by introducing improved seeds. The area is now coming to be the model in Ethiopia. To facilitate such opportunity, the road penetration and improvement has been plaid a paramount role as qualitative data confirms.

5.CONCLUSIONS

This research has focused to evaluate the agricultural input changes due to interventions of roads at three different locations in Ethiopia. These three road corridors have great contribution to the national economy. In other saying, keeping other factors constant, it is due these road penetrations that better output gained accompanied by adoption of modern agricultural inputs particularly in Corridor Ginchi - Kachsi. The P values form paired sample t test shows that there are positive development changes in some areas but also negative such as in Corridor Weldiya - Mille and Galago - Gendewuha. Therefore, the output is not as expected which is not matching with good introduction of agricultural technology. This study tries to proof the importance of impact evaluation at the study areas by answering the questions of 'what works and what doesn't?, and how is the extent of the impact produces information to the policy makers; and finally contribute individual and organizational learning that can be inspired by doing impact evaluations. Informing decision makers on whether to expand, or improve the intervention, programs and policies are linked to this point for further alternative interventions.

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