THE EFFECT OF RURAL ROAD TRANSPORT INFRASTRUCTURE ON SMALLHOLDER FARMERS' AGRICULTURAL PRODUCTIVITY IN HORRO GUDURU WOLLEGA ZONE, WESTERN ETHIOPIA

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ABSTRACT

This study was carried out to examine access to rural road infrastructure and its effects on smallholder farmers' agricultural productivity in Horro Guduru Wollega Zone, Western Ethiopia. A three stage random sampling technique was employed to select 500 farming households in the study area and data was collected on their socio-economic and farm specific characteristics. The collected data was analyzed using descriptive statistics and stepwise multiple regression analysis. The result of multiple regression model used revealed that distance to major market is important in predicting agricultural productivity of smallholder farmers at 5% levels of probability in Abe Dongoro, Amuru and Hababo Guduru districts. Ownership of intermediate means of transport was also found to influence agricultural productivity in Horro, Amuru and Hababo Guduru districts ($p = 0.05$). Further analysis of the regression model showed a significant negative correlation between distance to nearest all weather roads and distance to zonal head quarter on one hand and agricultural productivity on the other hand in Abe Dongoro, Hababo Guduru and Amuru districts. Rural kebeles of Abe Dongoro and Amuru districts which has vast agricultural potential were found to be the most inaccessible in Horro Guduru Wollega Zone. It is therefore suggested that interventions in the transport sector should include provision of rural roads as well as measures that will help improve vehicle supply in rural areas. An attempt has to be done also to increase the use of intermediate means of transport to ease agricultural inputs and outputs mobility and farm access.

Keywords: rural road, agricultural productivity, smallholder, Horro Guduru

Received 19 November 2016; Accepted 21 February 2017; Published online 19 April 2017

1. Introduction

The overall development of agriculture depends on various supportive rural infrastructural facilities (Usman et al. 2013). Efficient and effective rural transportation serves as one of the channels for the collection and exchange of goods and services, movement of people, dissemination of information and the promotion of rural economy (Adedeji et al. 2014). It is also clear that development of rural infrastructure generally contributes significantly to the level and quality of rural development. Countries that have developed their rural infrastructure have recorded higher and better quality of rural development than those that have failed to do so (Economic Commission for Africa 2013).

The existence of accessible, acceptable, efficient transportation system is a pre-condition for linking remote farm areas located far from consumer centers with the agricultural production process (Taiwo, Kumi 2013). The transport system is fundamental to economic and social development in rural areas, and significant investment is required to ensure it is of a suitable level. Transport is considered as a key factor involved in agricultural development all over the world. It is the only means by which food produced at farm site is moved to different homes as well as markets. Market for agricultural produce is created by transport; furthermore, transport increases interaction among geographical and economic regions and opens up new areas to economic focus (Tunde, Adeniyi 2012). Road transport is the most predominant mode of transportation in all over the world and this is a confirmation of the crucial role transport plays in the socio-economic development of a nation (Ajiboye, Afolayan 2009).

In Ethiopia, studies have shown that, at national level, the agricultural sector employs, at least, 80% percent of the working population. More than 48% of the Nation's Gross Domestic Product (GDP) comes from agriculture. The smallholder sub-sector plays an important role in generating national output and livelihood systems in the predominantly agro-based economy of Ethiopia. The agricultural sector of Ethiopia accounts for more than a third of gross domestic product and generates more than 90 percent of export earnings (Worku 2011).

In Ethiopia, the issue of rural transportation development has continued to be of national importance. For instance, most of the rural roads are in poor condition, and this has imposed significant cost on the national economy especially to the agricultural activities due to increased vehicle operating costs and travel times. The Federal Government of Ethiopia has embarked on various programs like Growth and Transformation Plan (GTP) at one time or the other to ensure the provision of adequate transport facilities to meet the needs of the rural population but these programs have not been able to

https://doi.org/10.14712/23361980.2017.7
Tamene, S. – Megento, T. L. (2017): The effect of rural road transport infrastructure on smallholder farmers' agricultural productivity in Horro Guduru Wollega Zone, Western Ethiopia
AUC Geographica, 52, No. 1, pp. 89–99

achieve required successes. It is against this background that this study examines the impact of rural road transport infrastructure on agricultural productivity in Horro Guduru Wollega Zone, western Ethiopia. This study underlines the essentiality of the role and contribution of the rural road transport systems in supporting efficient rural agricultural activities, especially the productivity of small-scale producers.

In light of the above, it becomes expedient to examine rural transportation problems, so that the extent of the problems can be known, and possible solution proffered to achieving sustainable rural development. In this paper, an attempt has been made to analyze the effects of rural road infrastructure on smallholder farmer's agricultural productivity.

