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Full Length Research Paper

Assessment of operational aspects of the input supply chain under national agriculture input voucher scheme (NAIVS) in Tanzania

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This study examines the operational aspects of the National Agriculture Input Voucher Scheme in Tanzania from 2009/2010 to 2010/2011 based on secondary and primary data. Primary data were collected from a random sample of 300 households in four regions namely: Rukwa, Mbeya, Morogoro and Shinyanga. Secondary data were collected from the Ministry of Agriculture Food Security and Cooperatives (MAFC), Agro dealers and Local Government Authorities. Results indicate that 88% of farmers reported delayed subsidized inputs significant at $p = 0.05$. The inputs become available during planting season when most of the household food stocks and income is exhausted and this makes top up price unaffordable. It was also observed that the top up price is more than stipulated cost sharing of 50% between farmers and the government. Other pitfalls reported in the system include input adulteration and violation of NAIVS guidelines for input distribution. It is recommended that inputs and crop calendars be established that would ensure inputs arrived to beneficiaries ahead of the planting season. In addition, efficient monitoring and evaluation system should be put in place to minimize inefficiency emanating from violation of NAIVS guidelines.

Key words: Tanzania, input vouchers, farmers, institutional framework, subsidy programme.

INTRODUCTION

Many African countries resumed fertilizer subsidy in early 2000 in an attempt to enable smallholder resource poor farmers use inputs to boost production and reduce poverty (Ricker-Gilbert and Jayne, 2009; Chibwana et al., 2010; Danning et al., 2009b). The new system of subsidy is market "Smart" and concurrent with Abuja declaration which resolved to increase timely access and raise fertilizer use by farmers in African Union (AU) member states to an average of 50 kg/ha by 2015 (Danning et al., 2009a; Tiba, 2010; Yawson et al., 2010). It is market smart as pointed out in Minde et al. (2008) and Baltzer and Hansen (2011) because it has a specific

target, measurable impacts, achievable goals, results orientation and timely duration of implementation. Additionally, the declaration aims to eliminate barriers to fertilizer access such as tariffs on fertilizers and fertilizer raw materials in order to increase productivity, reduce food insecurity and poverty levels among smallholders. The new scheme originated from Malawi as a small starter pack in 1998 (Dorward and Chirwa, 2011; Druilhe and Barreiro-Hurlé, 2012). Other African countries such as Nigeria, Zambia, Tanzania, Kenya, and Ghana adopted the initiative at different time (Druilhe and Barreiro-Hurlé, 2012). The Government of United

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Republic of Tanzania resumed subsidy programme in 2003/2004 which was implemented through subsidising transport for companies that were involved in the distribution process of the inputs. The idea was to reduce the input cost below the market price to all farmers. Constraints in the distribution system of agricultural input under this arrangement were frequently reported. Some of the complaints raised include subsidy fertilizer ending up in the shops of input suppliers and thus being sold at the market price, inputs being smuggled to neighbouring countries, delayed inputs delivery, re-bagging fertilizer in warehouses and inputs not being effective due to quality deterioration. Additionally, many targeted farmers could not access the inputs under the 2003/2004 programme modalities and it was difficult to identify beneficiaries and non beneficiaries.

The National Agriculture Input Voucher Scheme was introduced in 2008/2009 as a reform of the previous subsidy policy programmes. Under NAIVS beneficiary, farmers are selected based on eligibility criteria. Some of eligibility criteria require farmers be residing in the village, and be willing to apply the subsidy inputs in the target crops in the area of a ½ ha (Pan and Christiaensen, 2012). Also, it targets farmers who have not afforded to apply inputs in the previous five years and able to pay the cash top up. Eligible farmers are provided vouchers that entitle them to buy inputs from agro-input dealers at a subsidized price. The voucher has a face value of inputs that government supports the farmer. It is contrary to previous National agricultural input subsidy programmes where the subsidy inputs were sold at a lower price than the market price of inputs to all farmers. NAIVS intends to increase the existing 9 kg/ha of fertilizer use, which is below Africa average of 21 kg/ha, and the world average of 100 kg/ha (Ricker-Gilbert and Jayne, 2009; Eboh et al., 2006; Baltzer and Hansen, 2011). It is also a government response to escalating food and input prices in the world aimed at increasing productivity and food security.

Allocation and distribution of inputs under NAIVS involves a chain of actors with established committees from national to village level. Selection of eligible farmers and committee members is guided by set guidelines. Each committee is assigned responsibilities for implementation to ensure targeting and timely delivery (MAFC, 2012). A pilot study by Pan and Christiaensen (2012) pointed out poor targeting performance whereby 60% of vouchers were captured by village elites. Moreover, the increase in number of vouchers available for distribution was found to enhance the targeting performance. Baltzer and Hansen (2011) have pointed out that, study by Pan and Christiaensen (2012) focused mainly on targeting and did not discuss the performance of the input voucher delivery system. Consequently, there is limited knowledge on how the framework operates in delivering inputs to beneficiaries. It is uncertain whether or not the distribution process abides to stipulated national guidelines.

Also, it is not well known whether the programme has

managed to correct the inefficiencies of previous subsidy programmes. Effective implementation of subsidy programmes requires a well functioning institutional framework in the supply chain. Polski and Ostrom (1999) defined institution as a broadly known rule, custom or strategy that creates incentives for behaviour in a repetitive circumstance. Institutions are distinguished into three pillars of regulative, normative and cultural-cognitive institutions. Regulative institutions encompass incentive schemes, public procurement policies that are referred to as the formal institutions, while the remaining pillars are referred to as informal institutions (Truffer et al., 2009). The success of subsidy policy reform depends on the institutional arrangements available for translation of intentions into actions and outcomes. Evaluation, design or policy reform requires a systematic way of analysing existing arrangements, generation and comparison of alternatives. The analysis should contain well organised survey of how stakeholders act and reason for acting in a certain way rather than another (Polski and Ostrom, 1999).

The objective of this study therefore is to examine the operational framework of the input supply chain under the National Agricultural Input Voucher scheme in Tanzania. Specifically, the study to assess subsidy inputs distribution system in term of availability of vouchers, timely delivery, input quality and shared price. The knowledge from this study will provide insights on the existing strengths and weaknesses in the delivery system and form the basis for policy reform recommendations.

MATERIALS AND METHODS

Sampling design

Research was carried out in four regions namely: Mbeya, Morogoro, Rukwa and Shinyanga, whereby purposive and random sampling methods were used. Mbeya and Rukwa regions were chosen because these were pilot areas and main food crop producers. Recently, Morogoro and Shinyanga are new comers into the programme, moreover, Morogoro has been identified by the government as an emerging grain basket for the nation, and Shinyanga is among the major cash crop producing regions such as cotton that have benefited from NAIVS. From each participating village, farmers registers were used as sampling frames. Simple random sampling technique was used to obtain 5% of farmers for interview from respective registers. Boyd et al. (1981) contends that, a sample of 5% of the total population is statistically adequate in sampling. The distribution of respondents in the villages involved in this study is shown in Table 1.

Data collection procedure

The study used both primary and secondary data. Primary data were collected in a survey using a semi structured questionnaire administered to 300 households. Some of the collected data were on constraints and challenges on NAIVS input supply chain, access to inputs, distribution procedures, selection of the end users and agro dealers as well as participation in service delivery. Focus group discussions were conducted with key informants such as stockists, District Agriculture and Livestock Development officers

Table 1. Names of region, districts and villages involved in the survey.

Region	District	Village	Criteria of selecting	Non beneficiaries	Beneficiaries	Sample of farmers	Major crop(s) for input voucher
Rukwa	Sumbawanga	Chitete	Accessible	21	14	35	Maize
		Katete	Inaccessible	16	12	28	Maize
Mbeya	Mbozi	Isangu	Accessible	16	27	43	Maize/paddy
		Itaka	Inaccessible	7	36	43	Maize/paddy
Shinyanga	Bariadi	Ibulyu	Accessible	23	29	52	Cotton
		Nguliyati	Inaccessible	17	32	49	Cotton
Morogoro	Mvomero	Lusanga	Accessible	21	13	34	Maize/paddy
		Kinda	Inaccessible	10	6	16	Maize

(DALDOs) and Ginnery managers.

The main crops under subsidy that were considered in this study were maize and rice as food crops and cotton as a traditional cash crop. From each district, two villages were selected based on accessibility criterion; one village was accessible in terms of road network and other village inaccessible. Secondary data were gathered from public and private institutions and internet sources. Pretesting of the questionnaire was undertaken in "Wami-Luhindo" village located in Mvomero district. This village received input subsidy and has similar characteristic to villages under the subsidy programme.

Analytical framework

Institutional Analysis and Development (IAD) framework (Figure 1) was applied in the assessment of NAIVS operational aspects. In IAD framework, policy issue or objective is defined clearly, followed by analysis of physical and material conditions as they influence policy action and situation and constrain institutional arrangements. Physical and material conditions refer to physical and human resource capabilities related to providing goods and services. These include capital, labour, technology, financial resources, storage and distribution channels which play a significant role in policy design and implementation (Polski and Ostrom, 1999). Determination of physical and material condition of goods or services requires answering important questions that are focused in economic nature of activity.

Also, it considers the way a good or service is provided, produced, as well as the physical and human resources required for producing goods or services, and other important aspects in the distribution channel of goods and services. It analyses the community attributes such as demographic features, norms, values, beliefs, degree of general understanding and preferences on policy oriented strategies and outcome.

NAIVS operational framework

Six main actors were involved in the NAIVS implementation framework. Every actor assigned specific responsibilities stipulated in the National Voucher Guidelines (MAFC, 2012). Efficient operations were expected to result into timely delivery of quality inputs to target farmers and increased crop production. IAD framework is applied to evaluate the activities and performance of involved actors in the NAIV framework presented in Figure 2.

Data analysis

Data were analysed based on descriptive statistics using frequencies and cross tabulation with chi-square test. The statistical package for social sciences (SPSS) version 18 and Excel programmes were used.

RESULTS AND DISCUSSION

Government budget on input subsidy

Results revealed continued increase in government budgets for input subsidies from Tsh. 2.0 billion in 2003/2004 to Tsh. 128.7 billion in 2010/2011 fiscal year. Also the quantity of subsidized fertilizer and the number of beneficiaries has substantially increased as depicted in Table 2. In earlier years, the subsidy was supported from government budget, although from 2009 World Bank allocated a total of US\$ 299 million to support the subsidy programme (World Bank, 2012). It was difficult to account the number of beneficiaries in the previous subsidy programs although under NAIVS the number of beneficiaries is determined. In 2008/2009, the numbers of beneficiaries were 740,000 and increased to 2,011,000 in 2010/2011. However, the number decreased to 1,800,000 in 2011/2012 as farmers received the subsidy in 2008/2009 graduated from the program and were expected to be self dependent. These results are promising although it is unclear whether or not graduated farmers are self dependent. Baltzer and Hansen (2011) have pointed out that, sustainability of smart subsidies are expected if farmers are able to accumulate finance and productive assets to overcome market barriers after programme termination.

Input subsidies reduce fertilizer cost to farmers who otherwise would be excluded from fertilizer use due to limited ability to afford its cost. Increases in subsidy budget are associated with increase in demand for agricultural inputs which is likely to increase productivity.

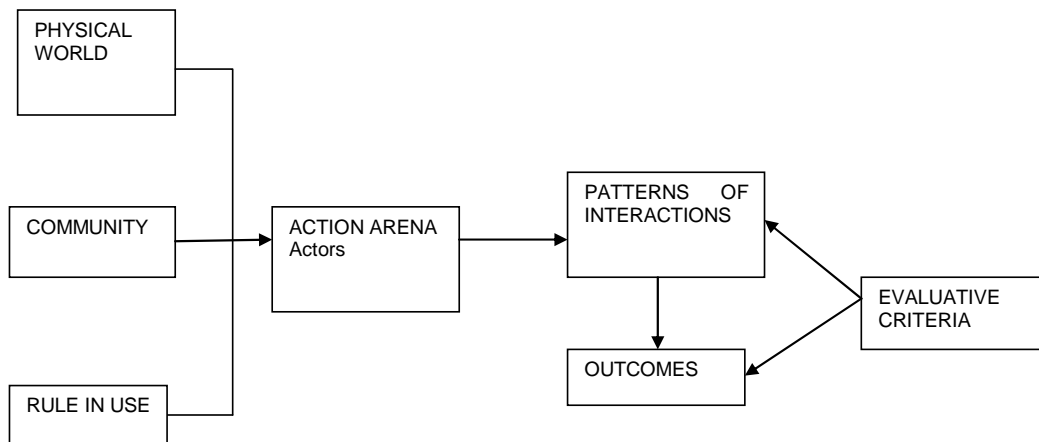


Figure 1. Institutional analysis and development (IAD) framework (Polski and Ostrom, 1999).

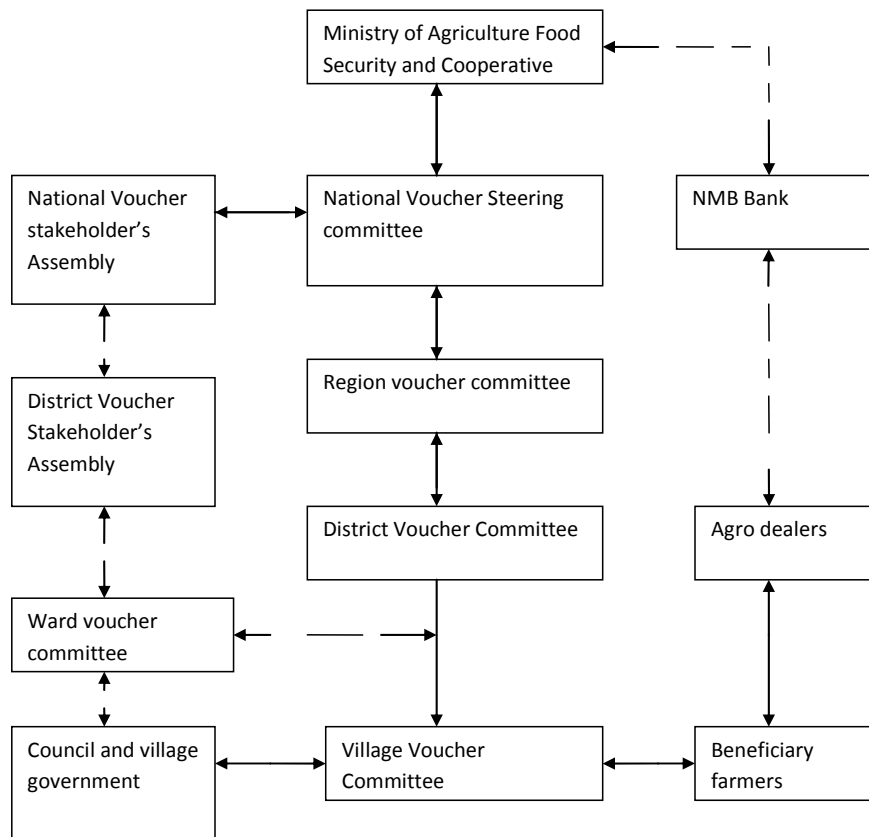


Figure 2. NAIVS implementation framework (MAFC, 2012).

However, increased demand for agriculture inputs might inflate input prices in the long run depending on the supply side of the inputs. Also, increased budgets on subsidies drive resources away from other public goods (Wiggins and Brooks, 2010; Nagy and Edun, 2002).

Cost sharing / cash top up

Fifty percent (50%) cost sharing between the government and eligible farmers was not practical in some districts as could be noted from Table 3. In Sumbawanga district,

Table 2. Budget for fertiliser subsidies to farmers (MAFC, 2013).

Year	Quantity of fertiliser subsidised (tons)	Amount of money spent on fertilizer (billions)	Subsidy as percentage of total agricultural budget	Number of beneficiaries
2003/2004	39,387	2.0	3.7	
2004/2005	81,766	7.2	11.3	
2005/2006	63,000	7.5	6.0	
2006/2007	90,755	21.0	17.3	
2007/2008	83,076	19.5	14.8	
2008/2009	130,000	31.9	28.0	740,000
2009/2010	142,000	69.2	30.3	1,511,900
2010/2011	201,015	128.7	50.8	2,011,000
2011/2012	195,959	118.6	45.9	1,800,000

Source: MAFC (2013).

Table 3. Variation in input costs at free market price and subsidy price.

Location	Input type	Free market price (Tsh)	Voucher value (Tsh)	Farmers contribution (Tsh)	Percentage of farmers contribution
Chitete	OPV maize seeds	39000	20000	19000	49
	DAP/NPK	82500	30000	52500	64
	Urea	72167	22000	50167	70
Katete	OPV maize seeds	39700	20000	19700	50
	DAP/NPK	82900	30000	52900	64
	UREA	72400	22000	50400	70

there was variation in farmer contribution depending on the location. The district established transaction costs to be charged by an agro dealer per bag of input including the profit margin depending on distance from main input supplier. There was variation in the amount of cash top up charged to farmers depending on input type and this cost exceeded 50% stipulated in the national input subsidy guideline. In Mbozi, prices were under the control of market forces of supply and demand. Farmers were free to use the voucher to buy fertilizer at any agro dealer in the district and there were many agro dealers. In Bariadi, the cost sharing was as stipulated in the national voucher guidelines, whereas Mvomero revealed mixed results. In Lusanga, cost sharing was 50% while in Kinda farmers received seeds free of charge with no fertilizers disbursed in 2010/2011 season. It was not clear whether the fertilizer was not in the distributed package or fertilizer was used to compensate the cost of seeds. However, report from the Ministry of Agriculture Food Security and Cooperatives (MAFC) revealed distribution of subsidies as a package suggesting malpractice in Kinda.

Total cost of top up contribution per subsidy package per eligible household in Rukwa was 123,000 TSh; and this was considered 41% higher than anticipated for interviewed households. Top up was considered afforded

by large scale farmers with more than 35% households undecided on who is able to afford the top up. This implies that, rich farmers benefit more from subsidies than poor farmers. It was noted that input distribution is done during planting season when most farmers do not have food stock left for sale to purchase inputs. Although, some farmers expressed the need for loans to purchase inputs, there were limited alternatives for credit services. To cope with top up, some farmers shared the cost for the input package and share the inputs. In case, farmers offered the voucher to their relatives who were able to pay top up although those relatives were not in the list of beneficiaries. By implication, farmers who share the subsidy package do not attain technical efficiency in production. Also, wealthier farmers benefit more from subsidy than poorer making economic efficiency of the programme doubtful.

Number of beneficiaries during 2008/2009 to 2009/2010 period

Generally, there has been increased trend in the number of beneficiaries (Figure 3). In absolute terms, Mbeya region leads in the number of beneficiaries followed by

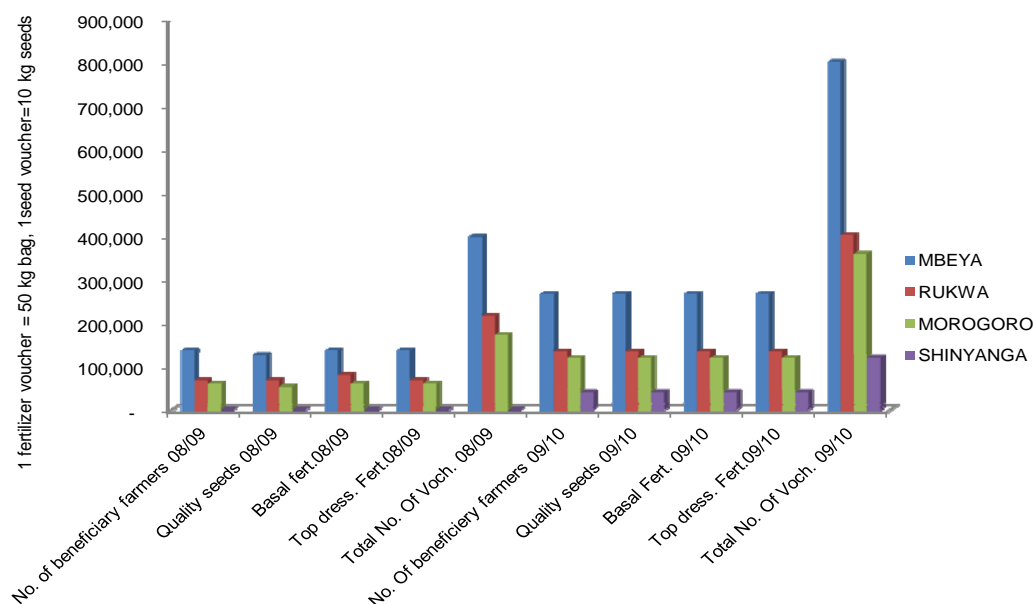


Figure 3. Number of input vouchers distributed to beneficiary farmers in the study regions.

Table 4. Percent response on subsidy received by household through voucher from 2008/2009 to 2011/2012.

Districts	One year	Two years	Three years	More than three years
Sumbawanga	37.04	37.04	25.93	0.00
Mvomero	73.68	26.32	0.00	0.00
Mbozi	17.74	30.65	51.61	0.00
Bariadi	38.98	40.68	18.64	1.69

Rukwa region. Morogoro and Shinyanga regions have lowest number of beneficiaries and input vouchers. Shinyanga region did not receive vouchers in 2008/2009. This is because cash crops were not targeted during the first year of NAIVS although in the subsequent years it was introduced. Increase in the number of beneficiaries and vouchers imply more fertilizer use and likely increase in productivity. However, the impact of these changes on productivity of target crops is a subject for another paper.

