Assessing the Effect of the Shift of Rural Labor towards Non-Agricultural Sectors on Rice Cultivation in the African Environment: Evidence from Sierra Leone

Alhaji M. H Conteh, Xiangbin Yan, and Alfred V Gborie

Abstract—The crop rice is the staple food of most Sierra Leone with no close substitute. However, its cultivation has been on its last legs over the years. The decline in the domestic rice cultivation has had vicious socio-economic implications such as hiking consumer prices, balance of payment dilemmas with debt burden. The objective of this study is thus, to assess the effect of the shift of rural labour towards non-agricultural sectors on rice cultivation. The tools utilized for analyzing the problem under consideration involved a thorough descriptive statistics and generalized linear model using OLS technique. Increased rural population was established positive and significant in affecting rice cultivation. Fertilizer utilization was insignificant in rice cultivation. For reducing the shift of rural labor force towards nonagricultural sectors, the government should make the agricultural sector very lucrative.

Keywords—Regression Model, Rice Cultivation, Rural Migration, Sierra Leone.

I. INTRODUCTION

RICE is the second most widely grown cereal crop and the staple food for more than half the world's population [1]. It is eaten by about 3 billion people and is the most common staple food of the largest number of people on earth [2]. China is the major rice producing country [3], having about 30 Mha under rice paddy cultivation with a total rice yield of 190 Mt, and with a current rain fed irrigated area of 670,000 ha; it is an extremely developed economic location of great significance to China's food production [3]. The Food and Agriculture Organization (FAO) estimates that around 517 million metric tons of rice — 86% of total production — is used directly for human consumption[4], and this area lies in Asian countries, most of which are under considerable population pressure.

Thus, rice is very important to numerous Asian governments [5] and is subject to a variety of trade distortions even in normal times. As a result, rice became a key contributor to the South-east Asian economic development.

Alhaji M. H Conteh (Corresponding author) is with the Management Science and Engineering, School of Management, Harbin Institute of Technology, PO Box: 150001, Harbin, China (Tel: +86 18745735938, e-mail: hadjmannc90@yahoo.com).

Xiangbin Yan is with the Management Science and Engineering, School of Management, Harbin Institute of Technology, PO Box: 150001, Harbin, China (e-mail: xbyan@hit.edu.cn).

Alfred V Gborie is with the Mathematics Department, Njala University, Sierra Leone (e-mail:alfredgborie@yahoo.com).

The setting up of the International Rice Commission under the sponsorship of the UN and other international organizations was an acknowledgment of the significance of the crop in the direction of increasing world food production.

Rice is developing as a staple food crop in Africa [6], where it is grown in around 40 countries [6].Recently, rice has become a staple food for both urban and rural consumers[7] throughout West African including Sierra Leone. Yet the West African region has observed a sharp drop in rice cultivation within the last two decades. However, attempts are ongoing to reverse that trend by drastically increasing the supply of rice grain for its mounting population. Western Africa experienced a slow growth of the agricultural sector [8]. However, rice cultivation has been increasing more rapidly than population in many parts of the globe, but Africa has been declining behind with the exclusion of very few countries such as Nigeria and Burkina Faso, that witnessed to have made a few improvements to food security. This difference between rice cultivation and increased population growth in Africa is impacting harmful results including external debt burden.

The barriers that appear to affect agricultural efficiency in Africa are lack of adequate irrigation, drought, diseases, pests, limited fertilizer use, civil wars, and inappropriate national policies. Besides numerous other economies, rice takes a focal point in the economy of Sierra Leone and its state of cultivation has both political and socio-economic implication.