2. Problem statement and research objectives

Many rural Africans still suffer from poor access to markets, health, schooling, and high transport costs (Perschon, 2001). Inadequate rural roads make it hard for farmers to produce more and to transport any surpluses after harvest. Traffic on most rural roads still consists mainly of pedestrians often carrying head loads (DFID 2008; Lindsay 2015). Poor and inadequate rural roads have been the main concern by both small producers and consumers. Rural Africa has only 34% of road access covered as compared to 90% in the rest of the world (AFDB 2010).

Rural transport infrastructure is still poorly developed in Ethiopia, and therefore it is a crucial impediment for the growth of the rural as well as national economy. For instance, only 27% (Lulit 2012) of the rural population has access to all weather roads in 2011, compared to 60% in India and 61% in Pakistan (Giz 2013). The road density of Ethiopia per thousand square km was 49 km during the same period which falls far behind the average road density of lower middle income countries which is about 0.3 km/sq.km (IRF 2006; Lulit 2012). Therefore, most places in the country especially in the rural areas have still low road accesses and poor connectivity to major road networks.

Ethiopia's rural road network is one of the least developed in sub-Saharan Africa. The poor tends to live in isolated villages that can become virtually inaccessible during the rainy seasons. When there is a post-harvest marketable surplus, it is not always easy to reach the markets. Limited accessibility has also cut off small-scale farmers from sources of inputs, equipment and new technologies. Crop productivity is therefore low because farmers lack these important inputs. In particular, inadequate access to fertilizer is a real problem in many parts of Ethiopia where farmers have to cope with diminishing soil fertility (Fakayode et al. 2008). Consequently, efficient rural road transport infrastructure is central to raising agricultural productivity and increasing growth in Ethiopia. However, evidence show that a weak rural road transport infrastructural base has been one of the major factors militating against the attainment of the Ethiopia's growth and development objectives.

It is extremely difficult for most farmers who live and farm in the Horro Guduru Wollega Zone to gain access to all weather roads vehicles on which to transport their farm produce to home and market centres on time. In effect, the socio-economic wellbeing of the smallholder farmers is seriously affected due to high cost of agricultural in- puts and depressed prices of farm produce. Poor road conditions, high transport costs and distant markets have been identified as factors that hamper improved market access for smallholder farmers in Horro Guduru Wollega Zone.

Despite being the second populous country in Africa and one of the poorest, the question of how to reverse low agricultural productivity in Ethiopia is one that the research community has scarcely touched upon. To the researcher's knowledge, no attempt has been made to estimate the effects of poor rural road infrastructure on the structure of smallholder farm production in Ethiopia. This paper aims to fill that gap using cross-sectional data from the survey of 500 farming households in four districts of Horro Guduru Wollega Zone, Western Ethiopia.

The principal objective of the study was to investigate the effect of rural road transport infrastructure on agricultural productivity of smallholder farmers. Particularly, this research was undertaken to achieve the following three specific objectives: (1) identify the socio-economic characteristics of smallholder farmers in the study area, (2) identify the available and mostly used means of transportation in the study area, and (3) examine farmers' agricultural productivity level in relation to the existing road transportation infrastructure.

3. Research methodology

3.1 Study area

This study was conducted in Horro Guduru Wollega zone, Western Ethiopia. The capital town of the zone, Shambo, is located 314 km away from Addis Ababa to the Western part of Ethiopia. The zone comprises nine rural districts. According to the report of (CSA 2011), Horro Guduru Wollega zone covers a total land area of 8,097 km^2; a total population of 641,575 of which 50.09% are male and 49.91% are female. This study was conducted in four districts of Horo Guduru Wollega zone namely, Ababo Guduru, Horro, Abe Dongoro and Amuru (Figure 1).

3.2 The research design

Survey designs are the most important research designs in quantitative research (Creswell 2012). In