Targeting delivery

In Mvomero, 73.68% of households reported to have benefited from the subsidy for one year, and there was no household that reported to receive vouchers for three years (Table 4). In Mbozi and Sumbawanga, some smallholder farmers benefited from subsidy for up to three years. Even with some farmers receiving subsidy for three years, it was not provided consecutively. No farmers were found to benefit from subsidy for four years in the three districts. However, in Bariadi district, smallholder farmers received vouchers for up to four

years. In Bariadi district, provision of subsidy through vouchers system was changed during 2011/2012 season by introducing contract farming. Subsidy through contract farming does not limit the number of years the smallholder farmers should benefit from the programme. Under contract farming, farmers borrow inputs from a ginnery company and are required to sell cotton to the company at harvest time. Deductions for the input costs are made from sales of cotton and the balance remitted to the farmers. This is achieved through farmer groups. This implies that farmers who do not belong to groups do not benefit from the programme. Farmer groups are used for insurance purpose as social cohesion act as collateral. However, it is unclear how farmers will respond at harvesting time as the contract farming is still new.

Evaluative criteria and outcome

Eligibility criteria and farmers selection

Selected farmers were eligible to receive one bag of fertilizer (di ammonium phosphate) DAP (50 kg), one bag

Table 5. The likelihood of poor and rich farmers getting subsidy.

District	Response (%)			
	Sumbawanga	Mvomero	Mbozi	Bariadi
Selection in favour of relatively rich people	62.26	43.24	47.50	41.18
Selection in favour of relatively poor people	18.87	13.51	15.00	11.76
Equal chances of selection for poor and rich people	9.43	43.24	28.75	43.53
Poor chances of selection for rich people	0.00	0.00	0.00	1.18
Poor chances of selection for poor people	9.43	0.00	8.75	2.35
Total	100	100	100	100

Table 6. Voucher delivery time in the four districts (2008/2009 to 2011/2012).

Districts	Responses (%)	
	Late delivery	On - time delivery
Sumbawanga	30(91)	3(9)
Mvomero	32(88)	3(12)
Mbozi	61(95)	3(5)
Bariadi	50(79)	13(21)
Total	163(88)	22(12)

χ^2 (3, $N = 185$) = 8.01, $p = 0.05$.

of urea (50 kg) and 10 kg of maize seeds or 15 kg of rice seeds. Cotton farmers were eligible for cotton seeds and one acre pack of pesticides. The number of vouchers that were distributed to districts and villages did not meet demand of eligible farmers. As a result vouchers were given to farmers alternately; farmers who received vouchers in one year did not get them the following year. Inadequate vouchers created corruption and social conflicts among politicians, village leaders and farmers. On the other hand, non beneficiaries started refusing to contribute in community development projects in the village. They claimed to be discriminated and argued that subsidy input beneficiaries should be responsible to pay back in terms of contribution to community development projects. Farmers in the list of beneficiaries were forced to accomplish pending contributions in community development projects before they were given the vouchers. This was associated with inadequate awareness of the eligibility criteria. It was noted that farmers did not graduate after three years, which is contrary to exiting strategy in smart subsidies. Smart subsidy requires farmers to be subsidized for three consecutive years and graduate from the programme. After graduation, farmers are expected to become self sufficient and able to support themselves. Results presented in Table 5 show the likelihood of poor and rich farmer's selection in the programme.

In Sumbawanga and Mbozi, selection favoured relatively rich people likely related to the targeting criteria for farmer's ability to contribute the cash top up. Similar

findings have been reported in Malawi where subsidized fertilizer was often provided to wealthier households with community and political connections (Ricker-Gilbert, 2011).

Input subsidy delivery

The government prepares vouchers and deliver them to selected farmers through a series of committees from the national to the village level. Farmers submit the vouchers to selected agro dealers to redeem the inputs. The voucher has the value the government contributes and should be approved at district level. Agro dealers submit vouchers to a selected bank, which has been contracted by government; in this case, the National Microfinance Bank (NMB) to redeem money. Distribution is supposed to follow the National voucher guidelines stipulating the procedures to be followed by every actor in the channel. For example; recruitment of village vouchers committee and eligible farmers required farmer's participation through village assembly. Also village assembly were to select names of agro dealers to enter competition at district level where qualified dealers were approved. Observations indicate that village committees existed in all villages were gender balanced.

Timely delivery

Results on whether or not vouchers were delivered on time reveals that; 88% of households did not receive the inputs on time significant at χ^2 (3, $N = 185$) = 8.01, $p = 0.05$ (Table 6). Also, 68% of vouchers were delayed for more than seven weeks. In some situations where inputs were delayed, farmers had already planted maize using saved grains from the previous season. In such situation, they required only top dressing fertilizer, but instead they were forced to take the whole input package including basal fertilizer and asked to save the seeds and basal fertilizer for use in next cropping season. This was difficult as farmers resources are limited and have other priorities to allocate their money. Delayed inputs had consequences on continued reliance on poor quality

Table 7. Percent response on quality of distributed inputs.

Full name of village	Not quality inputs	Quality inputs
Chitete	1(5.9)	16(94.1)
Katete	0(0.0)	16(100.0)
Isangu	14(46.7)	16(53.3)
Itaka	8(22.2)	28(77.8)
Ibulyu	15(50.0)	15(50.0)
Nguliyati	13(38.2)	21(61.8)
Lusanga	1(6.3)	15(93.8)
Kinda	5(62.5)	3(37.5)

$\chi^2 (7, N = 187) = 31.4, p = 0.00$. Note: Number in the parenthesis is in percentages.

seeds and low adoption of production technologies. The farmer's decision of timely planting was interfered and in some situations late planting was practised, thereby increasing the probability of getting lower yields as they were totally dependent on rain fed agriculture. These findings imply failure to attain the NAIVS objective of timely delivery of inputs to farmers at reduced costs. Also, it is contrary to NAIVS guideline which requires vouchers to be distributed prior to planting season.

In some situations, special forms (paper certificates) were used to substitute vouchers to reduce the delayed time. However, the forms were useful when the MAFC informed Local Government Authorities to print the documents in advance. Even with these government efforts, about half of households who received the paper certificates were not able to purchase subsidized inputs as the certificates were rejected by agro-dealers (Malhotra, 2013). The implication is that, printed paper certificates were not the best option to overcome delayed vouchers. Also, a delay in disbursements of funds for used vouchers was noted leading to agro dealers default in loan repayment. The consequence was limited loan access from the National Microfinance Bank (NMB) to supply inputs in the following season, and failure of small agro dealers to remain in the input supply business. Smart subsidies such as NAIVS are aimed to promote private sector involvement in input business. Agro-dealers aim to generate profit from input business. Profit limiting environment is likely to encourage agro-dealers to exit from the input business lowering market competition which is not in favour of farmers.

Quality of distributed inputs

Results on whether or not the distributed inputs are of the right quality are significant $\chi^2 (7, N = 187) = 31.4, p = 0.00$ (Table 7). In Kinda, 62.5% of farmers reported poor quality of distributed maize seeds because they had low germination rate. Households in Isangu (46%), reported poor quality of distributed fertilizers. They complained of DAP being mixed with Minjingu which is relatively cheap;

and table salt was sold as calcium ammonium nitrate (CAN). Despite distribution of inputs through ginneries under contract farming in Bariadi, poor quality inputs were also prevalent. In Ibulyu village, 50% of farming households reported poor quality of pesticides, and argued that cotton seeds did not germinate. Quality inputs have standard criteria according to manufacturer specifications. Quality fertilizer has ability to release desired nutrients in the applied site where quality seeds have higher germination, plant vigour and high productivity. Seed germination, plant vigour and physical characteristic of fertilizers such as texture were determining factors of input quality.

Efficacy of pesticide was the main quality factor. Use of quality seeds, fertilizers and pesticides are crucial in agriculture productivity. Poor quality of delivered inputs implies that farmers have to incur extra costs of inputs and labour for replanting. Application of poor quality inputs is also a moral hazard especially under unpredictable weather conditions. Farmers in the study area depend entirely on rain fed agriculture and missing the first rains or late planting/replanting is likely to cause low production or even crop failures.

Voucher committee selection

Leadership reputation was stipulated as a requirement of members of village voucher committee. Some village leaders recruited weak representatives in the village voucher committee to protect their dishonesty interests. Reports from key informants revealed that, in some situations farmers were involved in selection of committee members, but were not courageous to refuse the names suggested by their leaders. Farmers were not well informed about their role stipulated in the national voucher guideline. They felt that by rejecting the appointed candidates they would face problems in their community because they would be considered to have acted against the system. In addition, more than 73% of farmers did not know where to report problems associated with the programme. In the guideline there is

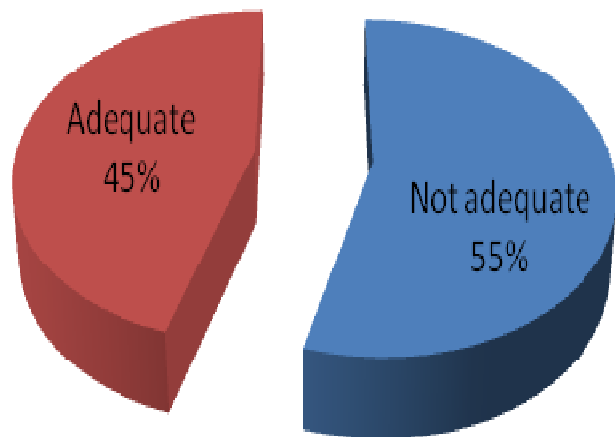


Figure 4. Availability of extension service under NAIVS.

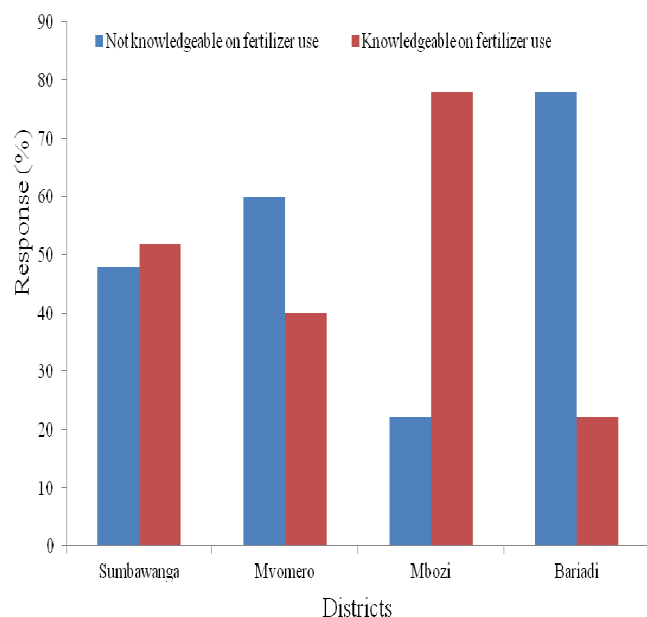


Figure 5. Household knowledge on chemical fertilizer use in percentage.

a provision of an opportunity to appeal to higher levels. Village complaints needs to be reported at ward level, ward to district and district complaints reported to region level, but farmers were not aware. The only option was to report problems to village leaders but in situations where village leaders were the source of problem, farmers were in dilemma.

Selection of agro dealers

Criteria for selection of agro dealers included possession of capital enough to run smoothly the service, short

distance from village, experience in input business and possession of Taxpayer Identification number (TIN). The application procedure was to send application to village government where village assembly chose the names of preferred stockists. Stockists with business based in the village were given priority. The chosen stockists were screened at district level. Research investigations revealed violation of procedures for some districts. In such districts, selected agro dealers were not from the list suggested by the village assembly and had no input shop in the district. Chosen agro dealers had limited capital to be able to distribute subsidy inputs on time and throughout the season.

Nevertheless, key informants reported that selection of committees and agro dealers was interrupted by some politicians.

Extension and farmer’s knowledge on input use

Extension service

Inadequate extension service under the voucher scheme was reported by 55% of farmers (Figure 4). Sixty five percent of respondents claimed that extension service was mainly based on verbal communication and only 20% mentioned use of leaflets. Key informants reported existence of demonstration plots in Bariadi contrary to other study locations. It was unlikely to deliver adequate message to farmers due to limited capacity of extension staff. Farmers in Bariadi were of the opinion that extension service provided by Techno-Serve could be better if assigned to the district council as they possess strong extension capacity. It was also noted that contract farming is more likely to improve the extension service revealed by use of demonstration plots.

Knowledge on chemical fertilizer use

Figure 5 presents variations in the number of farmers knowledgeable about level of chemical fertilizer application from one study location to another. Results show that 78, 52, 40 and 22% of farmers in Mbozi, Sumbawanga, Mvomero and Bariadi, respectively were knowledgeable to use chemical fertilizer. High knowledge of farmers on chemical fertilizers use in Mbozi and Sumbawanga is associated with earlier introduction of subsidy in these locations. Subsidies are known to stimulate the adoption of improved technologies (Lee, 2005). The long term objective of the government support of subsidy programme was to promote adoption and efficiency application of essential productivity enhancing inputs (URT, 2012). Farmers in these locations might have adopted the use of fertilizers and improved seeds associated with early introduction of subsidy in these locations. This is expected to increase agriculture productivity and food security.

Table 8. Percent response on quality of distributed inputs

Full name of village	Not quality inputs	Quality inputs
Chitete	1(5.9)	16(94.1)
Katete	0(0.0)	16(100.0)
Isangu	14(46.7)	16(53.3)
Itaka	8(22.2)	28(77.8)
Ibulyu	15(50.0)	15(50.0)
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Lusanga	1(6.3)	15(93.8)
Kinda	5(62.5)	3(37.5)

Household education and awareness on input subsidy

The level of awareness on input subsidy distribution slightly varied among educated and low educated household heads [$\chi^2 (3, N = 300) = 7.7, p = 0.05$]. Awareness of household heads with no formal education was 87.2%, compared to primary education 95.2% and secondary and above 100% (Table 8). High education exposure is associated with more ability to process relevant information and increases the chances of adoption of improved technologies (Morris et al., 1999, Kaliba et al., 2000).

Influence of socio-economic attributes in receipt of subsidy inputs

Some of the socio-economic characteristics such as age, gender and marital status were tested to find out whether or not they have relationship with vouchers received by household. A chi square statistic test results reveals no significant relationship between these variables and subsidy input received by household. However, when same variables were tested for awareness of subsidy distributed to farmers, only age of household head was significant $\chi^2 (3, N = 300) = 8.32, p = 0.04$. Household heads with age below 30 years were less aware than household heads with age 30 and above. Age has been reported to be used as indicator of farming experience. Such experience makes certain information search and cost easier (Mpogole and Kadigi, 2012). In addition, aged male households have been associated with strong networks and better connection to community and village leaders. These findings imply that, sometimes farmers were equally treated in the voucher scheme. However, women and disadvantaged groups were not given priority as stipulated in the guideline.

Monitoring the distribution of vouchers

Strong security was maintained in distribution of voucher

from national level to district level. Observation from focus group discussions and key informants revealed that after submitting the vouchers to villages, there was no security force to take care of vouchers. This was a risk to village leaders who were responsible for handling the vouchers. Furthermore, voucher committees were not paid anything despite workload involved in voucher distribution. This could be one of the sources of temptation to cheat when bribed by unfaithful stockists. Furthermore, there were limited funds and facilities for monitoring the programme. Also, the training of committee members on their role in the scheme was not adequate and some were overpowered by village leaders. Additionally, key informants reported political interference in the system in which politicians especially councillors have more power in subsidy inputs than technical staff. They demanded equal share of vouchers regardless of land attributes in order to impress their voters.

Follow-ups interviews from Prevention and Combating of Corruption Bureau (PCCB) caused annoyance to Local Government Authority workers and threatened their work security during voucher distribution.

Leakage and elite capture

Leakages were reported to happen in various ways in the NAIVS. Agro dealers colluded with farmers and village committee members in some locations to cheat. Farmers were paid 10,000 Tsh and village committee 20,000 Tsh to sign the voucher without receiving the inputs. This was also reported by the politician in one of the study location (Luhwago, 2011). Such situation benefited agro dealers than intended farmers and hampered the intended programme objectives. Other reported strategies used for stealing the vouchers were: inclusion of names of children and dead people in the list of beneficiaries. Unfaithful village executive officers (VEOs) and village committees colluded with agro dealers and forged vouchers using fake signatures as if farmers had received payments. Hiding subsidy inputs during distribution and selling them later at full price was also reported. These problems were reported in Mbozi and

Bariadi. Also, unfaithful agro dealers mixed inputs with poor quality /cheap material and sold them as good quality inputs. Existence of ineffective pesticides and poor quality seeds was associated with bureaucracy in the framework. Agro dealers were claimed to arrange with input manufacturers/stockists to provide substandard inputs.

CONCLUSION AND RECOMMENDATIONS

This study has assessed the operational framework of NAIVS in Tanzania. While in some locations the system operated well, challenges were encountered in other areas. The system reduced the cost of inputs to farmers. However, the top up contribution was still unaffordable by farmers. Distributions of inputs were done in lean season when farmers have no alternative source of income. In most cases the inputs were not distributed on time. Delayed input delivery was caused by lack of capital by agro dealers and long chain involved in the distribution of voucher. Bureaucracy existed in selection of agro dealers and independent monitoring and evaluation committee did not exist in the scheme. Generally, there were violations of guidelines in NAIVS framework. Therefore, we recommend establishment of credit institutions or system in the villages where farmers can obtain loans to purchase the inputs. Bureaucracy should be eliminated through provision of full mandates of agro dealer's selection to farmers. Ministry of Agriculture Food Security and Cooperatives should reimburse the vouchers in time to sustain agro dealers in input business. There should be established independent monitoring and evaluation system particularly at village level in order to control leakages and adulterated inputs. Programme awareness need to be raised to all farmers to enable them understand their rights and disciplinary measures to undertake for unfaithful leaders. Due to limited number of extension staff at village level, Ward Agricultural Resource Centres (WARC) should be strengthened by providing enough information regarding NAIVS.

Extension material such as leaflets, posters and magazines needs to be introduced into districts and villages to supplement the extension service. Public and private partnership collaboration in service delivery seems to be a promising option in extension service delivery which should be promoted. Generally, there is a need to establish and experiment a new short chain electronic vouchers delivery system to overcome the NAIVS inefficiencies.

REFERENCES

- Baltzer KT, Hansen H (2011). Agricultural input subsidies in Sub-Saharan Africa. Ministry of Foreign Affairs of Denmark. Danida, pp. 8-36.
- Boyd HW, Westfall R, Stasch SF (1981). Marketing Research Text and Cases, P. 813.
- Chibwana C, Fisher M, Jumbe C, Masters W, Shively G (2010). Measuring the Impacts of Malawi's farm input subsidy program, P. 2.
- Danning G, Kabambe P, Sanchez P (2009a). The African Green Revolution moves forward. Springer Science + Business Media B.V. and International Society for Plant Pathology 2009.
- Danning G, Kabambe P, Sanchez P, Malik A, Flor R, Harawa R, Nkhoma P, Zamba C, Banda C, Magombo C, Kaeating M, Wangila J, Sachs J (2009b). Input subsidies to improve smallholder maize productivity in Malawi: Toward an African Green Revolution PLoS Biol. P. 7.
- Dorward A, Chirwa E (2011). The Malawi agricultural input subsidy programme: 2005/06 to 2008/09. Int. J. Agric. Sustain. 9:232-247.
- Druilhe Z, Barreiro-Hurlé J (2012). Fertilizer subsidies in sub-Saharan Africa. Food and Agriculture Organization of the United Nations, pp. 2.
- Eboh EC, Ujah OC, Amaechina EC (2006). Do Government Fertiliser Subsidies Benefit Rural Poor Farmers in Nigeria? Making Sense out of Existing Data. PMMA Network Session Paper. Available online at: <http://132.203.59>.
- Kaliba AR, Verkuijl H, Mwangi W (2000). Factors affecting adoption of improved maize seeds and use of inorganic fertilizer for maize production in the intermediate and lowland zones of Tanzania. J. Agric. Appl. Econ. 32:35-48.
- Lee DR (2005). Agricultural sustainability and technology adoption: Issues and policies for developing countries. Am. J. Agric. Econ. 87: 1325-1334.
- Luhwago R (2011). How govt loses billions through the Farm Input Voucher System. The Guardian. Available at: <http://ippmedia.com/frontend/index.php?l=31035>
- MAFC (2013). Budget Speeches [Online]. [Accessed Available online at: <http://www.kilimo.go.tz/speeches/budget%20speeches/budget%20speeches.htm>
- Malhotra K (2013). National Agricultural Input Voucher Scheme (NAIVS 2009–2012), Tanzania: Opportunities for Improvement, P. 3.
- Morris ML, Tripp R, Dankyi A (1999). Adoption and Impacts of Improved maize production technology. A case study of the Ghana Grains Development Project. Economic Programme paper, pp. 99-101.
- Mpogole H, Kadigi RMJ (2012). Round potato (*Solanum tuberosum*) profitability and implications for variety selections in the Southern Highlands of Tanzania. J. Dev. Agric. Econ. 4:258-267.
- Nagy JG, Edun O (2002). Assessment of Nigerian Government Fertilizer Policy and Suggested Alternative Market-Friendly Policies. IFDC, P. 9.
- Pan L, Christiaensen L (2012). Who Is Vouching for the Input Voucher? Decentralized Targeting and Elite Capture in Tanzania World Development. 40:1619–1633.
- Polski MM, Ostrom E (1999). An Institutional Framework for Policy Analysis and Design. Indiana University, Department of Political Science.
- Ricker-Gilbert J (2011). Household-level impacts of fertilizer subsidies in Malawi. Doctor of Philosophy, Michigan State University, pp. 19.
- Ricker-Gilbert J, Jayne TS (2009). Do Fertilizer Subsidies Affect the Demand for Commercial Fertilizer? An Example from Malawi. International Association of Agricultural Economists, Beijing.
- Tiba Z (2010). The role of input subsidies: Operational guidelines on implementation. FAO Trade and Markets Division.
- Truffer B, Rohrer H, Markard J (2009). The Analysis of Institutions in Technological Innovation Systems-A conceptual framework applied to biogas development in Austria. Copenhagen: Copenhagen Business School, P. 7.
- URT (2012). Agricultural Public Expenditure Review (PER) for Inputs Support Programme, for FY 2012/13.
- Wiggins S, Brooks J (2010). The use of input subsidies in developing countries. Paris: OECD Headquarters, P. 13.
- World Bank (2012). Tanzania - Accelerated Food Security Project.
- Yawson DO, Armah F, Afrifa, EKA, Dadzie SKN (2010). Ghana's Fertilizer Subsidy Policy: Early Field Lessons From Farmers in the Central Region. J. Sustain. Dev. Afr. P.12.

Full Length Research Paper

Herd mobility, markets and informal insurance practices among herders in Ethiopia

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This paper examines portfolio of livelihood strategies that households employ in semi-arid and risky production environment. Results show that there are multiple choices available for pastoral and agropastoral herders to adapt to or cope with the changing conditions. These include herd mobility, relying on traditional early warning, informal asset transfer, livestock fattening (emergence of markets) and in some cases a complete shift from pastoralism. Moreover, the development of institutional arrangements to assist various forms of economic transaction that supported the flow of productive assets from less efficient to more efficient users emerged as herders tend to mix their strategies. The results imply the need to revise development strategies that erroneously perceive herding communities as homogenous groups. Interventions supporting sustainable livelihoods in pastoral areas emphasize supply of diverse packages in order to meet different demands.

Key words: Mobility, markets, informal insurance, traditional institutions.

INTRODUCTION

Pastoral herders occupy the marginal lands of Ethiopia and are mainly involved in livestock production. Their production system is increasingly challenged by frequent droughts and conflicts resulting from natural resource scarcity. As a result, their economy is unstable and heavily falling under the influence of natural and made-made problems. Consequently, they are deriving global and national attention to respond to such growing challenges in which Ethiopia spent hundreds of millions of dollars to support development activities in the pastoral inhabited regions. To make this successful, a precondition could be to understand how pastoral herders do survive and adapt in a risky livestock production environment, which has been a long-standing and insufficiently answered question. In the past, external interventions involving restocking that involves the distribution of animals to destitute households to support their stock rebuilding capacity were proved to be useful.

But evidence shows that the coverage was small and the impact was short-term as recurring droughts and epidemics influence the smooth recovery process. Although, the more powerful ones having strong social network are able to move out their livestock to graze elsewhere during drought, those relatively poor who fail to benefit from informal system do not benefit even from the restocking programs (Anderson, 1999).

Nevertheless, others who have relatively a good network with relatives, friends and marriage relationships with wealthy family manage to restock after crises. Such informal networks strongly support the coping efforts much more than the restocking interventions of outsiders as it also allows acquisition of breeding stock by species. This is not always the case. Moris (1988) observes the continuation of restocking intervention in some parts of Kenya and Ethiopia for destitute households. This shows that there is a variety of practices and experiences across

the region and have proved a mixed strategy available to suppress chronic vulnerability of pastoral households. In any case, one of the weaknesses of restocking interventions was that development agencies have undermined the significance of traditional institutions in enhancing grazing resource management and arranging wealth redistribution.

Moreover, it is essential to assess the outcome of settlement and restocking interventions on well-being. The major problem seen today in the semi-arid lands of eastern Africa is huge number of displaced people. Since they remain disconnected from their relatives and friends who can otherwise be a reliable source of breeding stock, farming has in general been considered as an immediate way to respond to the problem of stockless pastoralists to rebuild their herds. From a development perspective, settling pastoralists permanently into exclusive farming or fishing pursuits has not been successful (Unruh, 1993).

However, it has been proven to be most effective in restocking pastoralists who have reached a 'stockless' status. This might require casual involvement in crop production and reducing livestock number to enable them to cope after drought and permit resource regeneration (Belay et al., 2005).

In any case, such change of land use depending on climatic conditions could make the local institutional environment more complex. Restocking stockless pastoralists means adding more demand for fodder and more competition on common grazing area. This has a negative influence on the coping efforts of others who manage to survive and do not enter refugee. In some districts of the Somali region, drought being a prime causal factor for resource scarcity and conflict has led many to depend on food aid. The traditional restocking mechanisms, involving assurance of reciprocity, seems to have broken down with the continuous supply of food aid (Devereux, 2006). The recovery rates and access to grazing resources in trying to re-enter the pastoral life is now under constraint. Evidence on how and why such informal institutions have a limited role is urgently needed to support state intervention efforts. In order to understand the poverty reduction role of traditional institutions through facilitating exchanges at the time of stress, one needs to assess the local capacity based on the existing options and preferences of pastoral herders in times of environmental stress (Unruh, 1995).

The purpose of this paper is to examine the diverse practices pastoral and agropastoral herders consider and adopt to respond to and adapt to ecologically-induced stresses.

METHODOLOGY

Data were collected from three purposely selected districts in eastern Ethiopia (Mieso, Kebribeyah and Harshin) between 2009 and 2010. The region was selected due to the presence of challenges to the survival of pastoral commons, alternative market

outlets and possibility to draw on social insurance mechanisms among pastoral societies. Data collection involved some steps and mixed methods. In this case, the first few days of contacts with the villagers were spent on other matters rather than the main subjects of the study. This was essential in such seemingly marginalized society to establish friendly relationship with the key informants and to develop trust and make subsequent contacts easier and to prevent the key informants from constraining further contacts with the rests of village community members. The next step was discussion with these key informants on the major themes of the study with the intention of generating basic information that helps refine questions for the household survey. Key informant interviews were helpful in revising and adjusting the content of the questionnaire to fit into the realities on ground and used to formulate relevant hypotheses. One of the critical challenges in data collection was that those available were hopeless due to striking level of poverty and failed to show enthusiasm. In effect, enumerators were advised to begin with questions pertinent to respondent's situation in a more flexible way so that he would be at ease. The household survey covered 159 households from eight lowest administrative units (called 'kebeles') with the help of four enumerators. And the issues included in the survey included mobility patterns, participation in different kinds of markets, the role of informal livestock exchange and contribution to poor herders restocking efforts, livelihood sources, land use and access to land for private use and the constraints undermining the possibility to conserve the pastoral communal grazing land and the interaction between private land use and water-points and the link between property rights and livelihoods.

As processes of institutional change and factors associated with change in land use, property rights and shift in livelihood strategies can be captured using a more qualitative approach, data from focus group discussions and expert key informants were used to write this paper. Based on the existing literature and insights from the focus-group discussions, a hypothesis has been formulated for variables that could affect contribution of livestock as:

Age

In the pastoral setting, older people tend to be richer than younger ones as herd accumulation is possible even in the context of unpredictable weather. Thus, age was hypothesized to affect contribution positively.

Loss of livestock due to diseases

The more the number of livestock a household loses due to diseases and other reasons, the greater lesser would be the probability of contribution of livestock as informal insurance for the poor. This variable was hypothesized to have a negative effect on contribution.

Livestock owned

Pastoral communities expect that wealthy herders, influenced by embedded norms, are expected to share their wealth with others. Such an expectation encourages rich pastoral households to contribute more than others. As a result, it was anticipated that holding larger herd influences contribution positively.

Using improved seed

This is measured as a dummy variable. Investment in farming activities undermines the labor available for herding where less

emphasis could be given to livestock production. This has been a recent phenomenon as many herders lost their herd due to frequent drought occurring in the area. Therefore, those using improved seed for cultivation can contribute less livestock. And the effect was hypothesized to be negative.

Frequency of mobility

This has been a traditional livestock production strategy in the pastoral environment. Those who have a chance to move frequently from their settlement are expected to save their stock from epidemics and have access to better grazing resource. Hence, practicing mobility frequently was hypothesized to have a positive effect on contribution.

Use of crop residue (dummy)

More reliance on crops and crop residue is usually among small-herders than large herders. Feeding crop residue is often practiced among those herders engaged in fattening; they produce for markets, rather than for subsistence. This was anticipated to have a negative effect on the decision to contribute.

Private grazing land (ha)

Herders establish enclosure as a livestock feed bank at times of feed stress, which in turn enable them to keep more herd than others. It was hypothesized to have a positive effect on contribution.

Size of landholding (ha)

Earnings from crops increase as herders invest in crop farming. The proportion of income from livestock would be less when compared to large herders. Thus, larger landholding reduces the chance to contribute herd as social insurance for the poor.

Renting oxen

This is a practice in which herders are characterized by agropastoralism and are engaged in such economic transaction. As they keep limited herd size, they do have a few or none to contribute. Hence, it was expected to have a negative effect on contribution.

Hosting relatives

This is a reciprocal sharing of grazing resources. It serves as a strategy to minimize risk of livestock loss and is common among pastoralists on the basis of close kin. Thus, involvement in hosting relatives was hypothesized to have a positive effect on contribution. Finally, to identify those factors determining households' contribution of livestock for the poor as a social insurance, a binary logistic regression was used.

RESULTS AND DISCUSSION

The main livelihood source for (agro) pastoral households is livestock production and parallel engagement in other

activities including crop farming, petty trade, charcoal burning (which is thought to be destructive to thresource base while it is being recognized as an immediate source of cash income) and remittances from distant relatives involved in businesses in the urban areas and abroad. Survey data show that 32.1% of the sample households were engaged in wage employment and 13.8% in petty trade. The study has shown that the highest income was earned from petty trade, whereas sale of grains becomes the lowest. Sale of fuel wood mainly charcoal is another income sources ranking next to petty trade. It is practiced by half of the sample households. Another form of sustaining livelihoods is dependence on inter-household assistance, which is believed to be an informal insurance. It is characterized by mutuality as current contribution produces an expectation on future reciprocation. The fluctuating nature of poverty in uncertain rangeland environment increases the need to understand the importance of cooperation for asset mobilization. Cooperation provides a means for various members of indigenous community to rely on their own people supporting them from falling into chronic poverty. It is a system where households share resources with other marginal households and extend such norms to assist distant relatives. This is believed to be one alternative to overcome vulnerability and collapse of families due to deprivation of productive assets that can be recognized as forms of risk-sharing.

In this context, village chiefs and elders organize pooling of assets required for the survival of the poor. For instance, among agropastoralists, those households having no oxen but own land obtain group support for traction power and other necessary inputs. Across the case study sites, it is common to contribute female animals, grain or milk. This is usually a voluntary action enabling households to remain in the system. Those having strong social capital (good networks) manage to restock after drought-induced crises.

This indicates that informal networks strongly support the recovery process. Therefore, the risk of losing livelihoods and ending in destitution is not a straightforward step but it may be a circumstance coming after failing to recover through informal insurance, which needs to be considered as another benefit from building social capital. Local actions in the rangelands are not restricted to recovery practices. They involve precautionary activities to manage the likely effects of risks (such as violent attacks, environmental change, policy changes and market failure). Without providing detail accounts of risk assessment, the results indicate that the way resource users assess and perceive risk provides evidence as to whether informal institutions are able to create options for access to grazing resources in a changing rangeland environment.

Understanding how informal insurances, markets and pastoral mobility jointly enable a pastoral household to deal with risk related factors is critical to designing projects and programs that fit into diverse priorities based

Table 1. Average herd ownership and landholding size among herders using crop residue.

Asset possession	Districts					
	Mieso		Kebribeyah		Harshin	
	No	Yes	No	Yes	No	Yes
Livestock (TLU)	2.65	3.22	7.23	7.11	5.86	7.10
Landholding (ha)	1.91	1.81	3.73	3.52	3.64	2.45

on location, production system, wealth and exposure to various kinds of hazards (Smith et al., 2001).

Mobility and markets

The ways herders perceive and assess risk determine the mechanism through which they secure their livelihoods from the production system by deploying private or communal resources even in the face of greater inequality. These mechanisms are explained as follows:

Mixing diverse strategies during drought

Households manage stress using different strategies: food purchase, casual employment and support from relatives. These strategies are affected by exogenous factors such as the market prices. Some households purchase food grains through selling livestock. However, a decline in livestock prices and a rise in food prices during drought period is a challenge for households pursuing this coping strategy. Poor market conditions, poor infrastructure and low capacity to bargain for better prices increases their vulnerability to drought shocks since they are forced to sell more livestock to purchase grains than under a normal condition. Wage employment, though rare, is another drought time livelihood option that poor herders consider – an opportunity which is rare in places far away from agropastoral areas or towns. Paid wage labour has been observed in Mieso than in Kebribeyah district due to access to main transport line and road-construction activities. Such employment is not dependable and intermittent in nature.

A third mechanism of survival under stress is direct dependence on relatives. Large family herders usually depend on income from their relatives who have not been equally affected because of variability in rainfall conditions since they live on other clan territory. These are groups with high network density. They reciprocate for their relatives when they encounter similar environmental problems. This livelihood strategy is effective when the scale of drought is low and affects certain part of the region.

Fattening animals

Herding families which are better-off and have a few

livestock are engaged in fattening animals through supply of fodder from purchase or contract grazing. Many households in Mieso practice it – entering a commercialization phase. Access to infrastructure, especially roads and railway connected to the capital Addis, is a unique opportunity to earn better and reasonable prices for the fattened animals. Among animal resources owned, poultry and goat are preferred compared to others when market is considered; whereas, goat and camel easily adapt to the changing feed resources since they browse on leaves. This encouraged more and more agropastoralists to change their production strategy similar to Harshin pastoralists. Reasonable price level, availability of feed, non-susceptibility and fast reproducibility of goats together with access to market created more incentive to produce these species. This has an implication for the focus of agricultural extension services and technological support to improve availability of feed where herders tend to rely on crop residue to feed the animals. Knowledge of indigenous practices and technological preferences should be an entry point to respond to local need. This strategy seems to be adapted, as more households tend to permanently cultivate small plots of land.

Table 1 shows that in Mieso and Harshin, households practicing the use of crop residue as animal feed tend to have large livestock holding compared to others in Kebribeyah.

More labour for herding

There has been an increasing trend in allocating herding labour due to declining feed sources and increasing conflict threats. Consequently, agropastoralists have two options, either to limit herd size and provide feed from surrounding or to reduce time spent on farming and maintain herd size through searching feed elsewhere; although, the drought condition is more or less equally affecting farming and herding. A household's choice in this particular case is determined by the functioning capacity of institutions of herding defined by groups in terms of protecting the herd. If herding institutions are effective, a household can focus on farming and maintain herd size simultaneously.

Reliance on traditional early warning

Traditional ways of drought forecasting exist where

pastoral herders experience long-existing tradition of self-reliance though there is a difference among households in terms of access to information. Such indigenous knowledge is embedded in and central to their belief system compared to the scientific early warning practices of the National Disaster Prevention and Preparedness Commission that often pledges for food aid than saving livelihoods. The traditional practices include looking at the condition of the star, the sun and the moon as well as observing animal behaviour. These are simply shared ideologies and results of repeated observation by individuals gifted with such power. Although, scientifically unexplainable in terms of cause and effect, such belief system influences the behaviour of the community. It is a practice based on indigenous knowledge. Results from the focus group discussion reveal that households with low level of network density have lower chance of access to information on such traditional early warning, which makes them mitigate the undesired effects of shocks in a very poor manner. The number of relatives living in other villages determines this showing that sharing information is again segregated on the basis of social capital. This is consistent with the evidence from other studies where exposure to risk and its perception are influenced by a number of socioeconomic factors, one of which is individual's network (Smith et al., 2001).

The costliness of information, simply because of not being part of the informal network, causes differences in the way households mitigate the effects of disaster. In general, those which are part of the network take some measures subsequent to such forecast. These are isolating calves from cows, interruption of milking and searching for alternative feed for the calf. But they are often reserved from selling their animals during drought contrary to evidence from the literature on drought induced distress sale. De-stocking and restocking following drought period, as an adaptive strategy practiced elsewhere, is not common in this study area. Selling decisions are mostly related to household cash requirements, which take place during normal rainfall years. This strategy has been followed for a long time and is remaining stable.

Share-cropping contract

The last and peculiar survival strategy for the poor agropastoral household is share-cropping contract solely practiced among 66.7% of the sample households from Mieso. This is a newly emerging institutional arrangement between oxen owners and those who only possess farmland or only labour. Discussions reveal that there are two types of contracts: unequal sharecropping and labour contribution and equal sharecropping and labour contribution – both having different property rights arrangements. Interesting here is examining differences in rules of sharing benefits- ex ante agreement and ex-post implementation of contractual agreements – in which

the latter is influenced by change in state of nature. The emergence of contractual market transaction indicates the gradual transformation of herders into market economy. There were two forms of share-cropping common in the district:

Unequal sharecropping: This is an arrangement between those possessing land and oxen and others who are poor and contribute only labour – owner employees someone on his farm. The hired labour contributes only his labour and finally shares the crop – obtaining one-third of the total harvest, whereas, two-third remains for the land right holder. Village leaders also indicate that poor people who do not have oxen but possess land do not prefer such contractual arrangement since it leads to overexploitation of labour. Working alone on the farm in such harsh environment is tiresome. The bargaining power of the poor is also limited, as they do not have options other than accepting these rules. In circumstances where the hired individual and the employer are close relatives, he can have a chance to informally mobilize family labour from the land right holder.

Equal sharecropping: This is a land lease contractual arrangement where the landowner¹ contracts out his land to someone who has oxen and needs additional land. The landowner does not have oxen unlike the previous case. It is an agreement involving pooling of physical assets from both parties. The agreement involves equal contribution of labour and sharing of outputs. A written contract is made in the presence of village elders and a copy of contract is kept with the village leader. Failure to commit to the agreement in the contract will cause interference of the elders and the village leader who mediated the contractual process. This is a typical case of externally enforced contract demanding the action of the third party, which is the elders' group. What will happen if nature disturbs the contract and crops fail to yield? This has been often the case in the district consequent to recurring droughts and erratic nature of rainfall. Agropastoralists of Mieso do not rely much on crop production as livelihood source compared to livestock. In cases of crop failure, a household which owns a farm but few or no livestock will be compensated with cash payment (100 to 200 Birr). The contracting person who has been cultivating the land accomplishes the payment mainly because there is still a chance to graze livestock on the farm, where biomass from the failed crop serves as an alternative feed source.

Such compensatory arrangement is not based on initial contract but practiced simply to assist the landowner having no livestock to cope or survive during abnormal rainfall years. The landowner deprived of oxen prefers receiving compensation from his partner to selling the

¹ Landowner throughout the text is to mean land right holders without having the right to sell as land constitutionally falls under state ownership.

crop biomass to other members of the village even if he can obtain better prices than he is compensated. The property rights arrangement is then mutually beneficial and is done to develop trust with his partner and to ensure sustaining contracts with the same partner. Change in the state of nature brings about adjustment in the initial contract and new arrangement is established. Such contracts are internally enforceable between contracting agents and explicit in nature involving deliberate action. In this contracting process, the distribution of costs and benefits and the bargaining capacity of the parties look symmetrical. Access to key production resources has become decisive in ensuring fair distribution of benefits.

Comparing both situations of contracts, the second one seems more sustainable than the first for two reasons: 1) the landless and oxen-less households rarely exist unless a person migrates in from distant villages due to conflict or other reasons making the first type of contractual arrangement non-typical, and 2) increasing poverty, livestock raids and drought problems have in some cases brought a few households to become oxen-less while some others still have oxen.

Mobility

Knowledge on how both pastoral and agropastoral households have been mitigating drought through their individual action provides a clue as to the type of policy interventions demanded to assist local action. To examine whether mobility with the herd or selling part of the herd is preferred, respondents have been requested to provide reasons why they: 1) opt for an action but do not pursue it, or 2) opt and pursue it. Analysis of the reasons is useful to check whether their actions are constrained by the existing property rights system or market infrastructure. There are cultural and economic criteria causing dilemma in individual decisions to reduce vulnerability to drought effects. Herders might have different reasons. This sub-section compares the situations in the case study districts.

Mieso District: Three categories of households can be distinguished with respect to their individual selling and mobility decisions.

i) Long mobility with herds: This option has been preferred for several reasons. Saving cash during time of drought is difficult as immediate need of spending on food items is given a priority. This brings a question 'whether or not the establishment of saving facilities will encourage selling of animals' and the kind of marketing policy and intervention strategy required. There is a general feeling that when costs of mobility (for example, possible loss of animals due to *Isaa* raids) is compared to the possibility of investing cash on direct food items,

mobility is preferred to selling since villagers can protect themselves. Some households feel that weight loss during drought period artificially reduces the prices of livestock, making selling difficult, whereas keeping the animals until after drought period to allow the animal to regain weight may be useful. For instance, if two animals out of four die, the remaining two after drought period can compensate for the lost animals since market prices rise due to two reasons: 1) an increase in weight and general status of survived animals, 2) a relative lower level of supply to markets close to marginal areas. Therefore, development interventions that reduce the transaction costs of searching for a reasonable market would support pastoral decisions to reduce livestock production risk.