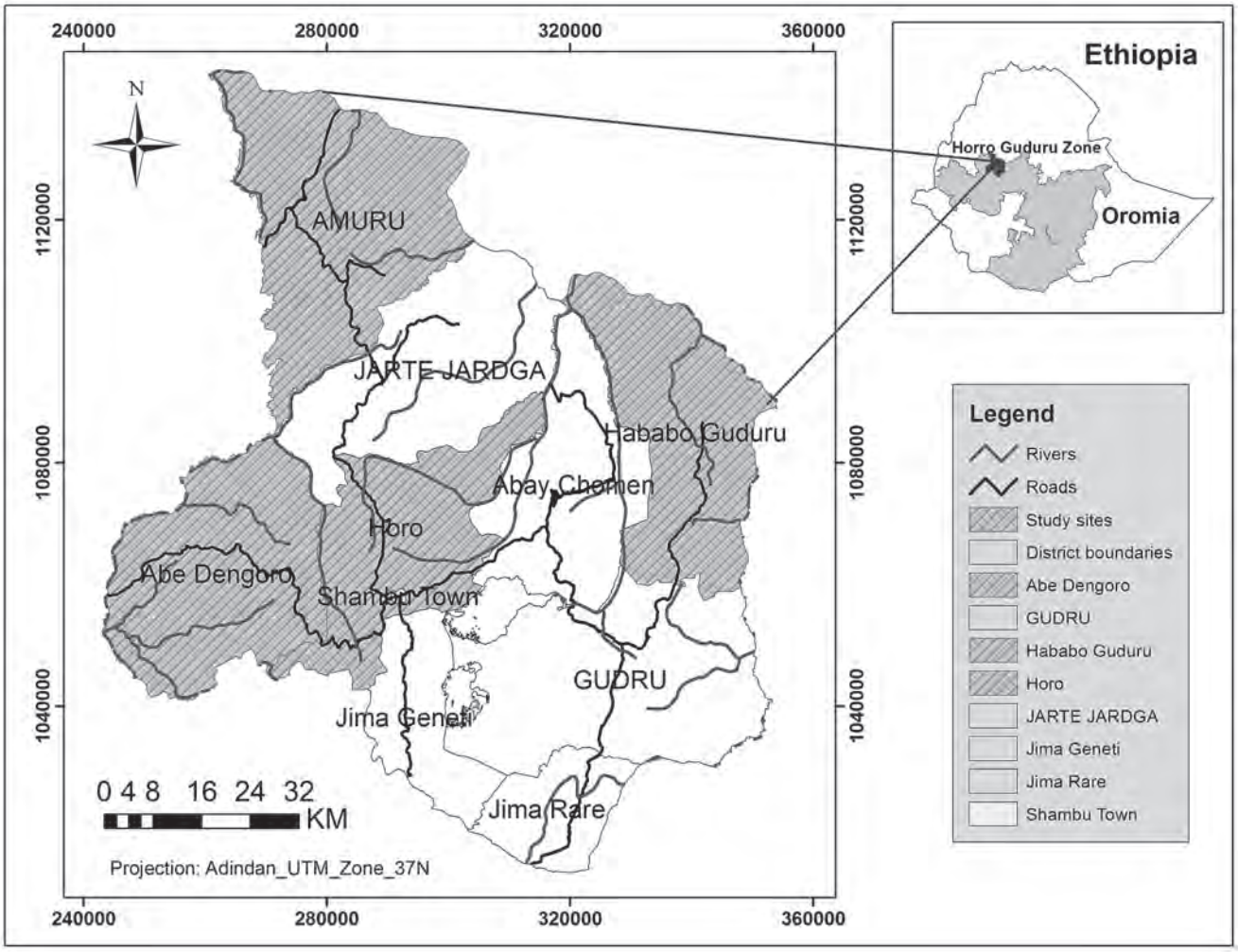

Fig. 1 Map of study area, Horro Guduru Wollega Zone by districts.
Source: Adapted Finance and Economic Development Bureau of Oromia, 2016.

explaining the effect of rural road transportation infrastructure on the agricultural productivity of smallholder farmers, survey research design was adopted and relevant data were collected through structured household questionnaire. The questionnaires are designed to collect data regarding farm-household characteristics (i.e. age, gender, education, family composition and farm size), the existing rural road transport facilities in the area, the available and mostly used means of transportation, quality of rural roads and status of smallholder farmers' agricultural productivity. Thus, for this specific research a cross-sectional survey method was employed as it is comparatively less costly, less time consuming, easier to employ, and most appropriate for data collection from smallholder farmers (Brown, Suter 2012; Saunders et al. 2007).

3.3 Sampling technique and sample size determination

Horro Guduru Wollega Zone was identified as one of the potential cereal crop producing corridors of Ethiopia. On the contrary, the existing rural road transport infrastructure in the zone is not satisfactory to support the existing agricultural potential of the area. Keeping this in view, HGWZ was purposively selected by the researcher. A Multistage simple random sampling procedure was used to derive a sample size of 500 respondents in 16 rural kebeles of the four districts of the study area. The first stage involves a random selection of four districts from the nine districts of HGWZ. Alternatively, the names of all districts of HGWZ were written on pieces of paper and the desired sample (four districts) were selected by picking the required number of papers. In such simple random sampling method, the selection of one district is independent of the selection of another district. As a result, four districts (Hababo Guduru, Horro, Amuru and Abe Dondoro) were selected. The second stage involves the random selection of four rural kebeles (RKs) from each of the four districts making a total of 16 RKs. The same simple random sampling procedure was used in the selection of RKs in each district.

The third and final stage was the random selection of farm households from each RK. The list of farm households in each RK was compiled with the assistance of the extension agents and RK manager. This list of farm

households will form the sampling frame for this particular research. According to Gray et al. (2007) suggestion, the researcher used 95% confidence level (plus or minus 5 percentage points as a reasonable margin of error) to determine the sample size for this specific study. Accordingly, there will be only a 5 per cent chance that the actual coverage in this population is outside the margin of error determined by the survey. In other words, we can be confident that in 95 out of 100 surveys the true rate in the population would lie within this margin. These calculations must be repeated for each of the sample RKs in the respective sample districts. It is usual that RKs may vary considerably in the number of smallholder farmers they contain and hence to avoid bias, probability proportional to size (PPS) was employed (Table 1). RKs with larger size of smallholder farmers would have a proportionately greater chance of being included in the sample than those with small size of smallholder farmers. Thus, 500 smallholder farmers from the four districts were sampled for the study (Table 1).