Households which may expect to succeed in maintaining more than 50% of their herd from drought prefer this choice. This is a good reason for most herders to move around looking for better pasture to ensure the survival of their animals during drought other than immediately selling – a situation which leads to a need for government policy to adjust market structure in a way it supports herd rebuilding strategy of pastoralists and agropastoralists as an effort to reduce vulnerability and poverty. All sorts of collective action that pastoralists organize within their vicinity or through forming strong networks among their distant relatives and kinships reflect their interest to save herd loss. To enable coping local level collective action demands the complementary role of market. Integration of market mechanisms with traditional institutions is indispensable. Post drought coping is only possible if at least a few animals survived, which makes recovering successful since it is hard to obtain a single animal from other members of the community. This makes putting greater energy in search for feed and water under drought condition extremely essential. Most believe that the risk of entire herd loss should be left for chance. In this context, mobility is preferred mitigation strategy. In doing so, livestock could be saved in its live form, which undermines the market risk associated with immediate price rise after drought. Many of the households pursue a 'moving' to 'selling' strategy. If most members of the various villages pursue this strategy, what will happen to the grazing and browsing resource base? This question is pertinent because drought conditions force herders from use of grass to vegetations and leaves, even for cattle, yielding undesirable effect on the natural ecology.

Responses so far reaffirm this phenomenon marking already a threshold for continued degradation of the rangelands.

ii) Selling part of the herd: This option has been preferred for entirely different reason. Some prefer selling animals entirely and opening up small businesses to sustain life and generate reliable income (end pastoral life) other than losing the whole animals in cases where risk of 100% loss occurs in long drought period. Others

think in terms of immediate household needs and prefer selling to moving the herd to buy food for the household consumption since saving cash for post-drought herd rebuilding is far from being possible (end pastoral life). This implies the need to give emphasis to provision of emergency food aid before those drought-affected groups sell most of their herd. It is clear to see that costs of recovery can be much higher than early drought intervention in terms of building the capacity of herders to avoid distressed sale. Poverty reduction strategies should address the diverse needs and intentions of pastoralists and agropastoralists as some of the mitigation strategies that some choose end up in incapacity to recover after drought. Old people prefer to sell their herd and stay in their own village by saving cash for post-drought purchase.

iii) Conditioned mobility or selling: Households involved largely in petty trade prefer selling their livestock to mobility. Why? In fact, the choice for mobility among very strategic village members depends usually on the availability of information where to move that is, information about better pasture area, which means their decision is not random; rather, it is based on information obtained through their informal social networks. Some households adjust their mitigation efforts based on past experiences. Those which consumed all their cash due to extreme food shortage in the previous drought did not sell the core herd during drought. They make a distinction among species and sexes of animals as 'core' and dry herd. The core refers to those essential for herd rebuilding, and the dry ones are required mainly for immediate consumption through slaughtering or sales. The tradition of giving priority of access to better pasture for core herd and selling for non-core herd is typical in both pastoral and agropastoral systems to cope with vulnerability. All institutions creating access options for pasture and water in the rangeland during the period of environmental stress is to save at least the core herd.

Pastoral herders have experienced that keeping the livestock for prolonged period could lead to weight-loss in times of feed stress in which they prefer selling. In preferring for either strategy, households consider the opportunity cost of maintaining and selling herd based on the reliability of information they have at the time of decision-making. Personal network of a household and the resource conditions within the safely movable area also affects the decision. Although, price level is an important determinant of herders' selling decisions immediately before drought, the social cost of mobility during drought in terms of causing family disintegration influences the decision.

Kebribeyah District: The decisions and actions of households are determined by certain factors. Weight loss long before realizing drought shock discourages selling. Absence of alternative income sources or

livelihood always brings a dilemma to sell or not that will eventually produce an influence to keep animals under risky condition. Above all, selling decisions are mainly based on availability of pasture in accessible areas. For poor herders, selling the livestock entirely (in spite of unfavourable terms of trade) does not ensure survival in drought years and yet selling is preferred. An interesting observation here is that individual level decisions are influenced by group level capacity to arrange access to better grazing area. Other studies reveal that an increase in costs of veterinary services and access to water points are the two main reasons for the poor to prefer selling. Restocking through savings, markets and social insurance are extremely limited for the poor and even more readily accessible for the ex-ante wealthy (McPeak and Barrett, 2001). In fact, mobility is mainly the choice of large herders. Poor and small herd owners prefer selling to mobility. Large herders make use of their strong informational power to migrate more easily compared to small or poor herders. While relatively wealthy households pursue herd mobility, poor herders practice partial selling and purchase of feed from crop growers for the remaining herd. The justification for the poor members is that once sold it is hard to replace the herd. This implies that ex-post coping is a challenge to some households when they have poor personal networks and poor relatives. Other groups sell part of the herd to cover food expenditure even if livestock feed is available elsewhere. This implies the need to provide food aid to such marginal groups to avoid the risk of selling their animals at cheaper price whenever the group can move its herd to a specific place for grazing.

Those who would decide to sell consider sensitivity to feed scarcity as species selection criterion. For example, sheep is sold earlier than other species. Herd size, feed availability, market prices, and household's food expenditure are the four crucial factors influencing herders' strategic decision to mitigate the effect of drought. These factors tend to affect the decision of poor and relatively better-off households differently.

Harshin District: In this district, households that are afraid of conflict between different clans limit mobility and prefer selling. Animal strength also determines the decisions for either option. Weak animals expected to die during mobility to distant pasture will be sold and strong ones maintained. Mobility remains crucial as an asset-saving mechanism other than maintaining or improving livestock productivity. Traditional institutions supporting mobility help overcome household vulnerability. Those having a few livestock can still try to escape the drought effects through moving within the clan territory. This differs from Kebribeyah, where small herders tend to sell instead of searching feed. So herd size does not determine selling decisions in this situation. Still important difference exists between large and small herders in terms of distance of mobility. While small herders are

limited to clan's territory, large herders move either across the border towards Somaliland or other clans' grazing area. The latter group arranges such mobility together with non-clan members who live in their clan's grazing area but have a plan to migrate to their clan's grazing land. Hence, difference in wealth among herders determines the extent of mobility.

Other observed important feature for those choosing mobility is preference for species of animals. For instance, supply of draft power and milk for a household brought a shift in production strategy of herders. Categories of animals required for both purposes are retained in the herd. This is contrary to a few decades back when crop-farming did not make a livelihood source and herders focused on keeping female animals. Such a change in preference is largely related to uncertainty, livelihood diversification, grazing scarcity and institutional change (that is, property rights to land). Insights from the group discussion indicate that there are herding families which prefer mobility within clan's land until they are left with a single animal other than selling. A question arises whether this is because of low opportunity cost of keeping compared to selling. Further probing proves that this is mainly influenced by a household's capacity to save money and the drive to maintain herd size for reasons of prestige having symbolic value. Such norms having less economic significance influence decisions at household level.

Market development and strategic shift

Access to market makes intensive livestock production more profitable. This depends on geographical location. Focus group discussions conducted in Mieso District show that there is a regular consultation among community members to reduce livestock number to increase animal productivity. This is in contradiction with the argument dominant in the literature that risk-buffering mechanisms can only be successful if herders concentrate on increasing livestock size. Intensive feeding other than extensive grazing is considered not only because mobility is difficult but also due to a reduction in feed availability in communal grazing land. None of the villagers believe in increasing livestock size and are more inclined towards commercialization. Relatively, better access to veterinary services than that of Kebribeyah and Harshin motivates herders to prefer quality to quantity since the risk of loss due to diseases incidence can be controlled. This does not mean that opportunistic stocking is not practiced to manage risk in changing resource conditions. Number of livestock does not count in achieving food security at household level, but the purpose it serves. For instance, an attempt to increase livestock number means reduced productivity (milk per cow and inadequate traction power). However, there is preference among species of livestock in increasing herd size. For instance, goat and camel are

preferred to cattle because they can easily adapt to changes in feed conditions and rely on perennial trees. This has an implication on programs and policies for livestock development in the area.

In addition, male camel is rented as means of transporting goods to market as these areas are far from the modern means of transport. The rate of rent depends on how far the animal travels; minimum cash obtained being 10 Birr per day. Keeping male camel in the herd, as an asset base of a household, serves as a recovery strategy after prolonged drought. Camel milk has a medicinal value for treating different diseases including stomach aches caused by drinking polluted water from cisterns. This saves the medical cost, which otherwise a poor household has to cover through selling whatever it owns. As a survival strategy in the marginal rangelands, different aspects of benefits derived from each livestock species is a determining factor in retaining the minimum required number from each species. This has an implication for intervention strategies to improve household well-being in terms of recognizing local preferences.

Asset transfer as informal insurance

An important informal insurance in the pastoral and agropastoral production systems is self-reliance where internal resource mobilization and asset transfers help the poor cushion against the impacts of shocks. In eastern Ethiopia, it is recognized as a "charitable obligation intrinsic to the Islamic religion" (Devereaux, 2006:57). This inter-household assistance is characterized by mutuality as current contribution produces an expectation on future reciprocation. Hence, the fluctuating² nature of poverty in uncertain rangeland environment necessitates understanding the norms fostering cooperation for asset mobilization. Cooperation provides a means for various members of indigenous community to rely on their own people supporting them from falling into chronic poverty. It is a system where households share resources (livestock, grain and others) with other marginal households and extend such norms to assist distant relatives. This is believed to be one alternative to overcome vulnerability and collapse of families due to deprivation of productive assets. The result reported in Table 2 requires careful interpretation. It is important to note that the amount contributed and received do not necessarily much in all cases since some of those households which contributed and/or received might fall out of the overall sample households. In terms of contributions, it is likely that households which contributed livestock might have contributed grain as well. The last row in Table 2 provides the sample

² This is referring to a situation where those wealthy households in the past have become poor while the rests with less livestock earlier have improved their livestock possession through time.

Table 2. Average amount of informal assistance in the last three years period (in Birr).

Districts	Received			Contributed		
	Livestock	Grain	Others	Livestock	Grain	Others
Mieso	136	27	25	89	41	20
Kebribeyah	54	37	56	104	48	34
Harshin	91	30	194	219	63	93
Overall sample (N)	105	30	73	121	48	40

Table 3. Sample households who contributed and/or received assistance over three years.

Events	Responses	Districts			Total
		Mieso	Kebribeyah	Harshin	
Contributed	No	14	23	11	48
	Yes	66	17	28	111
Received	No	37	25	18	80
	Yes	43	15	21	79
Total (N)		80	40	39	159

households which have either contributed or received in the three case study districts. As a result, the overall sample in each category (received and contributed) does not add up to 159. In this context, village chiefs and elders organize pooling of assets required for the survival of the poor.

For instance, among agropastoralists, those households having no oxen but own land obtain group support for traction power and other necessary inputs. Across the case study sites, it is common to contribute female animals, grain or milk. This is usually a voluntary action enabling households to remain in the system. Those having relatively good network with different members of the community are often successful in managing to rebuild their livestock subsequent to drought-induced crises. This indicates that informal networks hold up the recovery process. In reality, small portion of the pastoral population benefited from this because those with poor informal networks often fail to gain from such system. There is also divergence between those who received and contributed since there is variation in time between contribution and reciprocation (Table 3). Interestingly, the result shows that we should not be pessimistic on the role of the informal insurance as 69.8% of the sample households have made contributions over the three years period. On the other hand, the fact that nearly 50% have received benefited from insurance means self-reliance at household level could remain critical.

As the frequency of drought increases, the reliability of informal insurance is reducing. Others provide evidence where such informal mechanisms are unable to shield households from large-scale and long-lasting shocks

(Fafchamps et al., 1998). This is because shocks produce persistent effects where temporary events carry over chronic impacts to the future welfare of households. This will reduce households' capacity to rebuild the assets lost that undermines their ability to contribute to economic growth (Dercon, 2003). Hence, those social relationships among community members that could have served as means of regaining assets can be weakened in the event of large-scale shocks developing persistent effects.

Informal asset transfer can occur at community as well as household levels. Transfer of resource is another economic link among pastoral households. Transfer refers to change of entitlement as resource or an asset flows from one to other person due to cultural or legislative influence. The forms of transfer identified include a gift on occasions of marriage and birth, support during time of disaster and a dowry system. A community with close interaction with the other provides gift during marriage and at birth. They also help each other at time of crises such as drought sharing food grains or contribute animals to enable the destitute to revive. The third form of asset transfer occurs most frequently and involves a large amount of livestock. The amount of asset transferred in a dowry system varies based on the status of a household. Arbitrarily, households in pastoral or agropastoral groups are categorized into rich, poor and middle wealth groups. The rich households invest on dowry up to 100 small ruminants, 5 camels and 5 cattle; whereas the poor does up to 20, 2 and 0, respectively. This pattern changes with situations of drought and good rain years.

The dowry system, being an incentive, encourages

Table 4. Determinants of households contribution of livestock for the poor (Y=1).

Variables	Coefficient	Standard error	Marginal effect	Mean of X
Age	0.006	0.017	0.001	41.9
Livestock owned (TLU)	0.100**	0.052	0.019	4.99
Livestock died due to diseases	-0.110**	0.051	-0.020	3.81
Use improved seed (yes = 1)	-0.165	0.429	0.039	0.52
Frequency of mobility	0.285***	0.011	0.053	2.87
Use of crop residue (yes = 1)	-0.615	0.529	0.125	0.78
Private grazing land (ha)	0.946***	0.378	0.184	0.88
Landholding (ha)	-0.750**	0.263	-0.142	2.53
Rent oxen (yes = 1)	-0.240	0.446	0.048	0.36
Host relatives (y = 1)	-0.375	0.418	-0.004	0.30
Constant	-0.555	0.857	-	-

Log likelihood: -83.90; Restricted log likelihood: -95.64; Chi-squared: 23.48 ($p < 0.001$). *** $p < 1$, ** $p < 5$, * $p < 10$.

adolescence groups to get married at early age, which contributes to over population of pastoralists. This will be an immediate cause for environmental degradation apart from natural factors. It uncovers that an economically beneficial and socially desirable system might have a deleterious effect on the natural environment. A household level asset transfer is a second form of asset transfer taking place from parents to children in the form of succession when they pass away. In all districts surveyed sons within a household take two-third of the entire assets owned by parents and the remaining one-third is left for female adolescence. This is not considered as a bias against female since religious rules advocate. In some cases, daughters are totally ignored in sharing parent's wealth. This has an implication on the management responsibility of female children towards the herd and the care they take even at the time of disaster. However, sons give great care with the expectation that they are going to own later. In other words, female children cannot be a good source of information for early warning and monitoring system. Although, changing such bias is difficult in the short run, giving more focus to male adolescence for data collection helps in getting reliable information. From the entire sample, 76% (121 out of 159 households) have contributed livestock to assist their poor community members (Table 2). The results in Table 4 provide the determinants for contribution of livestock to the poor to enable them to cope. Consistent with the qualitative data, livestock holding, frequency of mobility during drought period and possession of private grazing are likely influencing households to contribute livestock. On the other hand, loss of livestock due to diseases and engagement in farming are negatively influencing contributions. A direct interpretation of the coefficients is a bit tricky in such a logistic regression and a more appealing interpretation comes from looking at the marginal effects for binary and continuous predictor variables.

In the case of livestock death from diseases, an

increase in animal death by 10 units reduces the capacity of a household to contribute by 20% keeping all other variables at their mean values. Alternatively, efforts made to save 10 animals through better veterinary service intervention will likely increase the capacity to contribute by 20% so long as informal insurance norm persists. The model predicts that an increase in livestock size by one unit increases the likelihood of contribution by 1.9%. The use of enclosure as private grazing becomes vital since the likelihood of contribution increases by 18.4% when area enclosed increases by a hectare. A related study indicates that the feed reserved on enclosed land for dry season grazing enables a household to cope with feed scarcity (Beyene, 2010). An increase in land under private holding does not favour contribution as crop-production has become important for certain agropastoral herders – where an increase in landholding by a hectare reduces the likelihood of contribution of livestock by 14.2%. The model also predicts the positive influence of mobility in enhancing contribution in which a unit increase in the frequency of mobility increases the probability of contribution by 5.3%. Results from the group discussion also suggest that those with high network density are able to move their herd to mitigate the negative effects of drought.

Overall, where formal insurance and credit markets fail, as in many pastoral areas of Africa, studies confirm that inheritance of livestock within the close family members, multiple-ownership claims to livestock and croplands, livestock tenancy arrangements at birth, and bride-wealth at the stage of adolescence are some of the common forms of embedded informal insurance schemes (Swallow, 1993). At a wider scale, an extensive review of African economic performance shows that informal institutions facilitate adaptation in risky environment mainly in traditional societies where “liquid” assets (cash-based transactions) are limited. It is emphasized that establishing social connections assist livestock spread over a larger geographical area as risk management

activities (Collier and Gunning, 1999). A recent study on the informal social protection among east African herders reveals that mobilization of assistance for the poor households is determined on the basis of social networks and kinship structure. A poor household with wealthy relative can easily secure temporary assistance (such as livestock products) and insurance (livestock) than the poor without wealthy relatives (HPG, 2009). Likewise, a game theoretic approach to analyzing reciprocal informal insurance arrangements among Kenyan herders shows that herders create supplementary mechanisms such as the use of intermarriage to ensure the prospect of cooperation. This is expected to be essential in reducing the temptation to renege (Dixit et al., 2013).

Such evidence generates the question whether or not informal insurance has a role in accommodating households which are most vulnerable but characterized by very poor social capital. However, neither the focus group discussions nor the survey result gave an indication that such disaggregation in organizing informal insurance exists.

Conclusions

The study has shown the important role of informal insurance where state support and formal institutions of asset saving are either missing or inefficient due to a number of factors. The results from a simple logistic regression clearly support the qualitative evidence in that although some level of discrimination is observed among herders in planning mobility, the tradition of livestock asset transfer serves as informal insurance to enable destitute households to rebuild their herd in the aftermath of drought. There are two important lessons derived from this study. First, there needs to be revisions of development strategies that have erroneously perceive herding communities as homogenous groups. Development interventions that support sustainable livelihoods in semi-arid pastoral areas should consist of diverse packages that assist the success of various mitigation and coping strategies. Second, there is still a potential for traditional institutions to provide social protection in a risky environment. As sources of risk become diverse and internal capacities decline with the frequency and length of droughts, asset protection tasks to save livelihoods cannot be left to the traditional leaders and local chiefs.

REFERENCES

- Anderson M (1999). Rehabilitation, resettlement and restocking: ideology and practice in pastoralist development in: D.M. Anderson and V. Broch-Due (eds.) *The Poor are Not Us: Poverty and Pastoralism*. Eastern African Studies. Ohio University Press. pp. 241-267.
- Belay K, Beyene F, Manig W (2005). "Coping with Drought among Pastoral and Agro-Pastoral Communities in Eastern Ethiopia." *J. Rural Dev.* 28:185-201.
- Beyene F (2010). "Driving Forces in the Expansion of Enclosure among Pastoral and Agropastoral Herders in Ethiopia," *Quart. J. Int. Agric.* 49(2):127-146.
- Collier P, Gunning JW (1999). "Explaining African Economic Performance." *J. Econ. Lit.* 37:64-111.
- Dercon S (2003). Insurance against poverty. UNU World Institute for Development Economics Research (UNU-WIDER). A Policy Brief.
- Devereux S (2006). *Vulnerable Livelihoods in Somali Region, Ethiopia*. Institute of Development Studies, Research Report 57, London.
- Dixit AK, Levein SA, Rubenstein DI (2013). Reciprocal insurance among Kenyan pastoralists. *Theor. Ecol.* 6(2):173-187.
- Fafchamps M, Udry C, Czukas K (1998). "Drought and Saving in West Africa: Are Livestock a Buffer Stock?." *J. Dev. Econ.* 55:273-305.
- Humanitarian Social Group (HPG) (2009). Social protection in pastoral areas. A synthesis paper. Available at <http://www.odi.org.uk/hpg>.
- McPeak JG, Barrett CB (2001). "Differential risk exposure and stochastic poverty traps among East African pastoralists." *Am. J. Agric. Econ.* 83(3):674-679.
- Moris J (1988). Interventions for African pastoral development under adverse production trends. African Livestock Policy Analysis Network. Network Paper No. 16. Addis Ababa.
- Smith K, Barrett CB, Box PW (2001). "Not Necessarily in the Same Boat: Heterogeneous Risk Assessment among East African Pastoralists." *J. Dev. Stud.* 37(5):1-30.
- Swallow B (1993). The role of mobility within the risk management strategies among pastoralists and agropastoralists. Gatekeeper series no. 47, IIED.
- Unruh JD (1993). "Refugee Resettlement on the Horn of Africa: The Integration of Host and Refugee Land Use Patterns," *Land Use Policy* 10:49-66.
- Unruh JD (1995). Pastoralist Resource Use and Access in Somalia: A Changing Context of Development, Environmental Stress and Conflict. In: Sorenson, J. (ed.). *Disaster and Development on the Horn of Africa*. London: Macmillan. pp. 126-150.

Full Length Research Paper

Sheep market integration in the Central Rift Valley of Ethiopia

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This study examines the existence of the spatial market integration of the different pairs of sheep markets in the Central Rift Valley of Ethiopia. Using modern time series econometric technique, uncovered compelling pieces of evidence of strong steady state linkages of the various pair-wise combinations of the sampled CRV markets, with only an insignificant few segregated routes. The main conclusion of the study is that despite the geographic segregation of the sheep markets and the presence of fragmented and often inefficient distribution system, price signals and other market information are transmitted efficiently across the markets, thus negating the potential occurrences of unexploited arbitrage opportunities.

Key words: Price integration, spatial transmission, co integration, granger causality, vector autoregression (VAR).

INTRODUCTION

Small ruminants are integral part of livestock keeping in Sub-Saharan Africa (SSA), mainly kept for immediate cash sources, milk, meat, wool, manure, and saving or risk distribution (Kosgey, 2004). They are also sources of foreign currency (Berhanu et al., 2006). Moreover, due to their high fertility, short generation interval, adaptation to rain scanty environment and their ability to produce in limited feed resource they are considered as investment and insurance (Asfaw, 1998). Sheep contribute importantly to the GNP and welfare of individual animal owners. Sheep kept by small holders in Ethiopia are a major source of food consumption and cash income. In addition, to providing income from regular sales, sheep are ready saleable assets and can be traded for grains in time of shocks. Lambs can be sold at about one year of age if reasonably well managed and can provide quicker

returns than obtained from the cattle (Wilson, 1986). Measuring spatial price linkages of commodity market in developing countries of Africa has received much attention in the literature because of its implications for food and commercial markets. Competitive market equilibrium under well known conditions in Pareto efficient and this extends to competitive market equilibrium when trade occurs between markets at fixed transport costs (Takayama and Judge, 1971).

Property of competitive spatially equilibrium is characterized by the law of one price (LOP): if trade occurs between two markets, the price in the importing market equals that in the exporting market plus transport costs and the two markets are spatially integrated. However, existence of spatially integrated markets not necessarily implies the Pareto efficiency. Nevertheless,

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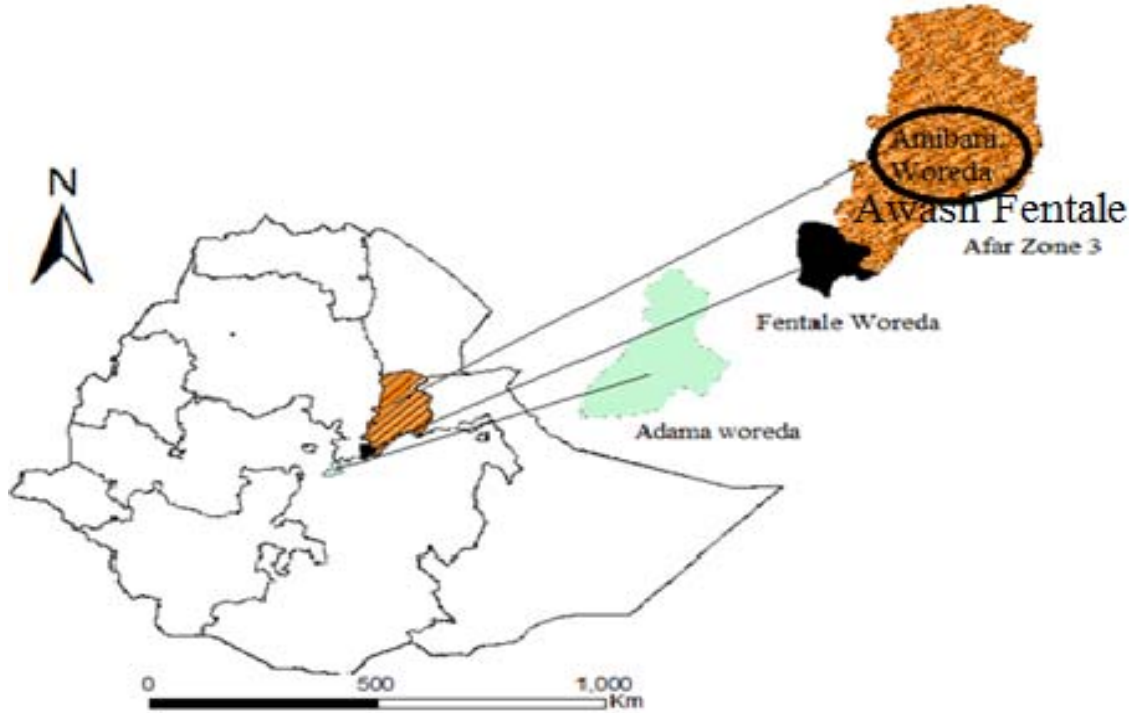


Figure 1. Sample area.

as Ravallion (1987) notes, ‘one can be interested in testing empirically for spatial integration, without wishing to rest the case for or against Pareto optimality outcome. Measurement of integration can be viewed as basic data for an understanding of how specific markets work.’

Objective

This objective is to evaluate sheep spatial market integration in Central Rift Valley of Ethiopia. The specific objectives are to examine the level of integration in the sheep markets in central rift valley of Ethiopia (Figure 1).

METHODOLOGY

Methods of data analysis

Correlation coefficients

Correlation coefficients of real price changes of market pairs are estimated by:

$$r_{ij} = \frac{\sum (\Delta P_{i,t} - \Delta \bar{P}_i) (\Delta P_{j,t} - \Delta \bar{P}_j)}{[\sum (\Delta P_{i,t} - \Delta \bar{P}_i)^2]^{1/2} [\sum (\Delta P_{j,t} - \Delta \bar{P}_j)^2]^{1/2}} \quad (1)$$

r_{ij} : the correlation coefficient of market price between the two markets, ($0 \leq r_{ij} \leq 1$).

Trends of spatial integration

The trends were estimated by the following linear model:

$$SPS_{ij} = \beta_1 + \beta_2 t + \varepsilon \quad (2)$$

Where SPS_{ij} is weekly price of the two spatially separated markets i and j .

Unit root tests

Augmented Dickey Fuller (ADF) test: The general form of this test’s regression looks as follows:

$$\Delta P = \alpha + \beta_t + (\rho - 1)P_{t-1} + \sum_{i=1}^n \gamma_i \Delta P_{t-i} + \varepsilon \quad (3)$$

Lag identification

The lag identification was done using the Akaike information criteria (AIC):

$$AIC_{ij} = \ln \delta_{ij}^2 + \frac{2k}{N} \quad (4)$$

Where AIC_{ij} is AIC statistic between markets i and j ;

Co integration test

The null hypothesis in such procedure is that of no co-integration,

Table 1. Correlation coefficient of ewe grades of body conditions.

Markets	Ewes fat	Ewes moderate	Ewes thin
	Market exchange price		
Werer- Awash	0.64**	0.50*	0.59**
Werer-Addis ketema	0.56**	0.42*	0.69**
Werer-Adama	0.54*	0.53*	0.13
Awash -Addis ketema	0.44*	0.31*	0.76**
Awash-Adam	0.46*	0.52*	0
Addis ketema-Adama	0.46*	0.41*	0

a: Correlation coefficients among different literature are strong ($r > 0.8$), moderate ($0.6 \leq r \leq 0.8$) and weak ($r < 0.6$). *: Correlation is significant at 0.05 levels. **: Correlation is significant at 0.01 levels. Source: Price data computed (2008-2011).

Table 2. Estimate of trends in spatial price spread of the ewe grades of body condition.

Market pairs	Ewe fat		Ewe moderate		Ewe thin	
	Cons.	Trend coefficient	Cons.	Trend coefficient	Cons.	Trend coefficient
Adam-Addis ketema	1.38*	0.02*	2.39*	-0.01*	0.49	-0.01*
Adama-Awash	1.12*	-0.02*	1.14	-0.01*	0.17	-0.00
Adama-Werer	1.17*	0.00	1.43	0.00	0.62	0.00
Awash-Addis ketema	5.46**	-0.4**	-1.19	0.01*	1.28	0.01*
Awash-Werer	0.45*	-0.2*	0.52	0.00	1.09	0.01
Addis ketema-Werer	0.63**	-0.03**	0.04	0.00	-0.96	0.03**

VEC: Correlations of autocorrelation were conducted for all market pair. **: Significant at 1%; *: significant at 5%. Source: Price data computed (2008-2011).

with the alternative hypothesis of co-integration.

$$P_t = \alpha + \beta X_t + V_t \tag{5}$$

With a co-integrating vector of (1, -β) using ADF:

$$\Delta V_t = \alpha + (\rho - 1)V_{t-1} + \sum_{i=1}^k \delta_i \Delta V_{t-i} + \varepsilon_t \tag{6}$$

Causality tests

The direction of causation in the price information flow was tested by Granger causality test. This test is used to establish the existence of a central market (Granger, 1969).

RESULTS AND DISCUSSION

Correlation coefficients

The ewe and ram was estimated using simple correlation coefficient. Six pair correlations were tested. Spatial sheep (ewe and ram) market pairs where identified by their levels of strength (that is, strong, moderate, and weak), significant at real price exchanges (Table 1). In accordance with this analysis, Werer-Awash and Werer-Addis ketema markets were moderately integrated with

0.64 and 0.56 respectively in grade fat types while the rest indicates weakly integrated including the moderate grade. The least correlation coefficient was recorded at Awash-Adama with moderate grade recording (0.31) followed by the Addis ketema-Adama at (0.41) with the same grade (body condition) which is a weak correlation ($r < 0.6$) but positively correlated.

Trends of spatial integration

The four market pairs were found to be negative trends of SPS in fat grade indicating that these markets where integrating over the past four years (Table 2), while the two markets are closer to arbitrage formation in the sample body condition. Awash-Addis ketema (-0.4) with the trend coefficient was the highest level estimated, followed by Awash-Werer, Addis ketema-Werer and Adama-Awash, respectively. Adama integrated with Addis ketema though it is not showed with degree of improvement which the trend coefficient (-0.02).

Causal test OLS

H_0 = all coefficient of lag of P_{ij} are equal to zero.
 H_1 = Coefficient of lag of P_{ij} are different from zero.

Table 3. Granger causality test of ewe grades of fat OLS.

Market pairs	Lag length	Causality (F-value)	P>F	Adj R-squared
Adama-Werer	4	5.94**	0.00	0.68
Adama-Awash	1	2.43*	0.05	0.66
Adam-Addis ketema	1	1.62* ²	0.12	0.66
Werer-Adama	2	4.30*	0.04	0.93
Awash-Adama	1	4.40*	0.04	0.82
Addisketema-Adama	1	4.78**	0.00	0.63
Awash-Werer	1	2.00* ²	0.12	0.82
Awsh-Addis ketema	1	2.66* ¹	0.10	0.81
Werer-Awash	1	11.55**	0.00	0.92
Addis ketema-Awash	3	4.69*	0.03	0.63
Addis ketema-Werer	3	3.84**	0.01	0.62
Werer-Addis ketema	3	6.01*	0.02	0.93

** : Causality is significant at 0.01. * : Causality is significant at 0.05. **¹: Causality is significant at 0.10 (weak). *²: Causality is significant at 0.25 (very weak). Source: Price data computed (2008-2011).

Table 4. Augmented Dickey-Fuller unit root test for ewe grades of fat.

Sample markets	Lag length	ADF τ -value	Mackinnon P-value	X ² at 10 lags (P > X ²)	τ -value at D(L)	P-value at D(L)	X ² at 10 lags (P > X ²)
Werer	2	-4.26***	0.00	14.47 (0.15)	-3.39**	0.05	7.04 (0.72)
Awash	1	-4.56***	0.00	25.26 (0.01)	-4.17***	0.01	24.15 (0.01)
Addis ketema	1	-6.44***	0.00	22.20 (0.01)	-4.38***	0.00	8.66 (0.57)
Adama	4	-6.56***	0.00	28.90 (0.00)	-5.71***	0.00	14.99 (0.13)

Lag length was determined based on the significance level of the lag structure. ***, ** and * indicate significance at 1, 5 and 10% respectively, τ -value in the parenthesis, X² = Durbin's alternative test for serial correlation, the values in the parenthesis show the significance level to reject the null hypothesis (H₀: No autocorrelation). Source: Price data computed (2008-2011).

There is reasonable justification that Granger-cause of Werer ewe with grades of fat market on Adama market with significant cause effect to price at lag 4 with (1%) having the adjusted R squared value of 0.68 explaining the effect with the rejection of the null hypothesis, while the vice versa with lag two at the significant level of (5% and above) Adama cause effect on Werer with 4.30 F-value so the causation is a feedback from the two markets at (5%) with strong Granger cause from the former. Addis ketema market to cause influence on the Adama market is very weak (with significant level of 10% and above) (Table 3).

Unit root test

Order of integration of price

$$P_t = \alpha + bP_{t-1} + \varepsilon_t$$

H₀: the price series for sheep contains unit root,
H₁: the price series for sheep are non unit root.

The hypothesis for the ADF test of unit root can be expressed as:

$$H_0: P_t = P_{t-1} + \varepsilon_t$$

$$H_1: P_t = \Delta P_{t-1} + \varepsilon_t$$

The results of the unit root test show that prices are stationary at different differenced orders integration in Werer, Awash, Addis ketema and Adama, which demonstrate that the order of integration in weekly prices is order one, that is I(1) for Awash and Addis ketema, while I (2) and I (4) for Werer and Adama since the analysis of ADF test statistics greater than the critical values of (1%), (5%) and (10%) of the interpolated Dickey-Fuller in absolute term and the Mackinnon P-value approximates to zero; with these the null hypothesis of the unit root rejected in favor of stationarity alternative with the ewe at the grade of fat (Table 4). White noise is a stationary process and there is a useful generalization of the random walk which requires that the first differences are stationary (Table 5):

Table 5. White noise test for ewe with grades of fat.

Portmanteau test for white noise				
Sample markets	Portmanteau/Q/statistic at level	P>X ²	Portmanteau/Q/statistic at lag 4	P>X ²
Werer	4091.44***	0.00	1581.46***	0.00
Awash	1984.98***	0.00	1144.79***	0.00
Addis ketema	712.22***	0.00	378.62***	0.00
Adama	1116.22***	0.00	503.47***	0.00

X² = Durbin's alternative test for serial correlation. ***: Significance at 1%. **: Significance at 5%. *: Significance at 10%. Source: Price data computed (2008-2011).

Table 6. Engle-Granger co-integration of two step OLS and unit root grade of fat.

Sheep	Markets	Werer	Awash	Addis ketema	Adama
Ewe	Werer		-3.14**	-4.05***	-3.62***
	Awash	-4.26***		-4.23***	-4.53***
	Addis ketema	-6.15***	-5.43***		-6.15***
	Adama	-4.26***	-5.31***	-5.78***	
Ram	Werer		-4.48***	-6.07***	-5.29***
	Awash	-4.95***		-5.32***	-5.33***
	Addis ketema	-7.21***	-6.09***		-6.57***
	Adama	-7.17***	-6.81***	-7.25***	

***, ** and * indicate significance at 1, 5 and 10%, respectively. Source: Price data computed (2008-2011).

$\Delta P_t = \varepsilon_t$, ε_t is stationary.

Co-integration test

Engle-Granger cointegration test (EG): The EG (Engle and Granger, 1987) test uses a more generalized formulation, if β is a vector of coefficients and P_t is a vector of non-stationarity variable, then there will be a cointegration vector β such that:

$$\beta P_t = \varepsilon_t$$

That there will be a linear combination and the left side will be stationary. ε_t will be the deviation from the long run equilibrium of the sheep price variable and is called "equilibrium error". Testing for cointegration is about finding this cointegration vector. By assumption for instance, the price of Werer and Awash markets will have one cointegrating vector. As shown in Table 6, the result of the ADF unit root tests of the residuals at test statistics with comparison to the critical values of 1, 5 and 10%, respectively and considering the Macknnonian p-value to the test statistic after the OLS regression of the EG test involving the different market pairs. The table reveals that out of the 12 possible pairs, all routes produced stationary residuals at 1% significant level for cointegration except that of Werer-Awash the

Macknnonian P-value shows 0.03 significance for the test statistic of 3.14, the critical value of 5% with grade of fat.

Maximum Eigen value tests: The first of the vector autoregression (VAR) based EG-ADF tests for econometric cointegration is put into application, and the outcomes are shown in Table 6. The table shows computed values of the Johansen Maximum Eigen value test statistic for the various market pairs. The higher the value for trace statistic, it is more likely market pairs linked in a steady state way. The critical values for the test use 5% (Table 7).

Johansen trace statistics test: Using an alpha option in the analysis, there is a possibility to get short term adjustments price parameters in the out. This helps to investigate which market responds more if there is a market shock in the routes of paired markets or the market price response to change of exogenous factors in the marketing system of sheep in the Central Rift Valley of Ethiopia. From these differenced market pairs in Table 8, signifies response to shock the higher the P> chi² the lesser the degree of responds to shock in the market system. With this justification in the pairs of market Werer-Awash, the Awash market responds faster more to market price shocks with differenced value of 0.00 which is more significant compared to Werer market. Considering the route of Awash-Adama price movement

Table 7. Maximum Eigen value statistics of Johansen cointegration for ewe grade of fat.

Market pair	Johansen maximum Eigen value test statistic			
	Maximum rank	Eigen value	Trace statistic	Critical value at 5%
Werer-Awash	1	0.10	15.64	3.74
Werer-Addis ketema	1	0.18	18.64	3.74
Werer-Adama	1	0.21	16.06	3.74
Awash-Addis ketema	1	0.18	19.87	3.74
Awash-Adama	1	0.18	20.23	3.74
Addis ketema-Adama	1	0.19	37.55	3.74

Zero rank values indicate lack of cointegration with $p > 0.05$. Source: Price data computed (2008-2011).

Table 8. Market pairs respond to market shock for sheep.

Markets pairs	Ewe grade of fat		Markets pairs	Ram grade of fat	
	Adjustment parameters			Adjustment parameters	
	Ch ²	P> Ch ²		Ch ²	P> Ch ²
Werer	0.29	0.59	Werer	4.27	0.04
Awash	13.14	0.00	Awash	8.41	0.00
Werer	4.51	0.03	Werer	4.10	0.04
Addis ketema	39.83	0.00	Addis ketema	35.13	0.00
Werer	3.10	0.08	Werer	4.27	0.04
Adama	21.33	0.00	Adama	8.41	0.00
Awash	2.07	0.15	Awash	1.21	0.27
Addis ketema	28.35	0.00	Addis ketema	22.37	0.00
Awash	9.63	0.00	Awash	9.68	0.00
Adama	13.51	0.00	Adama	30.50	0.00
Addis ketema	45.67	0.00	Addis ketema	8.77	0.00
Adama	2.03	0.15	Adama	18.76	0.15

Chi² = Result of trace statistic. Source: Price data computed (2008-2011).

respond to shock both markets responds at faster rate which having 0.00 significant level.

Inference drawn from the co- integration test result: A result reached by the empirical evaluation of econometric co-integration with the three tests used are almost unanimous in their results of the Central Rift Valley market for sheep were highly integrated notwithstanding the presence of a few market pairs that are weak spatially integrated when the price trend is analyzed using Maximum Eigen value statistics. These markets pair which curiously involve Werer-Awash and vice versa way exhibit aberrant behavior, the explanation of which is beyond the scope of this study. Just the same, out of the 12 possible regional market pairs, 11 are found to be spatially integrated, for a better than 98% successes rate in considering the ewe and ram.

Granger causality of market prices VAR model: The information provided by Table 9 indicates the high level of

integration among ewe with grade of fat markets. Except for some non-linked markets, the various market pairs exhibit Granger causality in either directions, or are linked in a feedback relationship. Only about 3 market pairs show evidence of segregation, 9 of which coincide with the ones identified by the Engle-Granger and the Johansen cointegration test approaches. The only non-linked pairs identified by the Granger causality approach not identified by the other tests is the Werer-Adama and Awash-Addis ketema route which showed a value of 0.18 and 0.24, respectively. The symbols exhibited in Table 10 are the causality directions of the market. For instance, a symbol => means that the information provided by the row market contribute in the price formation in the column market. A symbol <= on the other hand, suggests that the column market is the one providing the information for the formation of prices in the row market. When the symbol <=> is noted for the market pair, the conjecture is that there is some sort of feedback statistical causality between the paired market. Finally, the empty space

Table 9. Granger causality wald test for sheep using VAR model.

Market pairs	Ewes grade of fat		Market pairs	Ram grade of fat	
	Ch ²	P> Ch ²		Ch ²	P> Ch ²
Werer-Awash	0.41	0.82	Werer-Awash	4.72**	0.03
Awash-Werer	4.27*	0.10	Awash-Werer	4.02**	0.05
Werer-Addis ketema	5.99**	0.05	Werer-Addis ketema	6.15***	0.01
Addis ketema-Werer	16.57***	0.00	Addis ketema-Werer	20.87***	0.00
Werer-Adama	3.39	0.18	Werer-Adama	7.25***	0.01
Adama-Werer	17.83***	0.00	Adama-Werer	16.59***	0.00
Awash-Addis ketema	2.87	0.24	Awash-Addis ketema	2.47	0.12
Addis ketema-Awash	5.29*	0.07	Addis ketema-Awash	9.48***	0.00
Awash-Adama	3.98*	0.10	Awash-Adama	8.40***	0.00
Adama-Awash	6.33**	0.04	Adama-Awash	12.03***	0.00
Addis ketema-Adama	19.77***	0.00	Addis ketema-Adama	2.51	0.11
Adama-Addis ketema	1.61*	0.10	Adama-Addis ketema	10.04***	0.00

Chi² = Result of causality EG. ***: Significance at 1%. **: Significance at 5%. *: Significance at 10%. Source: Price data computed (2008-2011).

Table 10. Causality directions of linked markets based on results of Granger causality test.

Markets	Werer	Awash	Addis ketema	Adama
Werer		<=	<=>	<=
Awash			<=	<=>
Addis ketema				<=>

=> means the row Granger cause the column price formation, <= means the column Granger cause the row price formation, <=> price Granger cause feedback each other. Source: Price data computed (2008-2011).

implies market pair to be non-integrated or non causation to each other.