Tab. 1 Sample design outlay for selecting study respondents.

Sample Districts	RK	Total farm household size	Sample size at 95% confidence level
Hababo Guduru	Moti Kawo	713	37
	Lalistu Loya	717	39
	Koticha Melole	260	15
	Sirba Loya	416	22
Horro	Odaa Buluk	549	25
	Haro Aga	1117	57
	Tokuma Alshaya	789	39
	Abe Dulacha	692	30
Amuru	Jawi Migir	516	29
	Gobu Sirba	476	25
	Haro Gudina	418	23
	Warabera	236	19
Abe Dongoro	Lomicha	978	47
	Oda Boti	433	24
	Botora Bora	469	28
	Mender 25	873	41
Total		**9652**	**500**

Source: Own sample design by using data obtained from kebele, 2016.

3.4 Methods of data collection

Both primary and secondary information were obtained for the study. The primary data were gathered through a structured household questionnaire administered by trained enumerators to the selected household heads of smallholder farmers. The study questionnaire was first pre-tested for reliability and validity. Essentially, the data was cross-sectional in nature. These data were collected between February 2016 and June 2016. The primary data include: the socio-economic characteristics of smallholder farmers such as marital status, gender, household size, farming experience, farmland size, level of education, mode of transportation often used for transporting agricultural produce from farm to home and from home to market. Rural road transport infrastructure condition such as distance to major market, distance to the nearest all weather road, ownership of intermediate means of transport in household, road distance to zonal headquarter, travel time on foot to nearest major city are among the primary data included in the household survey.

A pre-tested structured questionnaire for sample household farmers was used for primary data collection. A total of 500 copies of structured questionnaire were directly administered to the selected 500 smallholder farmers across the 16 selected samples RKs. Sample household farmers generally agreed to answer the questions willingly, and non response was almost zero. The data collection exercise took five months and involved the researcher and trained data collectors in each selected sample RKs.

The primary data obtained from the study respondents was augmented with secondary data sources. The secondary data was collected from books, journals, bulletins, magazines, internet and other literature materials. Production and productivity of major agricultural crops and related information of the study area was collected from CSA abstracts and statistical handbooks as well as from regional, zonal and district level agriculture and rural development offices.

3.5 Data processing and analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software version 20. Data gathered from respondents was subjected to different statistical techniques. These were including the descriptive statistics (mean, percentage, frequency, coefficient of variation). Inferential statistics such as simple correlation, stepwise multiple regression methods was employed to examine and establish statistical relationship between agricultural productivity as dependent variable and rural road transport infrastructure as various independent variables. A multiple regression analysis provides a means for objectively assessing the degree and nature of the relationship between dependent and independent variables. The multiple regression analysis for examining the relationships between rural road transport variables and smallholder farmers' agricultural productivity level was carried out in a stepwise method because it takes into account the issue of collinearity, the identification of outliers and the significance of linear regression coefficients. The stepwise method is sequential in approach, starting the analysis by selecting the best predictor of the dependent variable. Additional independent variables are selected in terms of the incremental explanatory power they can add to the regression model. Independent variables

are added as long as their partial correlation coefficients are statistically significant.

In order to check whether there is a problem of multicollinearity, the rule of thumb, according to Gujarati (2004), is a value ≥ 0.8 in correlation coefficients between variables. As a result, Variance Inflation Factor (VIF) was computed for the variables used in regressions and no problem of multicollinearity was detected. Similarly, to check for model fit, the Hosmer and Lemeshow Test was used, which correctly predicted more than 80% of the variables.

3.6 Analytical model

The dependent variable, smallholder farmers' agricultural productivity level (yield), was measured in quintals per hectare (q/ha) and in birr/quintal. The following analysis seeks to establish whether there is any systematic relationship between rural road transport condition and smallholder farmers' agricultural productivity level. For this purpose a multivariate regression analysis was employed. This is because the model and variables used in this analysis satisfy the following three principles of this method: (1) there is only one dependent variable, (2) this variable is a parametric number, and (3) there are several parametric independent variables. Social science researchers commonly describe the different ways they measure things numerically in terms of scales of measurement, which come in three flavors: nominal, ordinal, interval or ratio scales (Brown 2001). Each is useful in its own way for quantifying different aspects of variables. Before analyzing a data set, it is important to determine each variable's scale of measurement because certain types of statistical procedures require certain scales of measurement. In this research, the variables used to explain the socio-economic characteristics of smallholder farmers are measured at nominal and ordinal level of measurement. Whereas, many of the dependent and independent variables used in the regression analysis in this research are measured at an interval or ratio level of measurement. A multiple regression analysis provides a means for objectively assessing the degree and nature of the relationship between dependent and independent variables. The regression model for this specific case is of the form:

$$Y = a + b_1x_1 + b_2x_2 + b_3x + \ldots + b_{27}x_{27} + U_i$$

In which:

Y = the agricultural productivity level (the dependent variable), measured by the monetary value of the total annual yield from farm in birr comprising all crops grown on the farms and their market prices;

a = intercept;

b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8 … b_{27} = change (coefficient) in agricultural productivity levels associated with a unit change in the farmers socio-economic variables and rural road transport variable (the independent variable) considered.