CONCLUSION AND RECOMMENDATION

The primary result of the study is the empirically determined high level of spatial market integration of the inter-market sheep prices. Out of the twelve possible sample market pairs, using Granger-Causality Wald test using VAR model for cointegration showed statistically significant level of spatial integration except Werer-Awash, Werer-Adama and Awash Addis ketema for ewes with grades of fat yet it is verified with other test the significant integration spatial market prices with results of the three empirical procedures confirming each other's results. Only the market pairs of Awash-Addis ketema and vice versa routes are found to be non-spatially integrated using maximum Eigen value statistics of Johansen cointegration test for ewe grade of fat. This does not mean that no trading is possible along these routes and there exists market failures along these routes. In the integrated pairs, what the study uncovered the statistical alignment of prices in these pairs. In other words, there exist long-run equilibrium relationship of the prices in the

identified market pairs, and that the price transmission mechanism is stationary with having no unit root test for the sample year taken. The Granger causality OLS tests conducted on all sampled market pairs identified what the theory predicts that at least a unidirectional causality exists in the integrated market pairs. Interestingly, market information in deficit sample is apparently being used in the price formation at the sheep producing (the rural markets).

In some deficit-surplus market pairs, significant feedback causality is noted. All of the inference procedures used in the study generated almost identical results except few slight exceptions, thus giving me sufficient confidence on the empirical validity of my results, the interregional sheep price transmission system is highly efficient. Spatial market integration should foster a sustainable use expected to favor the sharing of risk across markets smoothing idiosyncratic price variations. Using weekly sheep price data from Central Rift Valley, results show that markets are integrated. Prices are co-integrated, short-term integration is largely prevailed and there is evidence of market integration. Yet large price differentials occasionally persist between adjacent areas for periods of time. In the long run, substantial investment in transportation system is required to improve the integration of markets. Market integration will play a

crucial role in improving the food security situation of the region, which account for the highest number of meat deficit district in the country. In the case of the interregional market for sheep in the CRV of Ethiopia, the study uncovered the existence of a high level of spatial integration. Higher than 95% of all market pairs have long-run equilibrium price linkages, and that short-run deviations from equilibrium will readily be corrected through the efficient transmission of price setting information.

The following are the possible implications of the findings made:

- (i) The results shown in the discussion part dictate that the 'law of one price' was found in operation in the inter-market sheep price of the CRV for different body condition category for ewe and ram,
- (ii) For the sheep traders to take advantage of the high level of spatial market integration, the problem of the highly inefficient and fragmented distribution and transportation systems must be addressed with market information backup systems,
- (iii) Because of the high level of spatial integration of markets, government price support and other market-oriented policies are expected to achieve their intended goals in Werer, Awash and Addis ketema with food security programs furthermore.

The greater the extents of domestic market integration, the more modest are the informational and technical demands necessary for policy formulation at Woreda, and regional level if aggregated from different direction, it can be used for higher level policy formulation.

- (i) Further research on market integration for sheep using advanced level II (with transfer costs data) and level III (with transfer costs and trade flows data) analysis should be supported,
- (ii) Market integration studies across marketing stages must also be encouraged,
- (iii) Efforts should also be expended to empirically determine the extent of spatial market integration for other major agricultural commodities and its by products.

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REFERENCES

- Asfaw N (1998). The response of Ethiopian Grain Markets to Liberalization. Grain Market Research Project, working paper, Ministry of Economic Development and cooperation, Addis Ababa.
- Berhanu G, Hoekstra D, Azege T (2006). Improving the Competitiveness of Agricultural Input Markets in Ethiopia: Experiences since 1991. Paper presented at the Symposium on Seed-fertilizer Technology, Cereal productivity and Pro-Poor Growth in Africa: time for New Thinking 26th Triennial Conference of the International Association of Agricultural Economics (IAAE), August 12 – 18, 2006, Gold Coast, Australia.
- Engle RF, Granger CWJ (1987). Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrical* 55(2):251-276.
- Kosgey IS (2004). Breeding Objectives and Breeding Strategies for Small Ruminants in the Tropics. Ph.D. Thesis. Wageningen University, The Netherlands 272 P.
- Ravallion M (1987). Testing market integration. *Am. J. Agric. Econ.* 6:102-109.
- Takayama T, Judge GG (1971), Spatial and Temporal Price and Allocation Models, Amsterdam: North-Holland Publishing Co., 528 pages. Two volume edition 1976.
- Wilson RT (1986). Livestock production in the central Mali: Long-term studies on cattle and small ruminants in the agropastoral system. ILCA Research Report No. 14.

Full Length Research Paper

The Ricardian analysis twenty years after the original model: Evolution, unresolved issues and empirical problems

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This paper analyses the wide body of literature that concerns applications of the Ricardian approach to assess the economic effects of climate change on agriculture. Beginning with the original model proposed by Mendelsohn, Nordhaus and Shaw in 1994, the article discusses researchers' main criticisms of the model and the innovations suggested to overcome its limitations. Finally, the study summarises the unresolved issues and empirical problems that need to be examined in future research. New issues to be explored include the capture of future technologies, implementation of price changes, choice of the best variables to represent climate, simulation of seasonal effects and identification of the best technique to hypothesise the relationship between profits and climate. The paper also discusses operative problems, such as the availability of the most suitable data, the adoption of spatialisation techniques and the enlargement of the time horizon to be covered.

Key words: Climate change, economic effects, agriculture, Ricardian analysis.

INTRODUCTION

The literature proposes several methods to assess the impact of climate change on agriculture (United Nations Framework Convention on Climate Change [UNFCCC], 2008). However, an examination of the proposed models and the empirical evidence reveals that the Ricardian method is the most commonly used microeconomic approach. This method, proposed by Mendelsohn et al. (1994), was originally formulated to overcome the main limitation of the production function approach, which is based on a crop-specific analysis that fails to take into consideration the possibility for farmers to implement adaptation strategies to cope with the effects of

climate change. The principal innovation introduced by the Ricardian analysis is a 'black box' treatment of farmers' adaptation strategies. This means that the model does not require to explicit adaptation strategies among the explanatory variables because these are considered in the model implicitly. The key idea is that farmers aim to maximise their profits through a specific combination of output and input, given the values of exogenous variables such as climate, soil, altitude and other constraints outside their control (Mendelsohn and Dinar, 2009). By regressing farms' net profits with these variables it is possible to estimate the marginal effects of climate

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change on farmers' profits. Moreover, by simulating changes of climate scenarios and projecting into the future the estimated relationship between economic performance and climatic variables, it is possible to measure the economic impact of the hypothesised climate changes on agriculture (Mendelsohn et al., 1994).

From the beginning, this method has produced scepticism and criticism (Cline, 1996; Fisher and Hanemann, 1998; Darwin, 1999; Quiggin and Horowitz, 1999). This has generated a profitable and stimulating debate among researchers over the last 20 years. Despite the initial doubts, the Ricardian approach has been applied to different geographical contexts and scales (Kurukulasuriya and Mendelsohn, 2007; Maddison et al., 2007; Mendelsohn and Seo, 2007; Strzepek and McCluskey, 2007; Seo and Mendelsohn, 2008; Van Passel et al., 2012). It was also adopted to account for climate change impacts on the agricultural sector in developed and developing countries (Kumar and Parikh, 1998; Weber and Hauer, 2003; Liu et al., 2004; Deressa et al., 2005; Schlenker et al., 2005; Seo et al., 2005; Deressa, 2007; Eid et al., 2007; Jain, 2007; Kabubo-Mariara and Karanja, 2007; Mano and Nhemachena, 2007; Molua and Lambi, 2007; Fleischer et al., 2008; Kabubo-Mariara, 2008; Wang et al., 2008; Mendelsohn et al., 2010). Recently, it was demonstrated that it is also possible to apply this method in very small regions (De Salvo et al., 2013).

Mendelsohn and Dinar (2009) raised some questions about the future evolution of the Ricardian analysis and, recently, some of these were answered fully or partially. These concerns: (i) the use of net revenue instead of land value as the dependent variable (Mendelsohn et al., 2007); (ii) the choice of the most appropriate functional form for the Ricardian function (Lang, 2007; Fezzi and Bateman, 2012); (iii) the independent factors included in the model as control variables (Deressa, 2007; Eid et al., 2007; Mano and Nhemachena, 2007; Kabubo-Mariara and Karanja, 2007); (iv) the treatment of the relationship between climate change, irrigation and the impacts on agriculture (Schlenker et al., 2005; Kurukulasuriya and Mendelsohn, 2008a); and (v) the stability of the estimated coefficients over time (Masseti and Mendelsohn, 2011). Other problems remain unresolved feeding the current debate among researchers. These mainly concern how the climate should be represented in the analysis and the need to take into account aspects not yet considered, such as how to capture the effects of technological innovations and prices changes.

This article focuses on a literature review of the Ricardian analysis and considers principally the most recent debate on its use. It aims to highlight the issues currently being debated among researchers in order to discuss the critical aspects and the potential development of the method, especially in relation to the questions not yet resolved. Final considerations concern the empirical problems faced by scholars in applying this approach.

ORIGINAL MODEL

Until the mid-1990s, the most popular microeconomic method used to measure impacts of climate change on agriculture was the production function approach, a crop simulation model that explains the agronomic relationship between production and climate, soils and management practices. The main limitation of this method is that it is a crop-specific analysis and endorses the so-called 'dumb-farmer' hypothesis. It fails to capture farmers' behaviour, especially as it concerns the switch from crops less suitable to crops more suitable to climate change (Mendelsohn and Dinar, 2009). As highlighted by Mendelsohn et al. (1994), the impacts assessed using this method are overestimated.

To overcome this limitation, Mendelsohn et al. (1994) propose the Ricardian approach, which assumes, in its original formulation, the following specification:

$$V = \int P_{LE} e^{-\phi t} dt = \int [\sum P_i Q_i(X, F, Z) - \sum R X] e^{-\phi t} dt \quad (1)$$

where: P_{LE} is the net revenue per hectare; P_i is the market price of the crop i ; Q_i is the output of the crop i ; F is a vector of climatic variables; Z is a vector of soil and economic variables; X is a vector of purchased inputs (excluding land); R is a vector of input prices; t is the time; and ϕ is the discount rate.

Mendelsohn et al. (1994) base their model on the following two assumptions: (i) a perfectly competitive market for both outputs and inputs, and (ii) interest rate, rate of capital gains and capital per acre are equal for all plots of land. The latter assumption ensures proportionality between land value and land rent. Consequently, it is possible to reduce the profit maximisation function (1) to a cross-sectional analysis in which the land value (or, as most recently suggested, the farm's net revenue) is regressed against climate and soil characteristics, and other control variables. Obviously, the coefficients estimated are consistent only if the model includes all the relevant explicative variables. Otherwise, climate change effects on the dependent variable are mixed with the effects caused by other factors, and the consequent bias of coefficients is unknown in terms of both sign and magnitude (Deschênes and Greenstone, 2007).

In the Ricardian analysis climatic variables are included among the regressors to simulate climate change. Taking into account the agronomic literature on this topic, Mendelsohn et al. (1994) hypothesises a quadratic relationship between the net profit and climatic variables, choosing as proxies for these the long-run averages of temperature and precipitation (climate normals) measured during the period 1951 to 1990. They also simulate a seasonal effect, considering the value of each climatic variable for the most representative month of each season (January, April, July and October).

Recently, other authors have assumed new ways of

representing the climate scenario as well as new hypotheses to estimate the relationship between profits and climate. Using satellite data, Mendelsohn et al. (2007) test the importance of climate normals and inter-annual variance for explaining the net revenue from cropland and the fraction of land used for cropland. Schlenker et al. (2006) suggest the use of 'degree days' between 8 and 32°C, instead of the average temperature, to represent climate in the model. They also suggest measuring the climatic variables during the growing season only (April–September). Massetti et al. (2013) criticise these choices, arguing that average temperatures provide a more accurate result than degree days, and that seasons matter in explaining the relationships between climate scenario and economic performance. Table 1 summarises the work of the most relevant scholars on these issues.

MAIN CRITICISMS OF THE ORIGINAL MODEL AND PROPOSED SOLUTIONS

The validity and robustness of the Ricardian approach have animated an international debate among researchers. Cline (1996) made one of the first criticisms, which concerns the partial equilibrium nature of this analysis because it implies no change in prices. Cline argues that as a consequence, underestimation of climate damages and overestimation of climate benefits occur.

The Ricardian method is also criticised for its static nature. The impacts of climate change on agriculture should be analysed dynamically, emphasising changes of climatic variables over time rather than at one level (Quiggin and Horowitz, 1999). Further, several scholars agree that one of the main weakness of the traditional formulation proposed by Mendelsohn et al. (1994) is the lack of irrigation modelling (Cline, 1996; Fisher and Hanemann, 1998; Darwin, 1999). In particular, Fisher and Hanemann (1998) demonstrate that the omission of irrigation from the analysis can lead to an incorrect estimation of climate parameters' signs and magnitude.

Mendelsohn and Nordhaus (1999a, 1999b) respond to these criticisms. Mendelsohn and Nordhaus (1999b) support their approach through the estimation of a formulation in which they modify the hedonic function, taking into account the effect of irrigation in the constant term. However, this formulation fails to consider the other estimation coefficients, especially those related to climatic variables. Schlenker et al. (2005) estimate separate regressions for rainfed and irrigated lands, demonstrating that the Ricardian function differs in the presence and absence of irrigation, especially as it concerns the parameters related to the climatic variables. They conclude that irrigated and dry lands cannot be pooled in a single regression function. Consequently, the economic effects of climate change on agriculture need

to be assessed using different variables for dry land and irrigated areas in the model specification.

Schlenker et al. (2005) treat irrigation as an exogenous variable, causing sample selection bias (Mendelsohn and Dinar, 2009). Some applications have introduced innovative changes to the original approach, suggesting the use of a 'structural Ricardian model' to take adaptation into account (Table 1). These applications match the estimation of a binary or categorical model to simulate farmers' behaviour, with a second stage of analysis devoted to estimating the conditional net revenue for each considered choice.

In this way, Kurukulasuriya and Mendelsohn (2008a) discriminate between irrigated and rainfed lands, improving the Ricardian approach by treating irrigation as an endogenous variable. In addition, Kurukulasuriya and Mendelsohn (2008b) apply this approach to consider the possibility of farmers changing crops to cope with climate change. Seo and Mendelsohn (2008) apply this approach to livestock rearing, while Mendelsohn and Seo (2007) extend the application of the structural Ricardian model to different farm typologies.

One of the most significant difficulties affecting the estimation of the Ricardian model concerns data availability. In order to extend the application of this model to countries for which census data are not available, some authors propose using primary data from surveys of farms in different climatic zones (Lippert et al., 2009; Wang et al., 2008; Mendelsohn et al., 2010). In this case, more detailed data about farm activities are available, making it possible to consider net revenue instead of land price as the dependent variable. In relation to the choice of dependent variable, Mendelsohn and Dinar (2009) indicate that net revenue reflects short-term climatic variations, while land value reflects a long-term scenario. Moreover, net revenue is a more robust measure of land value than land price because it does not depend on discount rate assumptions about future revenues (Kurukulasuriya and Ajwad, 2007).

One further criticism of considering the net revenue as the dependent variable concerns its strong relation with the year of analysis. Mendelsohn et al. (2007) calculate a three-year average (1990, 1995, 2000) in order to provide a long-term measure of net revenue.

The use of farm survey data and net revenue as the dependent variables makes it possible to include in the analysis control variables as proxies for farmers' strategies for coping with markets and to control the climate change effects on profits. Some authors consider control variables to be the specific characteristics of the agricultural sector in different local scenarios using socio-economic variables (Eid et al., 2007) and farmer profile variables (Deressa, 2007; Mano and Nhemachena, 2007; Kabubo-Mariara and Karanja, 2007). Others include in the model—as exogenous variables—proxies for farmers' adaptation strategies (Molua and Lambi, 2007).

Recently, the scientific debate has focused on the

Table 1. Examples of some Ricardian model applications.

Authors	TH v. EM	Model type	CS v. PD	Agg v. Frm	NR v. LP	Functional form	Climatic variables	Seasonal effect?	Interaction effect?	Climatic variables' functional form	Case study
Mendelsohn et al. (1994)	TH EM	Ricardian	CS	Agg	NR	Linear	Temperature Precipitation	Yes	Yes	Quadratic	US
Kumar and Parikh (1998)	EM	Ricardian	CS	Agg	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	India
Maddison (2000)	EM	Ricardian	CS	Frm	LP	Linear	Temperature Precipitation Wind Speed Foggy Days	Yes	No	Linear	Wales, United Kingdom
Weber and Hauer (2003)	EM	Ricardian	CS	Frm	LP	Linear	Temperature Precipitation	Yes	Yes	Non-linear	Canada
Mendelsohn et al. (2004)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Sri Lanka
Schlenker et al. (2005)	EM	Ricardian	CS	Frm	LP	Linear	Degree days Precipitation	No	No	Quadratic	US counties east of the 100th meridian
Deressa et al. (2005)	EM	Ricardian	CS	Agg	NR	Linear	Temperature Precipitation	Yes	Yes	Quadratic	South Africa
Deschênes and Greenstone (2006)	TH EM	Fixed-effect	PD	Agg	NR	Linear	Degree days Precipitation	Yes	No	Quadratic	US
Deressa (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Ethiopia
Eid et al. (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Egypt
Jain (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Humidity	Yes	No	Quadratic	Zambia
Kabubo-Mariara and Karanja (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Kenya

Table 1. Contd.

Kurukulasuriya and Mendelsohn (2008a)	TH EM	Structural Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Africa
Lang (2007)	TH EM	Structural Ricardian	PD	Frm	LP	Quadratic Box-Cox	Temperature Precipitation	No	Yes	Non-linear	Germany
Mano and Nhemachena (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Zimbabwe
Molua and Lambi (2007)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Cameroon
Mendelsohn and Seo (2007)	EM	Structural Ricardian	CS	Frm	NR LP	Linear	Temperature Precipitation	Yes	No	Quadratic	Latin America
Fleischer et al. (2008)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	No	No	Quadratic	Israel
Kabubo-Mariara (2008)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Kenya
Seo (2008)	EM	Structural Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Africa
Seo and Mendelsohn (2008)	EM	Structural Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	Africa
Seo et al. (2008)	EM	Ricardian	CS	Agg	NR	Linear	Temperature Precipitation	Yes	Yes	Quadratic	Africa
Wang et al. (2008)	EM	Ricardian	CS	Frm	NR	Linear	Temperature Precipitation	Yes	No	Quadratic	China
Lippert et al. (2009)	TH EM	Structural Ricardian	CS	Frm	LP	Simple spatial error model	Temperature Precipitation	No	No	Linear	Germany
Masseti and Mendelsohn (2011)	TH EM	Ricardian (not standard)	PD	Frm	LP	Linear	Temperature Precipitation	Yes	No	Quadratic	US
Mendelsohn et al. (2010)	EM	Ricardian	CS	Frm	LP	Linear	Temperature Precipitation	Yes	Yes	Quadratic	Mexico

Table 1. Contd.

Fezzi and Bateman (2012)	TH EM	Ricardian (not standard)	PD	Frm	LP	Smoothing function	Degree days Precipitation	No	No	Linear	Wales, Kingdom	United
De Salvo et al. (2013)	EM	Ricardian	CS	Frm	NR	Linear Log-linear Box–Cox	Temperature Precipitation	No	No	Quadratic	Province of Trento (Italy)	

TH, theoretical paper; EM, empirical paper; CS, cross-sectional data; PD, panel data; Agg, aggregated data; Frm, individual farm data; NR, net revenue; LP, land price.

flexibility of the functional form and the possibility of using panel data for the estimation of the Ricardian function. According to Mendelsohn and Dinar (2009), the use of net revenue in the logarithm form as the dependent variable is most appropriate. Lang (2007) chooses land price as the dependent variable and introduces the use of a quadratic Box–Cox function to assess the impact of climate change on German agriculture. De Salvo et al. (2013) compare models estimated using the ordinal (linear and log-linear) net revenue formulations to those in which the dependent variable is specified as a Box–Cox transformation. Fezzi and Bateman (2012) propose the use of a smoothing function. However, the advantage of modelling the data without imposing a specific functional form is limited to continuous variables. Due to data unavailability, control variables are frequently expressed using dummy or categorical variables, for which it is not possible to use the smoothing function or Box–Cox transformation.

The need to adapt the Ricardian approach to panel data arises from different considerations. First, climate coefficients change over time (Mendelsohn and Dinar, 2009). Moreover, it is possible to obtain biased estimates if the dependent variable is the farm's net revenue measured in an unrepresentative year. Second,

the use of panel data resolves the distortions caused by the correlation between climatic variables and farmers' strategies treated explicitly in the model (for example, irrigation).

Deschênes and Greenstone (2007) propose the use of a fixed-effect model that represents the climatic impacts on profit and yields through weather variables. They argue that the results of the Ricardian function are not stable over time. Massetti and Mendelsohn (2011) refute this conclusion and demonstrate a broader stability of the Ricardian climate coefficients using panel data. In particular, relying on several approaches, Massetti and Mendelsohn (2011) suggest the use of the Chang Hsiao technique (Hsiao, 2003).

Deschênes and Greenstone's (2007) approach is also criticised by Fisher et al. (2012), who list the aspects that plausibly explain divergences between Deschênes and Greenstone's (2012) results and those obtained in previous studies, including that scholars do not consider the spatial correlation (Anselin and Lozano-Gracia, 2008). As highlighted by Kumar (2011), spatial correlation could affect the Ricardian analysis, considering both the dependent variable and the errors. A bias in the estimates of the *t*-statistic could occur if these sources of correlation are ignored. Researchers who treat spatial correlation explicitly are Polsky and Easterling (2001), Schlenker et al.