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3\ldots\ldots\ldots\ldots b_{27}x_{27} + U_i,$$

where:

Y = total annual yield from farm (monetary value in birr);

x_1 = farming experience (years);

x_2 = age of respondent (years);

x_3 = marital status (married, single and widow);

x_4 = distance to the nearest all weather road (km);

x_5 = education level of household head (no formal education, primary, secondary and tertiary education);

x_6 = ownership of intermediate means of transport in household (IMT) (number of IMTs in the household);

x_7 = vocational skill of household head (no = 1, yes =2);

x_8 = distance to Major Market (DSMM) (km);

x_9 = sex of household head (SEX) 1, if male; 0, if female;

x_{10} = road distance to zonal headquarter (km);

x_{11} = travel time on foot to nearest major city (min);

x_{12} = frequency of visits to the nearest town (daily, weekly, fortnightly, monthly and occasionally);

x_{13} = category of road access (asphalt concrete road, gravel road and earth road);

x_{14} = road surface condition (good, fair and bad);

x_{15} = road access condition (no vehicular access, dry season only access and all weather access);

x_{16} = road reliability in raining season (reliable and not reliable);

x_{17} = major means of transportation (head loading/human portage, animal drawn carts, pack animals and truck/car);

x_{18} = farm inputs (none, one input, two inputs and three inputs);

x_{19} = household size (number of household members);

x_{20} = farm size (hectares);

x_{21} = transport cost to the farm (in birr);

x_{22} = waiting time at the road side before accessing commercial vehicles (min);

x_{23} = distance to agricultural extension offices (km);

x_{24} = distance to agricultural farmer training centers (km);

x_{25} = distance to agricultural cooperatives (km);

x_{26} = distance to microfinance institutions (km);

x_{27} = distance to the farm (km);

U_i = error term assumed to have a zero mean and constant variance.

4. Results and Discussion

4.1 Socioeconomic characteristics of respondents

Table 2 presents the summary statistics for socioeconomic characteristics of the respondents. With respect to

Tab. 2 Socioeconomic characteristics of respondent smallholder farmers.

Sex of household head	Male	450	90
	Female	50	10
Marital status	Married	400	80
	Single	40	8
	Widow	60	12
Education level of household head	No formal education	120	24
	Primary education	260	52
	Secondary education	70	14
	Tertiary	50	10
Household size	1–3	125	25
	4–6	170	34
	7–9	130	26
	10–12	75	15
	Mean = 6		
Farming experience	1–10	40	8
	11–20	225	45
	21–30	110	22
	31–40	75	15
	41–50	50	10
	Mean = 15		
Farm size	≤ 1	50	10
	1.1–2.0	145	29
	2.1–3.0	170	34
	3.1–4.0	100	20
	>4	35	7
	Mean = 2.4		

Source: Computed from the field survey, 2016.

the first research question, it was found that the majority of the respondents are male (90.0%) and married (80%). About 24% of the respondents do not have formal education and this affects their innovation and diffusion of new ideas which might further reduce their agricultural productivity. An average household size of farming household in the study area is made of about 6 persons. The finding in this investigation was somewhat higher compared to a 4.8 persons per household at national level (CSA 2007). A possible explanation for this might be that they may be ready source of family labor on the farm. Furthermore, the rural economy is normally associated with small-scale family farms. Such units of production are characterized by labor intensive operations and limited resources.

Moreover, the study reveals that majority (45%) of the sampled farmers have between 11–20 years of farming experience. This indicates that most of the farmers sampled have enough farming experience. From Table 2, it can be seen that the mean score for farm land holding sizes per household was found to be 2.4 hectares which is above the national average of 1.14 hectares (CSA 2015). Just 10% of the respondents have farms less than 1 hectare where as the majority (34%) of the respondents cultivated between 2.1 and 3.0 hectares. This indicates that majority of the farming population in the study area are small scale farmers and were producing at subsistence level probably as result of the condition of poor rural road infrastructure that may not support large-scale and commercial production. Only 7% or 35 of the 500 respondents have farms above 4 hectares in size. This indicates that majority of the farming population in the area are small scale farmers.

4.2 Mode of transportation used by smallholder farmers

Table 3 shows that 44% of those who were interviewed indicated that they used human porterage as a means of transport to move their agricultural produce from farm to home. Likewise, Of the 500 smallholder farmers who completed the questionnaire, just 177 (30%) of them indicated that they employed the use of pack animal to transport their agricultural produce from farm to home whereas 21% use animal cart (mule, donkey or horse) for the same purpose. Surprisingly, only a minority of respondents (5%) reported that they are using motorized transport to move their agricultural produce from farm to home. Taken together, the most obvious finding to emerge from this analysis is that smallholder farmers largely depend on traditional non- motorized mode of transport to move their agricultural produce. This result is in agreement with the findings of different researchers (Usman et al. 2013; Starkey 2005; Barwell 2006) who observed that, most rural dwellers in Africa depend more on IMT than motorized transport. Surveys such as that conducted by Usman et al. (2013) have shown that owing to the very poor condition of road transport in Kwara State of Nigeria only 1.1% of the respondents own personal four wheeled vehicles and hence many people are forced to depend on motorcycle and bicycle as means of transportation. A similar work by (Porter 2013) revealed the fact that since Poor people rarely own motorized means of transport, so walking, cycling and animal traction predominates.

The higher percentage use of head porterage was observed in Abe Dongoro and Hababo Guduru which is 42% and 48% respectively as compared to the other two districts. There are several possible explanations for this result. First, these two districts are said to be far away from zone capital shambo and less attention was given to them with regard to road transport infrastructure development. Second, the physical topography of Abe Dongoro district is not welcoming the use of motorized transport. The most likely reason for the large percent (36%) of smallholder farmers in Horro district to use motorized transport (car) to move agricultural produce from home to market is due to its physical proximity to zonal capital. One possible reason behind the use of pack animals by the majority of respondents (43%) as compared to motorized transport (7%) is because of the bad condition of the rural roads from their home to markets. Another possible explanation for these results may be the lack of

Tab. 3 Mode of transportation of agricultural produce from farm to home and from home to market.

District	Mode of transport to move produce from farm to home				Total	Mode of transport to move produce from home to market				Total
	Headloading / human porterage	Pack animal	Animal cart	Car		Headloading / human porterage	Pack animal	Animal cart	Car	
Hababo Guduru	54 (48%)	33 (29%)	19 (17%)	7 (6.2%)	113 (100%)	44 (40%)	31 (27%)	7 (6%)	31 (27%)	113 (100%)
Horro	53 (35%)	57 (38%)	30 (20%)	11 (7%)	151 (100%)	30 (20%)	59 (39%)	8 (5%)	54 (36%)	151 (100%)
Amuru	38 (40%)	31 (32%)	19 (20%)	8 (8%)	96 (100%)	24 (25%)	36 (37%)	3 (3%)	33 (35%)	96 (100%)
Abe Dongoro	59 (42%)	56 (40%)	17 (12%)	8 (6%)	140 (100%)	34 (24%)	59 (42%)	5 (4%)	42 (30%)	140 (100%)
All	204 (44%)	177 (30%)	85 (21%)	34 (5%)	500 (100%)	115 (23%)	215 (43%)	35 (7%)	135 (27%)	500 (100%)

Source: Computed from the field survey, 2016.

adequate capital to pay for motorized transport. These results seem to be consistent with other research findings which revealed that bad condition of the road affects cost of transportation of agricultural produce (Moyo, Machiri 2015; Hine, Ellis 2001). It can therefore be assumed that the effect of higher percentage use of head porterage in the study area has limited the potential level of farmers' production for the reason that they can only carry certain quantity at a time.

4.3 Distance to major market and agricultural productivity

As indicated in Table 4 above, the correlations between distance to major market and agricultural productivity in

Tab. 4 Multivariate correlation analysis on rural road transport infrastructure condition and agricultural productivity using stepwise multiple regression method.

Districts	Stepwise regression method		
	Variables	Standardized Coefficients	R^2
Abe Dongoro	Distance to major market	−0.579	0.580
	Distance to the nearest all weather road	−0.670	
	The frequency of visits to the nearest town	+0.598	
	Transport cost for farm produce	−0.599	
Horro	Distance to major market	−0.328*	0.390
	Distance to the nearest all weather road	−0.279*	
	Ownership of intermediate means of transport in a household	+0.570	
	Category of road access	+0.430	
	Road access condition	+0.490	
	Transport cost for farm produce	−0.450	
Amuru	Distance to major market	−0.484	0.669
	Ownership of intermediate means of transport in a household	+0.540	
	Road distance to zonal headquarter	−0.440	
	Distance to the farm	−0. 490	
	Transport cost for farm produce	−0.450	
Hababo Guduru	Distance to major market	−0.597	0.563
	Distance to the nearest all weather road	−0.486	
	Ownership of intermediate means of transport in household	+0.520	
	Road distance to zonal headquarter	−0.620	
	frequency of visits to the nearest town	+0.480	

* Regression coefficient is not statistically significant at 0.05 levels.
Source: Computed from the field survey, 2016.

this investigation were higher for Abe Dongoro (–0.579), Amuru (–0.484) and Hababo Guduru (–0.597) districts. The regression results show that distance to major market negatively related (and statistically significant at the 5% level) to agricultural productivity. The implications for this finding is that farm households found at far distant from the market are less likely to produce crops for marketable surplus since the market price decays with physical distance, ultimately defining a threshold beyond which crop production is not economically viable.