(2006), Lippert et al. (2009) and Kumar (2011).

UNRESOLVED ISSUES AND EMPIRICAL PROBLEMS

Since the publication of Mendelsohn et al.'s original (1994) article, and despite criticisms and doubts about its validity, the Ricardian model has become one of the most applied econometric approaches to measuring the economic impact of climate change on agriculture. According to Mendelsohn et al. (2010), this is because 'it is easy to estimate, yields geographically precise values, and captures adaptation'.

Over the past 20 years, researchers have recognised the potential of this method. They have enriched its application with variants and evolutions in attempts to remove its principal limitations, such as the lack of irrigation modelling and its endogenous nature, the inexplicit consideration of adaptation strategies, the time instability of the Ricardian climate coefficients and the lack of spatial correlation treatment. Further, they have enlarged the application of the model to individual farm data and tested different functional forms, identifying those more versatile and flexible. Finally, they have demonstrated the applicability of this method to a small scale. As a

consequence, the use of this method has increased, despite the fact that some critical issues remain unresolved, including how to capture future technologies and how to consider changing prices. Other issues are currently under debate, including the choice of the best variables to represent climate, the need to simulate a seasonal effect, and the best method of hypothesising the relationship between profits and climate.

Further, to resolve technical issues, researchers undertaking original studies need to face operative problems, including those common to most empirical researches, such as data availability. Census data are frequently inaccessible and surveys are expensive. Consequently, alternative sources of information are required. For European countries, the Farm Accountancy Data Network (FADN)¹, which collects structural, economic and financial data from a representative sample of European farms, could be a data source of primary importance for Ricardian applications.

The technique used to link economic and climatic data is another relevant issue. Climatic data are frequently related to local meteorological stations, and the algorithm used to associate each observation with the values of the climate normals is key to ensuring variability and the significance of variables. To ensure the model's validity, the use of a local and specific spatialisation procedure is relevant, especially if it is applied on a small scale using farm data. However, data on farms' spatial coordinates are frequently unavailable. For instance, the FADN database do not contains farm's spatial coordinates and it is possible identify only the municipality where the observation is located.

A further concern is the time horizon covered by the available data. Frequently, data is available for only a single or a few consecutive years, and it is not possible to provide long-term statistics. This makes it impossible for an analysis to include the effect of changing output and input prices. For instance, the sampling procedure used by the FADN does not ensure the constancy of the investigated sample. Consequently, it is not possible to analyse farms' long-term changes in relation to other aspects that could be affected by climate change, such as soil usage, farmland, choices of capital and investments, and technological changes. This limits the possibility of estimating panel-data models, which seem to be the best solution to both unresolved critical issues and the numerous limits of the traditional Ricardian approach. As demonstrated, a panel-data approach removes year effects and produces more stable estimates of the climatic coefficients. Moreover, in order to consider the endogenous nature of the irrigation, the panel-data approach can be formulated to remove misspecifications due to the lack of consideration of adaptations and other phenomena that could occur in the long term as a response to climate change or other factors. However, a model that can meet all these

requirements is extremely sophisticated and requires the use of unpopular software using handmade functions—a significant limitation to its application.

In conclusion many advances were made to the Ricardian analysis during the last twenty years but there are still many critical issues to be solved. A further and wider use of the model need to overcome the most common empirical problems such as the availability of data at the suitable spatial scale and time horizon. Finally, the estimation of panel data models also involves the availability of specific packages to be implemented in the most used software.

REFERENCES

- Anselin L, Lozano-Gracia N (2008). Errors in variables and spatial effects in hedonic House price models of ambient air quality. *Emp. Econ.* 34(1):5-34.
- Cline WR (1996). The impact of global warming on agriculture [comment]. *Am. Ec. Rev.* 86(5):1309-1311.
- Darwin R (1999). The impact of global warming on agriculture: A Ricardian analysis [comment]. *Am. Econ. Rev.* 89(4):1049-1052.
- De Salvo M, Raffaelli R, Moser R (2013). The impacts of climate change on permanent crops in an alpine region: A Ricardian analysis. *Agric. Syst.* 118:23-32.
- Deressa T (2007). Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach. *World Bank Policy Res. Work. P.* 4342.
- Deressa T, Hassan R, Poonyth D (2005). Measuring the impact of climate change on South African agriculture: the case of sugar-cane growing regions. *Agrekon* 44(4):524-542.
- Deschênes O, Greenstone M (2007). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. *Am. Econ. Rev.* 97(1):354-384.
- Deschênes O, Greenstone M (2012). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather [reply]. *Am. Econ. Rev.* 102(7):3761-3773.
- Eid HM, El-Marsafawy S, Ouda SA (2007). Assessing the economic impacts of climate change on agriculture in Egypt: A Ricardian approach. *World Bank Policy Res. Work. P.* 4293.
- Fezzi C, Bateman I (2012). Non-linear effects and aggregation bias in Ricardian models of climate change. *CSERGE Work. P.* 2012-02.
- Fisher AC, Hanemann M (1998). The impact of global warming on agriculture: Rethinking the Ricardian approach. Working Paper Series, Department of Agricultural and Resource Economics, Berkeley, California Agricultural Experiment Station, University of California.
- Fisher AC, Hanemann M, Schlenker W (2012). The economic impacts of climate change: Evidence from agricultural output and random fluctuations in weather [comment]. *Am. Econ. Rev.* 102(7):3749-3760.
- Fleischer A, Lichtman I, Mendelsohn R (2008). Climate change, irrigation, and Israeli agriculture: will warming be harmful. *Ecol. Econ.* 65(3):508-515.
- Hsiao C (2003). *Analysis of Panel Data*, 2nd edn. Cambridge University Press, Cambridge.
- Jain S (2007). An empirical economic assessment of impacts of climate change on agriculture in Zambia. *World Bank Policy Res. Series Work. P.* 4291.
- Kabubo-Mariara J (2008). The economic impact of global warming on livestock husbandry in Kenya: a Ricardian analysis. Paper presented at the 16th Annual Conference of the European Association of Environmental and Resource Economists, Gothenburg, Sweden, 25-28 June.
- Kabubo-Mariara J, Karanja FK (2007). The economic impact of climate change on Kenyan crop agriculture: a Ricardian approach. *World Bank Policy Res. Series Work. P.* 4334.
- Kumar K (2011). Climate sensitivity of Indian agriculture: do spatial

- effects matter? *Camb. J. Reg. Econ. Soc.* 4:221-235.
- Kumar K, Parikh J (1998). Climate change impacts on Indian agriculture: the Ricardian approach. In Dinar A, Mendelsohn R, Evenson R, Parikh J, Sangi A, Kumar K, Mckinsey J, Lonergan S (eds), *Measuring the impact of climate change on Indian agriculture*. World Bank Technical P. 402, World Bank, Washington, DC.
- Kurukulasuriya P, Ajwad MI (2007). Application of the Ricardian technique to estimate the impact of climate change on smallholder farming in Sri Lanka. *Clim. Ch.* 81(1):39-59.
- Kurukulasuriya P, Mendelsohn R (2007). Endogenous irrigation: the impact of climate change on farmers in Africa. *World Bank Policy Research Working Paper* 4278.
- Kurukulasuriya P, Mendelsohn R (2008a). A Ricardian analysis of the impact of climate change on African cropland. *Afr. J. Agric Res. Econ.* 2:1-23.
- Kurukulasuriya P, Mendelsohn R (2008b). Crop switching as an adaptation strategy to climate change. *Afr. J. Agric Res. Econ.* 2:105-126.
- Lang G (2007). Where are Germany's gains from Kyoto?: estimating the effects of global warming on agriculture. *Clim. Ch.* 84:423-439.
- Lippert C, Krimly T, Aurbacher J (2009). A Ricardian analysis of the impact of climate change on agriculture in Germany. *Clim. Ch.* 97(3-4):593-610.
- Liu H, Li X, Fischer G, Sun L (2004). Study on the impacts of climate change on China's agriculture. *Clim. Ch.* 65(1-2):125-148.
- Maddison D (2000). A hedonic analysis of agricultural land prices in England and Wales. *Eur. Rev. Agric. Econ.* 27:519-532.
- Maddison D, Manley M, Kurukulasuriya P (2007). The impact of climate change on African agriculture: a Ricardian approach. *World Bank Development Research Group, Sustainable Rural and Urban Development Team, Policy Research Working P.* 4306.
- Mano R, Nhemachena C (2007). Assessment of the economic impacts of climate change on agriculture in Zimbabwe: A Ricardian approach. *World Bank Development Research Group, Sustainable Rural and Urban Development Team, Policy Research Working P.* 4292.
- Massetti E, Mendelsohn R (2011). Estimating Ricardian functions with panel data. *Climate Change Econ.* 2(4):301-319.
- Massetti E, Mendelsohn R, Chonabayashi S (2013). How does temperature affect land values in the US? FEEM Seminars, available at http://www.feem.it/userfiles/attach/201362113121452013.06.20_Emanuele%20Massetti_presentation.pdf.
- Mendelsohn R, Dinar A (2009). Climate change and agriculture: an economic analysis of global impact, adaptation and distributional effects. *Elgar, Cheltenham*.
- Mendelsohn R, Nordhaus W (1996). The impact of global warming on agriculture [reply to Cline]. *The Am. Econ. Rev.* 86(5):1312-1315.
- Mendelsohn R, Nordhaus W (1999a). [Reply to Quiggin and Horowitz]. *Am. Ec. Rev.* 89:1046-1048.
- Mendelsohn R, Nordhaus W (1999b). [Reply to Darwin]. *Am. Econ. Rev.* 89:1053-1055.
- Mendelsohn R, Seo N (2007). Changing farm types and irrigation as an adaptation to climate change in Latin American agriculture. *World Bank Policy Res. Work. P.* 4161.
- Mendelsohn R, Christensen P, Arellano-Gonzalez J (2010). The impact of climate change on Mexican agriculture: a Ricardian analysis. *Env. Dev. Econ.* 15:153-171.
- Mendelsohn R, Nordhaus WD, Shaw D (1994). The impact of global warming on agriculture: A Ricardian analysis. *Am. Econ. Rev.* 84(4):753-771.
- Mendelsohn R, Basist A, Dinar A, Kurukulasuriya P, Williams C (2007). What explains agricultural performance: climate normals or climate variance. *Clim. Ch.* 81(1):85-99.
- Molua E, Lambi CM (2007). The economic impact of climate change on agriculture in Cameroon. *World Bank Development Research Group, Sustainable Rural and Urban Development Team. Policy Res. Work. P.* 4364.
- Polsky C, Easterling WE III (2001). Adaptation to climate variability and change in the US Great Plains: A multi-scale analysis of Ricardian climate sensitivities. *Agric. Ecosyst. Env.* 85:133-144.
- Quiggin J, Horowitz JK (1999). The impact of global warming on agriculture: A Ricardian analysis. *Am. Econ. Rev.* 89(4):1044-1045.
- Schlenker W, Hanemann M, Fischer A (2005). Will US agriculture really benefit from global warming?: accounting for irrigation in the hedonic approach. *Am. Econ. Rev.* 95(1):395-406.
- Schlenker W, Hanemann M, Fisher A (2006). The impact of global warming on U.S. agriculture: An econometric analysis of optimal growing conditions. *Rev. Econ. Stat.* 88:113-125.
- Seo SN (2008). A microeconomics analysis of climate change impacts on livestock management in African agriculture. *MPRA Paper* 6903, Yale University, New Haven, CT.
- Seo SN, Mendelsohn R (2008). Measuring impacts and adaptations to climate change: a structural Ricardian model of African livestock management. *Agric. Econ.* 38(2):151-165.
- Seo SN, Mendelsohn R, Munasinghe M (2005). Climate change impacts on agriculture in Sri Lanka. *Env. Dev. Econ.* 10:581-596.
- Strzepek K, McCluskey A (2007). The impacts of climate change on regional water resources and agriculture in Africa. *World Bank Development Research Group, Sustainable Rural and Urban Development Team. Policy Res. Work. P.* 4290.
- United Nations Framework Convention on Climate Change (UNFCCC) (2008). Compendium on methods and tools to evaluate impacts of, vulnerability and adaptation to climate change, available at http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/2674.php.
- Van Passel S, Massetti E, Mendelsohn R (2012). A Ricardian analysis of the impact of climate change on European agriculture. *FEEM nota di lavoro*, 83/2012, available at http://www.oecd.org/tad/crp/VAN_PASSEL_WorkingPaper_Ricardian_Analysis.pdf.
- Wang J, Mendelsohn R, Dinar A, Huang J, Rozelle S (2008). Can China continue feeding itself?: The impact of climate change on agriculture. *World Bank Development Research Group, Sustainable Rural and Urban Development Team. Policy Res. Work. P.* 4470.
- Weber M, Hauer G (2003). A regional analysis of climate change impacts on Canadian agriculture. *Can. Pub. Pol.* 29(2):163-180.

Full Length Research Paper

Determinants of live animals and animal products trade within the ECOWAS sub-region: A gravity model approach

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The scope and direction of international agricultural trade among nations depend on a number of factors. This study, thus, sought to identify and evaluate the determinants of trade in live animals and animal products among member countries in the Economic Community of West African States (ECOWAS) sub-region. Panel data on values of bilateral merchandise imports of agricultural commodities (HS Codes 1-24) at 2-digits were obtained from the International Trade Centre (ITC) for the years 2001 to 2011. The data were analysed using descriptive statistics and gravity model. The value of all agricultural commodities imports within the region for the period stood at 4.56 billion US dollars, which accounted for 6.38% of the total value for all commodities imports in the region. Imports of live animals and animal products constituted 18.46% of all agricultural products imports for the period. The results also indicated that regional characteristics such as importer and exporter's Gross Domestic Products (GDPs), geographical distance, contiguity and usage of common official language did significantly affect the trade in live animals and animal products. Intra-ECOWAS imports of these products were consistent with the gravity theory and the trade pattern followed the Heckscher-Ohlin's theory of trade. The study therefore recommends that effort be made to improve on infrastructural facilities and harnessing of the resource endowments of member-countries to promote greater trade within the region.

Key words: Economic Community of West African States (ECOWAS), livestock trade, regional integration.

INTRODUCTION

External and internal motivation such as bilateral cordial relationship and specialization, respectively have been the major factors in the evolution and development of regional bodies in developing countries, especially bodies that are devoted to regional integration. After independence, African countries found the need (both political and economic) to associate with one another. This stemmed from the belief that for their economies to develop, certain obstacles had to be removed. Regional bodies were created to take advantage of relative resource endowments, economies of scale and comparative advantage in production and consumption

within the integrated region (Ogunkola, 1998).

On individual basis, without integration, many West African countries would find it difficult to overcome the problems of poor resource endowment, lack of technical manpower and other socio-economic, political and environmental constraints. It is believed that regional integration would obviate these difficulties, which are the bane of isolated and poor economies in the sub-Saharan African (SSA) countries and pave the way for sustainable growth and development. Indeed, the treaty establishing common commercial policy towards third countries; and the African Economic Community (AEC), which was

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signed in Abuja in 1991, perceived existing regional communities in the continent as building blocks thereby presuming the existence of a solid foundation on which it could build (ECOWAS, 2011). However, with over 40 regional bodies in the continent there is need for the evaluation of existing efforts at integration.

In West Africa, there are many regional bodies. Three of them can be identified as explicitly concerned with the promotion of intra-regional trade flows: the Economic Community of West African States (ECOWAS), Union Economique Monitaires l'Ouest Afrique (UEMOA) and Mano River Union (MARIUN). When ECOWAS was established in 1975, it aimed, among other things, at the gradual:

- 1) Elimination of custom duties and other charges of equivalent effect in respect of the importation and exportation of goods between member states;
- 2) Abolition of quantitative and administrative restrictions on trade among the member states;
- 3) Establishment of a common customs tariff; and
- 4) Abolition (as between the member states) of the obstacles inhibiting free movement of persons, goods, services and capital (ECOWAS, 2011).

These are laudable objectives, but the achievements have fallen far short especially in the area of trade liberalization. The Community has been trying to provide basic infrastructure such as good roads, reliable communication network, efficient transportation system and strong financial institutions, which, hopefully, will facilitate trading among member states.

There is no doubt that the Community, with 15 member states cutting across francophone and anglophone countries in the West African sub-region, has come a long way in trying to achieve set goals, notwithstanding all the constraints. It has established institutions necessary not only for effective management of day-to-day activities of the Community, but also for increasing trade flows among member states. The West African Monetary Agency (WAMA), an autonomous body that grew out of the West African Clearing House (WACH), was established to facilitate multilateral payments in the sub-region and to provide means of overcoming the multiplicity of currencies in the region. The fund for Cooperation, Compensation and Development (FCCD) was established as the financial arm of the Community. Its major functions are to mobilize financial resources for the implementation of the Community's projects and to supervise payment of compensation to member states that might have incurred losses in revenue as a result of the implementation of the trade liberalization scheme (TLS).

Review of Conceptual and Methodological Issues

Gravity model has been used in international agricultural

trade analysis for a long period of time now. This is because of its relevance in explaining the variables that determine international agricultural trade. Several empirical analyses in areas of agricultural policy, integration, border effects, economic sizes, trade potentials and other impedance of agricultural trade have been achieved using gravity model.

Ogunkola (1998) employed gravity model to analyse the trade potentials in the ECOWAS sub-region and found that the prospects for trade in the sub-region were indeed very great. In a similar study, Idsardi (2010) examined the determinants of agricultural export growth in South Africa using gravity model and found that various factors were shown to have significant impact on trade flows amongst which were economic market size, supply capacity and physical market size dominance.

Gravity model can also be augmented to analyse variables that cannot be measured. Dummy variables (qualitative variables) such as border effect, common language, regional integration, trade policy reform, just to mention a few, can be incorporated into gravity model for purposes of estimation (Hatab et al., 2010).

International agricultural trade is generally aimed at exchanging agricultural goods between or among countries that have agreement and understanding of each other to improve their economies. Agricultural trade is important to the poor in developing countries because most of the world's poor live in rural areas where agriculture is the key source of income and consumption (USAID, 2010). Agricultural trade provides a source of growth and agricultural growth stimulates growth in other sectors. Furthermore, the costs of supplying agricultural products are only partly determined by natural conditions like climate and soil but of greater importance could be per capita income, resources endowments, level of development, transportation costs and the size of a country's population. Therefore, identification and evaluation of the determinants of trade potentials within ECOWAS' nations, as concerns animal products, is considered an important research focus so as to contribute to the body of information available towards policy formulation and strengthening of the ECOWAS regional integration. Based on the above consideration, the specific objectives of the study were to:

1. Estimate the percentage volume, relative to all other agricultural products, and direction of trade in live animals and animal products among ECOWAS member countries, and
2. Assess the determinants of ECOWAS intra-trade in live animals and animal products during the period, 2001 to 2011.

Hypothesis of the study

The null hypothesis tested in this study was that ECOWAS regional characteristics did not influence trade

of live animals and animal products within the region.

MATERIALS AND METHODS

Study area

The study covered the entire ECOWAS. ECOWAS is the largest trade bloc in Africa. It was established on the 28 of May, 1975 in Lagos. Initially, it comprised sixteen West African countries. However, in 2000 Mauritania withdrew its membership from the ECOWAS thus reducing the number to fifteen member countries. Members of the trade bloc include: Benin Republic, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea Bissau, Cote d'Ivoire, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Agriculture (agrarian economy) accounts for at least 25% of the Gross Domestic Product (GDP) in all these countries and there is a combined estimated population of 280 million people as at 2010 with land area of about 5,112,913 km² (ECOWAS, 2011).

Sampling procedure

Data collected covered all the 15 ECOWAS member countries for purpose of analysing intra-ECOWAS agricultural trade on imports of live animals and animal products.

The panel data on the various agricultural commodities used comprised commodities on United Nations Harmonized System of classification (HS) codes 1-24. The choice of panel data was informed by the fact that it increases the efficiency of the estimators and significantly reduces the potential problem caused by the omission of variables. Secondly, panels can monitor unobservable trading partner-pairs' individual effects. The data were collected for the period of 11 years (2001 to 2011) giving 210 bilateral observations (that is 15 importing countries by 14 partner countries) for intra-ECOWAS trade.

The sub-categories of agricultural commodities were defined as follows: Section I (HS Codes 1-5): live animals and animal products; Section II (HS Codes 6-14): the vegetable products; Section III (HS Code 15): animal and vegetable fats and oils and other cleavage products; and Section IV (HS Codes 16-24): the prepared food stuff, beverages and tobacco.

Data collection

Panel data on values of bilateral merchandise imports of agricultural commodities (HS Codes 1-24) at 2-digits were obtained from Trademap (International Trade Centre-ITC) for the years 2001-2011. The choice of this period was to examine the effect of ECOWAS regional characteristics on trade after the birth of the present ECOWAS regional body following the withdrawal of Mauritania from the trade agreement in 2000. The data on GDP, per capita GDP, and the ratios between the nominal exchange rate and the official exchange rate of the countries concerned were obtained from the World Economic Outlook of the International Monetary Fund (IMF). Geographical distance between two partner-countries, population, countries' contiguity, infrastructure index and plausible use of common language were gathered from the

$$\ln Y_{ijt} = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \beta_{10} \ln X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \mu_{ijt} + V_{ijt} \quad (4)$$

In the above model (Equation 4):

1) Y_{ijt} indicates the amount of trade imports of country i from country j at time t . Although Elbadawi (1995) pointed out that, in principle, bilateral trade flows (exports or imports) would be influenced by the

database (Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)) of the French Research Centre in International Economics.