The result thus obtained is compatible with the findings of Stifel and Minten (2003) that got statistically significant and negative correlation between agricultural productivity and distance to market center. This finding is also in agreement with Hine and Ellis' (2001) findings which showed that intensity of food production decreases as distance to market increases. In contrast to this finding, however, Goletti et al. (2001) found that distance to the nearest market does not statistically affect farmer's productivity.

4.4 Distance to the nearest all weather road and agricultural productivity

The other rural road transport related variable used in the regression analysis to estimate the effect of rural road on agricultural productivity was the distance to the nearest all weather road. The results of the correlational analysis in this research showed a significant and negative correlation (–0.67) between distance to the nearest all weather road and agricultural productivity for Abe Dongoro district. This is the indication that the presences of all-times accessible roads as the principal means of access to the farm household causes transport services to exist, which in turn is expected to increase their agricultural productivity.

A strong relationship between distance to the nearest all weather road and agricultural productivity has been reported in the literature. For instance, prior study by (Obayelu et al. 2014) has noted the importance of paved or good gravelled roads for the evacuation of agricultural produce. The observed correlation between the two variables might be explained by the fact that the growth of farm productivity is linked closely to the type and quality of rural road infrastructure in place. This means that countries that will provide adequate, affordable and accessible road infrastructure in rural areas will succeed in increasing their agricultural productivity.

4.5 Frequency of visits to the nearest town and agricultural productivity

It is apparent from Table 4 above that the frequency of visits to the nearest town correlates positively with agricultural productivity (0.598) quite revealing that the higher the frequency of visit by smallholder farmers the higher their farm productivity. Recent investigations reported by Osuolale and Ogunniyi (2015) also support the hypothesis that the frequency of visits to the nearest markets determine access to agricultural input and output markets. In a similar case in South Africa, Chaminuka et al. (2008) found that farmers who frequently visit the towns usually access different service like extension services, cooperatives, banks and post offices at a time. It can thus be suggested that investing in the growth and development of rural town centres will have positive benefits for smallholder farmers by making such services more easily accessible.

4.6 Transport cost for farm produce and agricultural productivity

It is argued that competitive rural transport is required to ensure that the advantages from reductions in transport costs are passed on to smallholder farmers. Unfortunately in Horro Guduru Wollega Zone this is far from the case. A significant negative correlation was found between transport cost for farm produce and agricultural productivity (–0.45) denoting that the higher the transport cost that farmers pay for their agricultural produce to move from farm to home or home to market the lower their farm productivity. This result provides further support for the hypothesis that reduced transport costs lower the costs and profitability of supplying modern inputs such as fertilizers, seeds, extension services and other technologies which finally increases crop productivity. This finding seems to be consistent with other researches (Jacoby, Minten 2007; Sabandar 2004) which found that differences in crop productivity among farm households are partly attributable to transport costs.

4.7 Category of road access and agricultural productivity

Category of road access correlates positively with agricultural productivity (0.43), which means as the quality of road access increases (i.e from earth road to gravel) the productivity of smallholder farmers will increase. It is encouraging to compare this finding with that found by Ashagidigbi et al. (2011) who found a significant positive correlation between category of road access and economic productivity of farmers' output. Similarly, by using time series data for 256 districts in India Narayanamoorthy, Hanjra (2006) found a strong and positive relationship between road infrastructure development and agricultural productivity. These lines of reasoning have been supported by many African and Asian studies (Kassali et al. 2012; 2014; Tunde, Adeniyi 2012; Felloni et al. 2000; Qin, Zhang 2012).

4.8 Ownership of intermediate means of transport and agricultural productivity

Closer inspection of Table 4 above shows that ownership of intermediate means of transport was

highly correlated with agricultural productivity in Horro (+0.57), Amuru (+0.54), Hababo Guduru (+0.52) districts implying the higher the proportion of ownership of intermediate means of transport the higher the productivity of farm households. This result may be explained by the fact that the various intermediate means of transports complement motorized transport systems, fulfilling needs for collecting and distributing agricultural produce over relatively short distances. Another possible explanation for this result is that intermediate means of transport are appropriate to transport small and medium loads as compared to motorized means of transport. These results are in line with the work of Sabandar (2004), who argued that local market and intermediate means of transport are critical in relation to rural welfare. This finding corroborates the ideas of Stifel et al. (2013), who found a 50 percent reduction in transport costs when using IMT as opposed to motorized means of transport. Similar conclusions were raised by World Bank (1988), who argued that transporting crops to village markets and collection points often involves intermediate means of transport, to connect to the larger, motorized transport services needed to move produce to distant markets.

4.9 Road distance to zonal headquarter and agricultural productivity

As indicated in Table 4, the correlations between road distance to zonal headquarter and agricultural productivity were higher for Amuru (−0.44) and Hababo Guduru (−0.62) districts compared to those of other two districts. This higher correlation for Amuru and Hababo Guduru districts might be attributed to their relative remoteness from zonal center. This finding indicates that since zonal center is considered to be the hub for input and produce markets, as proximity to zonal center decreases farm productivity of farming household is found to decrease. In the literature, a well-established inverse relationship between these two variables was found by many studies. An example of this is the study carried out by Philemon (2014) that strongly emphasized remoteness and consequent poor access to social-services and opportunities as a key factor in low farm productivity. In another major study, Stifel and Minten (2007) found that rice prices are 13 percent more variable in the most remote areas compared to the least remote.

There are some empirical evidences that support these general arguments in Ethiopia as well. For example, Arethun and Bhatta (2012) conducted on contribution of rural roads to access to and participation in markets in Ethiopia and they come up with the conclusion that road accessibility as one of the major factors influencing the productivity of rural household. Likewise, Kifle (2010), in his dissertation work entitled 'Road Infrastructure and Rural Poverty in Ethiopia' found the fact that remoteness from the market forced smallholder farmers either to accept low prices for agricultural produce they market or consume it at farm level although they prefer to sell.

4.10 Distance to the farm and agricultural productivity

Finally, the other rural road transport related variable assumed to influence smallholder farmers' agricultural productivity was the distance to farm plot. Thus, in Amuru district there was a significant negative correlation (−0.49) between distance to the farm and agricultural productivity. Preliminary results from stepwise regressions indicate that distance to farm contribute to explain farm performance by correlating negatively, and statistically significant to agricultural productivity. Therefore, farmers in Amuru district covered long distances before getting to their farm plots and this is expected to influence the productivity and production performance of farmers. This result may be explained by the fact that when the farm land of smallholders is far apart from their home the greater was the cost of: transportation, farm management and supervision. This in turn hindered the optimal application of modern agricultural inputs and led to low productivity. It is encouraging to compare this finding with that found by Ojo and Afolabi (2003). In their study on 'Effects of farm distance on productivity of farms in Nigeria', Ojo and Afolabi found that farm distance to key infrastructure such as road correlate negatively with agricultural productivity. Similarly, further studies by (Ekbom 1998; Ojo 2008) also observed statistically significant effects of farm distance on agricultural performance of smallholder farmers.

5. Conclusion

The main goal of the current study was to explain the effect of rural road transport infrastructure on smallholder farmers' agricultural productivity in Horro Guduru Wollega Zone, Western Ethiopia. One of the more significant findings to emerge from this study is that distance to major market, category of road access, road access condition, ownership of intermediate means of transport, transport cost for farm produce, distance to the nearest all weather road and the frequency of visits to the nearest town, road distance to zonal headquarter were found to be important in predicting agricultural productivity in the study area. Spatial vulnerability in road quality and availability was observed among the four selected districts of Horro Guduru Wollega Zone. The quality of rural road infrastructure in Horro Guduru Wollega Zone indicates that the zone is still backward in terms of rural road infrastructure development despite its huge agricultural potential. A large proportion of the total length of all the roads in the study area is not paved. Due to the high agricultural potential of the area, these roads nevertheless, carry considerable volume of traffic in rural areas. The ability to carry traffic can be enhanced if these rural roads

are properly maintained. There is urgent need to rehabilitate the roads in order to improve rural road accessibility which further increases smallholder farmers' agricultural productivity in rural areas.

Acknowledgements

This research was financially supported by the Ministry of Education of the Ethiopian Democratic Republic, Addis Ababa University and Wollega University. Authors would like to thank the executive editor Eva Štefanová as well as the two anonymous reviewers for their constructive comments and recommendations.

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RÉSUMÉ

The effect of rural road transport infrastructure on smallholder farmers' agricultural productivity in Horro Guduru Wollega Zone, Western Ethiopia

The aims of this study are detailed analysis of the effects of rural road transport infrastructure on smallholder farmers' agricultural productivity in Horro Guduru Wollega Zone, Western Ethiopia. Rural transport connectivity increases smallholder farmers' crop productivity after controlling for other factors. The effects of this connectivity are assumed to take place through a decline in the transport costs of agricultural outputs, which raises the producer prices of agricultural produce. Reduced transport costs in rural areas also lower the costs and profitability of supplying modern agricultural inputs such as improved seeds, chemical fertilizers, extension services, and other technologies. Distance to major market, category of road access, ownership of intermediate means of transport, transport cost for farm produce, distance to the nearest all weather road and the frequency of visits to the nearest town were found to be important in predicting agricultural productivity in the study area. Results indicate that the quality of rural road infrastructure development in the study area is poor based on the proportion of asphalt concrete and graveled road per kilometer square. Spatial vulnerability in road quality and availability was observed among the four selected districts of Horro Guduru Wollega Zone. Therefore, there is urgent need to rehabilitate the roads in order to improve rural road accessibility which further increases smallholder farmers' agricultural productivity in rural areas.

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