Data analysis

Objective (1) was achieved by the use of descriptive statistics such as percentages while objective (2) was achieved using gravity model. The software used in the analysis was Statistical Package for Social Science (SPSS) version 16, using ordinary least square estimator. A theoretical basis developed by Baier and Bergstrand (2002) underlies the gravity model. This model originated from the Newtonian Physics notion. Newton's gravity law in mechanics states that two bodies attract each other proportionately to the product of each body's mass (in kg) divided by the square of the distance between their respective centres of gravity (in metres).

Later on an Astronomer, Stewart and Sociologist Zipf (Zhang and Kristensen, 1995) transferred this law to the social sciences and attempted to apply it to spatial interactions, such as trips between cities, using the following specifications:

$$I_{ij} = G(Pop_i Pop_j) / D_{ij}^\alpha \quad (1)$$

where I_{ij} is trips between city i and city j ; $pop_{i(j)}$ is population of city $i(j)$; D_{ij} is distance between city i and city j ; and G and α are the respective coefficients.

The gravity for trade is analogous to this law. The analogy is as follows: "the trade flow between two countries is proportional to the product of each country's 'economic mass', generally measured by GDP, each to the power of quantities to be determined, divided by the distance between the countries' respective 'economic centres of gravity', generally their capitals, raised to the power of another quantity to be determined" (Christie, 2002). This formulation can be generalised to:

$$M_{ij} = KY_i^\beta Y_j^\gamma D_{ij}^\delta \quad (2)$$

where, M_{ij} is the flow of imports into country i from country j , k is constant, Y_i and Y_j are country i 's and j 's GDPs, D_{ij} is the geographical distance between the countries' capitals and β , γ and δ are the respective coefficients. The linear form of the model is as follows:

$$\log(M_{ij}) = k + \beta \log(Y_i) + \gamma \log(Y_j) + \delta \log(D_{ij}) \quad (3)$$

Even though when estimated, this baseline model gives relatively good result, most estimates of gravity models add a certain number of dummy variables to equation (3) to test for specific effects. The gravity model has been applied to a wide variety of goods and factors of production moving across regional and national boundaries under different circumstances since the early 1940s (Oguledo and Macphee, 1994). Thus the functional form of the gravity model estimated in this study was as follows:

same factors, in this study imports were chosen rather than exports. The choice was informed by the fact that imports are better measured in the country of arrival because countries tend to monitor their imports more than their exports given that taxes are levied on the imports. Since the gravity model refers to the trade

volume, the study deflated the values of the annual imports, measured in US dollars, using the US Consumer Price Index (CPI).

2) X_1 and X_2 represent the GDPs in constant values (US dollar) of countries i and j , respectively. Given that the GDP is a variable that is indicative of the size of the economy, one expects $\beta_1 \geq 0$ and $\beta_2 \geq 0$ to confirm that the bigger the economy, the more significant trade becomes.

3) X_3 and X_4 represent the per capita GDPs in US dollars of countries i and j , respectively. Given that the per capita GDP is a variable that is indicative of the consumers' income level determining the purchasing power of the consumers in the respective countries, it is expected that $\beta_3 \geq 0$ and $\beta_4 \geq 0$, to confirm that the higher the income of consumers the more goods they can purchase, *ceteris paribus*.

4) X_5 and X_6 are variables that indicate the infrastructure index, which is constructed from three variables: the number of kilometers of roads and of railways and the number of telephone lines per capita. The index thus corresponds to the arithmetic mean of standardized variables. Considering that more developed infrastructure is likely to foster the movement of bilateral trade, it is also expected that $\beta_5 \geq 0$ and $\beta_6 \geq 0$.

5) X_7 measures geographical distance between country i and country j in kilometres. The greater the distance between the two countries, the more transport costs tend to rise, consequently reducing the volume of trade; hence, it is expected that $\beta_7 < 0$.

6) X_8 is a variable added to test Linder vs Hecksher-Olin theories that countries with similar characteristics trade more than dissimilar ones. The absolute difference values of the GDP per capita of country i and j was used. B_8 is expected to be negative when it obeys Linder's theory and positive if otherwise. Hecksher-Olin supported endowment factors as the major determinants in trade differences while Linder hypothesis identified taste differences, and the effect of development as the factors influencing trade.

7) X_9 is the real bilateral exchange rate between country i and country j at time t measured by the following formula: $TCR_{ijt} = (TCN_{i/\$/TCN_{j/\$}} \times (CPI_j / CPI_i))$, where TCN is the nominal exchange rate vis-à-vis the dollar and CPI is the price index, notably the GDP deflator. The negative impact of the real bilateral exchange rate will be reflected in $\beta_9 < 0$. This means that depreciation in value of the importing country's currency hinder imports and promotes exports.

8) X_{10} is a tax variable introduced into the model to indicate the incentives for conducting unregistered trade. Its coefficient will thus reflect the impact of unrecorded trade on official bilateral trade. It was represented in the model by the percentage of tax paid on commodities imported. Accordingly, it is expected that the coefficient $\beta_{10} < 0$.

9) X_{11} is the dummy variable relating to whether the two trading countries border each other. It takes the value 1 if the two are neighbouring countries and 0 otherwise. For neighbouring countries, trade is expected to be intensive; this assumes that $\beta_{11} \geq 0$ and positive.

10) X_{12} is a variable added to assess contribution of usage of common language between the partner countries in trade. It is expected that $\beta_{12} \geq 0$ and positive.

11) μ_{ij} is the error term that is representative of the specific bilateral effect, and v_{ij} is the habitual symmetrical error term.

Except for the dummy variables all the other variables were expressed in natural logarithm. The estimated coefficients of these variables are directly interpreted as elasticities. On the other hand the elasticities of the qualitative variables were given as the exponential of the estimated coefficients.

Hypothesis testing

The specification for the test of significance for the null hypothesis

of the study was as follows:

Null hypothesis

$H_0: \beta_1 = \beta_2 = \beta_n = 0$ (that regional characteristics did not significantly affect the trade of live animals and animal products in the region).

Alternative hypothesis

$H_1: \beta_1 = \beta_2 = \beta_n \neq 0$ (that regional characteristics did significantly affect the trade of live animals and animal products in the region). The hypothesis was tested using both the t-test the F-test for the statistical significance of the individual and combined variable effects on the dependent variable.

RESULTS AND DISCUSSION

Intra-ECOWAS imports of live animals and animal products

Total annual trade values of imports for the paired countries for all agricultural products and for the first products alone were computed as presented in Table 1. The value of all agricultural commodities imports within the region for the period of 2001 to 2011 stood at 4.56 billion US dollars, which accounted for 6.38% of the total value for all commodities imports in the region. The trade trends showed a tremendous increase from 3.92% in 2002 to 13.02% in 2008. After reaching this peak, it dropped to 9.52% in 2009 and later rose again to 12.45% in 2010. The highest trade values for the Section I products were observed in 2007 with corresponding percentage of 15.07%. The result indicated that the amount imported within the region varied with time. Assessment of the proportion of the Section I products (live animals and animal products) from the total agricultural products imports showed that Section I products accounted for 18.47%.

The percentages of each country's value for the total import values were analyzed and the findings are presented in Table 2. The results showed that Cote d'Ivoire alone accounted for more than half (52.39%) of the total all commodities imported within the region. Other countries like Mali, Senegal, Burkina Faso, Ghana and Nigeria accounted for 16.02, 8.45, 6.14, 5.42 and 4.20%, respectively. On the other hand, imports of agricultural products as a whole in the region seemed to spread across many countries. Burkina Faso and Mali had imports proportion of over 16% each while Cote d'Ivoire, Senegal, and Niger had over 13% each. The remaining countries like Nigeria, Togo, and Benin had the share of just slightly over 5% each while countries with least import trade proportion of less than 2% were Sierra Leone, Liberia, Guinea, Gambia, Cape Verde and Guinea Bissau.

With respect to the live animals and animal products imports, Cote d'Ivoire imported more than half (56.8%) of

Table 1. Value of intra-ECOWAS all agricultural live animals and animal products imports in thousand US dollars for the period 2001 to 2011.

Year	All commodities		All agricultural commodities		Section I Products (HS 1-5)	
	Total	%	Total	%	Total	%
2001	2,073,262	2.90	259,533	5.70	43,092	5.12
2002	1,522,408	2.13	178,537	3.92	15,575	1.85
2003	3,501,602	4.90	344,678	7.56	66,829	7.94
2004	3,318,687	4.65	356,741	7.83	42,071	5.00
2005	4,897,512	6.86	381,849	8.38	56,803	6.75
2006	4,472,975	6.26	407,137	8.94	102,464	12.18
2007	6,005,638	8.41	546,145	11.99	126,821	15.07
2008	31,566,971	44.21	593,465	13.02	116,506	13.84
2009	3,877,879	5.43	433,937	9.52	96,784	11.50
2010	6,247,203	8.75	567,459	12.45	90,471	10.75
2011	3,916,189	5.48	486,904	10.69	84,100	9.99
Total	71,400,326	100	4,556,385	100	841,516	100
%			6.38		18.47	

Source: Authors' computation using data extracted from ITC (Trademap) 2012.

Table 2. Value of Intra-ECOWAS all agricultural and live animal and animal products imports in thousand US by countries for the period 2001-2011.

Country	All commodities		All agricultural commodities		Section I products (HS 1-5)	
	Total	%	Total	%	Total	%
Benin	2270934	3.19	239227	5.25	44357	5.27
B/Faso	4380888	6.14	744122	16.33	24951	2.97
C/Verde	81671	0.11	4820	0.11	904	0.11
Cote d' Ivoire	37407642	52.39	668969	14.68	478004	56.8
Gambia	428354	0.6	20780	0.46	2446	0.29
Ghana	3868312	5.42	127580	2.8	20016	2.38
Guinea	957783	1.34	62584	1.37	918	0.11
G/Bissau	75415	0.11	22276	0.49	787	0.09
Liberia	1999764	2.8	64794	1.42	3186	0.38
Mali	6985998	16.02	729770	16.02	58589	6.96
Niger	2389332	3.35	617362	13.55	13148	1.56
Nigeria	2998489	4.2	289100	6.34	80108	9.52
Senegal	6033545	8.45	636936	13.98	57430	6.82
S/Leone	643953	0.9	55522	1.22	4390	0.52
Togo	878246	1.23	272543	5.98	52282	6.21
Total	71400326	100	4556385	100	841516	100
%			6.38		18.47	

Source: Authors' computation using data extracted from ITC (Trademap), 2012.

the total imports in the region. The percentages of other countries' imports of these products were 9.52%, 6.96%, 6.82%, 6.21% and 5.27% for Nigeria, Mali, Senegal, Togo and Benin, respectively. Other countries with a proportion of less than 2% of the imports included Cape Verde, Gambia, Guinea, Guinea Bissau, Liberia, Niger and Sierra Leone.

Determinants of ECOWAS trade in live animals and animal products

The OLS regression technique was employed for the analysis after testing several other estimators which did not give any superior results. To check for multicollinearity, simple correlation was run and the results

Table 3. Gravity regression results of determinants of trade in live animals and animal products within ECOWAS region.

Variable	Coefficient (B)	Std error	t-value	Exp (β) ⁻¹
X ₁	0.966	0.134	7.190***	
X ₂	0.767	0.121	6.325***	
X ₃	-0.263	-0.290	-0.907	
X ₄	-0.001	0.211	-0.006	
X ₅	0.036	0.356	0.100	
X ₆	-0.084	0.134	-0.622	
X ₇	-0.579	0.238	-2.433**	
X ₈	0.189	0.217	0.872	
X ₉	0.090	0.056	1.596	
X ₁₀	0.356	0.197	1.774	
X ₁₁	1.341	0.523	2.566**	2.82
X ₁₂	0.596	0.316	1.886*	0.81
Constant	5.220	3.437	1.519	
R ²	0.607			
F-Statistic	18.805***			
Number of observations	2288			
Relative bilateral trade	208			

Dependent Variable Y_{ij} ; All variables except dummies are in natural logarithms form *, **, *** indicate significance at the 10, 5, and 1% levels, respectively. Source: Authors' estimation using SPSS 16 (2012).

indicated that the population and land lockedness variables had high correlation coefficients. In an attempt to use another software Stata Version 9, these same variables were automatically dropped by the package. Thus, these variables were dropped from the final equations estimated. The issue of zero values recorded was handled using three methods suggested in literature; namely; using (i) Tobit model, (ii) elimination of zero data and (iii) addition of a minimum constant value all through to the actual dependent variable data collected. The results indicated that regression by addition of a minimum constant value was more efficient and explained the variations better than the other methods. Thus, it was adopted for the analysis. The results of the gravity equations are presented in Table 3. The model fitted the data well and explained over 60% of the variations in trade of live animals and animal products discussed as follows:

1) The GDP of the importing countries (X_1) and that of exporting countries (X_2) were used as proxies for marketing sizes of these countries. The coefficients of the GDP in importing countries were high and statistically significant at 1% level of significance, with all the expected positive signs. The positive and statistically significant coefficients of the importing and exporting countries' GDPs for the augmented gravity model were consistent with the theory behind the conventional gravity model, suggesting that the size of the economies should enhance the amount of trade between trading partners. The result implied that a percent increase in GDP of the importing countries increased imports of live animals and

animal products by 0.97% for the period under review.

2) The coefficients of the GDP of the exporting countries, which indicated the potentials for supply, were found to be positive and statistically significant at 1% level of significance. The result suggested that holding other variables constant, a percent increase in GDP of the exporting countries increased the supply of live animals and animal products by 0.77%. It, therefore, meant that GDP determined the pattern of trade in live animals and animal products in the region. This agreed with the findings of Hatab et al. (2010) which showed that GDP influenced most of the trade in agricultural products between Egypt and its partner nations.

3) The per capita GDP for importing countries (X_3), which proxied the consumer's income (purchasing power) showed negative sign and not statistically significant. The negative sign implied that as the income of consumers improved less of the products were demanded. The result thus suggested that the absorption effect was not as the result of the consumer's income but that of the economic or endowment size.

For the per capita GDP of the exporting countries (X_4), the coefficient estimated was negative and not statistically significant. The low value and non-significance of the coefficient for per capita GDP (income) of producing countries signified 'home market effects.' This suggested that an increase in income of the producing country increased the domestic consumption of the product thereby reducing the quantity to be exported to the partner countries. Thus, one can deduce from the results in Table 3 that, trade in live animals and

animal products in the ECOWAS region was determined more by the economic and resource endowment size than by the per capita GDP.

The coefficient of the infrastructure variable in importing countries (X_5) was positive but not statistically significant. On the other hand, the coefficient of the infrastructure variable for exporting countries (X_6) had negative sign and not statistically significant also. This meant that infrastructure variables in both importing and exporting countries did not explain variations in imports of live animals and animal products within ECOWAS region. This too could be explained by the nature of the trade involved. The bulk of it was in live animals trekking across borders, mostly using bush paths such that states of roads and other handling facilities were irrelevant to the trade at the level it was transacted.

The distance variable (X_7) coefficient had a negative sign and was significant at 5% level. The negative coefficient of this variable indicated that the distance between individual ECOWAS countries and their partner-countries affected ECOWAS imports negatively. A percent increase in distance (km) will reduce ECOWAS imports by 0.58%. The lower reduction in amount of live animals and animal products traded with increases in distance as compared to other sectors of agricultural products may not be unconnected with the fact that live animals transportation were more by movement of the animals across borders on foot and sometimes by trucks than by air. Nonetheless, distance invariably affected trade of live animals and animal products in the region.

The absolute values of the difference between per capita GDP (income) of importing and exporting countries (X_8) was added to the gravity equation of intra-ECOWAS trade to test for Linder vs Heckscher-Ohlin theories, that countries with similar characteristics trade more with each other. The coefficient of this variable was positive but not statistically significant for trade of live animals and animal products. This implied that the trade pattern followed the Heckscher-Ohlin's theory of trade but the effects were very minimal (not significant).

Real exchange rate (X_9) was added to the gravity equation to estimate the effects of currencies exchange between the importing countries and those exporting live animals and animal products in the region. The coefficient estimated had positive sign but not statistically significant. The non-significance of exchange rate of currency in the region could be as a result of common currency used by the French speaking countries in the region (UEMOA). This result implied that holding other variables constant, an appreciation of importing country's currency will increase imports of live animals and animal products by 0.09% but since it was not significant it meant the exchange rates were not major determinants of variations in trade of live animals and animal products in the region.

The coefficient of the tax (X_{10}) payable variable in the importing countries turned out, surprisingly, to be positive

but not statistically significant. This implied that tax was not a major explanatory variable in importing countries to influence changes in the amount of trade in live animals and animal products. This could be as a result of efforts made by ECOWAS trade agreement to eliminate tariff and other fees payable for some imported consumable goods in the region.

One of the geographical variables that explained variations in imports of live animals and animal products was contiguity (X_{11})-that is, countries sharing common border. The coefficient for contiguity was high, positive as expected and statistically significant at 1% probability level. This result suggested that sharing common border enhanced trade of live animals and animal products in the region. As shown in Table 3, holding other variables constant, sharing common border increased trade of live animals and animal products by 2.82 (exp 1.341) times than observed in countries that did not share common border. Therefore, contiguity explained variations in trade of live animals and animal products to a very high level in the region.

The coefficient of the common official language variable (X_{12}) was positive as expected and significant at 10% level of significance. The result implied that use of common language by partner-countries increased trade in live animals and animal products by 0.82 (exp 0.596) times than countries that did not share common language in the region. This was possible because common language helped in quick bargaining of prices and passage of other vital information. Thus, usage of common language positively and significantly influenced trade in live animals and animal products in the region.

Test of hypothesis

The test was done to evaluate the significance of the impact of the regional characteristic on Intra-ECOWAS Trade in live animals and animal products.

Null hypothesis

$H_0: \beta_1 = \beta_2 = \beta_n = 0$ (that regional characteristics did not significantly affect the trade of live animals and animal products in the region).

Alternative hypothesis

$H_1: \beta_1 = \beta_2 = \beta_n \neq 0$ (that regional characteristics did significantly affect the trade of live animals and animal products).

The F-test indicated the overall contribution of all the independent variables in the model to explaining variations in trade. The F-statistics of 18.81 showed how significantly [1% level ($p = 0.0001$)] the independent

variables combined explained the variations in the trade in live animals and animal products in the region.

Decision

Since the model was significant at 1%, it meant that not all variable coefficients (β 's) were zero. Therefore, the null hypothesis was rejected and it was concluded that regional characteristics did significantly affect the trade of live animals and animal products in the ECOWAS region.

CONCLUSION AND RECOMMENDATIONS

In recognition of the importance of international agricultural trade in most African economies, this study attempted to identify and analyse the determinants of trade in live animals and animal products within the sub-region. From the results, intra-ECOWAS imports of the products were consistent with the gravity theory that trade between countries depended on the mass (economic size) and inversely proportional to the distance between them. The per capita GDP in both countries (importer and exporter) turned out to be insignificant factors in determining ECOWAS imports of live animals and animal products. This implied that ECOWAS trade pattern, with respect to the products under consideration, followed a GDP pattern. That is, it concentrated on the demand and import of quantity-based products and depended on overall market size, rather than on per capita GDP pattern which centers on the import of quality-based high value-added products which are sensitive to income levels.

Based on the findings of this study, the following recommendations are made:

1. Non-tariff barriers in the Union's member-countries must be effectively eliminated so as to enhance cross border trade especially in the areas of live animals and animal products.
2. It is imperative that efforts should be made by the member-countries to improve on infrastructural facilities so as to promote processing, storage and cost-effective transportation and marketing of more value-added products within the sub-region.
3. Efforts are needed on the part of the Union at harnessing more of the resource endowments of member-countries and re-formulation and harmonization of trade policies in member-nations to promote greater trade within the region.

REFERENCES

- Baier SL, Bergstrand JH (2002). On the Endogeneity of International Trade Flows and Free Trade Agreements. *Am. Econ. Assoc. Annu. Meet. Rep.* pp. 1-25.
- Christie E (2002). Potential Trade in Southeast Europe: A Gravity Model Approach, Working Paper, the Vienna Institute for International Economic Studies-WIIW.
- ECOWAS (2011). Economic Community of West African States: Executive Summary; Jan-Feb. Reports. http://en.wikipedia.org/wiki/Economic_Community_of_West_African_States.
- Elbadawi IA (1995). The Impact of Regional Trade/Monetary Schemes on Intra-Sub Sahara African Trade, Mimeo AERC, Nairobi, Kenya.
- Hatab AA, Romstad E, Hun X (2010). Determinants of Egyptian Agricultural Exports: A Gravity Model Approach. *Mod. Econ. Sci. Res.* 1:134-143.
- Idsardi E (2010). The Determinants of Agricultural Exports Growth in South Africa, Contributed paper presented at The Joint 3rd Afri. Association of Agricultural Economists (AAAE) and 48th Assoc. of South Africa (AEASA) Conference, Cape Town, South Africa, September, *Agric. Econ.* pp. 1-17.
- Oguledo VI, Macphee CR (1994). Gravity Models: A Reformulation and an Application to Discriminatory Trade Arrangements. *App. Econ.* 26:107-120.
- Ogunkola EO (1998). An Empirical Evaluation of Trade Potential in the Economic Community of West African States, AERC Research Afr. Econ. Research Consortium, Nairobi 84:1-36.
- USAID (2010). Strategic Review: Feed the Future, USAID Report Paper October. pp. 1-25.
- Zhang J, Kristensen G (1995). A Gravity Model with Variable Coefficients: The EEC Trade with Third Countries. *Geogr. Anal.* 27:307-320.



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