The historical movement of population from rural to urban areas in the course of the development process has played a critical role [9], and in many developmental approaches in the world. The rural-to-urban migration has occurred within a context of rapid urban economic development and increased urban-rural income disparity[9]. However, the rural-urban movement is an extremely renowned factor weakening the farming sector in the developing countries. As stated by[10], that to examine the major factors of rural-urban migrants to leave their place of origin is innermost to identify the problems stunning agricultural development and economic growth of a deprived nation. The leading growth thought in the 1970s and 1980s periods was of the solid assurance that the only solution to achieve development in poor countries was to support the industrial divisions. In brief, inter alia, resources and supports were transferred from the rural sector towards urban industrialization. Arthur Lewis, in his surplus

labor theory, and followers were of this view. Authors [11], [12] and [13] saw the elimination of surplus labor from the rural division as economically and socially valuable since human resources were being withdrawn from locations where their marginal product was assumed nothing to locations where marginal product was optimistic and which grew speedily as a result of capital buildup and technological advancement. The import substitution (inward looking policies) practiced in many African countries (including Sierra Leone) subsequent to independence from colonial systems are held guilty, additionally, for fostering rural-urban swings. The present thoughts have, however, opposed these previous development paradigms, that they were quite unfavorable to growth when presently reflecting on the necessity of agricultural contribution for a continued progress of the developing nations. An additional issue that has been supporting labor movement from the poor rural areas is the good salary in other sectors compare to farm revenues in most African states. Comparative to price index, workers in developing countries perceive it cost-effectively and more valuable to go for other jobs than farming. In countries with minerals, such as Sierra Leone, citizens travel from farming to mining areas in search of better livelihoods. Reference[14] reported The Low Farm Household Model, that these situations exist in the Southern Africa countries where food shortage farm households deserted their farmlands in taking advantage of better earnings in other sectors such as the mining, since working in those sectors can improve their economic status to meet their daily requirements given food retail price levels. Consequently, agricultural sector became inactive in that sub region. Increasing labor movement has been observed across different regions and sectors and mainly from rural to urban areas[15], and this situation is mostly seen in Africa states including Sierra Leone. Rural-to-urban and, to a lesser extent, urban-to-urban population movement in the past, Starting from the late 1970s[16], due to the increasing rural-urban income inequality, the rural labor excess, and the instantaneous increase of labor requests of urban industries with communities, the presently observed rural-to-urban movement is extraordinary.

Rice is the leading and staple food in Sierra Leone. Even though the country has a huge arable land area to cultivate this most important crop with almost every farmer vigorously

involve in cultivating it, however, not all and sundry in the country is getting sufficient of it. Efforts of the present and past governments along with their respective partners over several years in investing in the agricultural sub sector in an attempt to make the nation rice sufficiency are so far not realized. In order to meet the essential responsibility of feeding its people and to even avoid social liability and political unrests, the government has unrelenting to spend huge money that would have been otherwise used to meet other pressing developmental needs to import rice into the country. The yield gap in rice production in Sierra Leone is not only huge but costly and therefore of serious national concern. The average yield generally obtained in Sierra Leone is about 1.43 metric ton/hectare and is sadly very low, it is

even worse in the upland ecology where most of the farmers cultivate rice. Some of the alleged constraints facing the farmers in Sierra Leone include the use of low yielding traditional varieties, low quality of seeds, pest and disease factors, nutrient imbalances, poor water management, high postharvest losses, lack of credit facilities and the shift of energetic rural labor force from agriculture to other sectors. There is evidence that Sierra Leone was self-sufficient in rice, the national staple, during certain periods[17].Yet, this was not continued. Sierra Leone's rice status had changed from being an exporter to an importer of rice [18].

Rice cultivation as a staple food in Sierra Leone has been decreasing over the last two and half decades. The Population and the domestic demand for the crop has been on the increase as the total area planted to the crop presenting negative tendency mostly caused by the shift of energetic rural labor force from agriculture to other sectors. It is against this background that the authors try to find out the roots cause of the wide yield gap in rice cultivation in Sierra Leone, thereby assessing the effect of the Shift of rural labour towards Non-Agricultural sectors on rice cultivation in Sierra Leone. As a result of the above, the authors will submit the hypothesis:

H1. That the shift of energetic rural labour towards non-agricultural sectors reduces rice output in Sierra Leone.

II. METHODOLOGY

A. Data Source

This study is based on archival data available from various sources such as the International Financial Statistics Year Books, FAOSTAT database, African Development Bank Indicators Tables, Statistics Sierra Leone (SSL) and Organization of Islamic Countries database.

The subsequent methods are used for the empirical investigation of the problem under consideration. A methodical descriptive statistical analysis is carried out by means of line graphs and scatter plots. A thorough tread assessment is used under this instrument. In this section the hypothesis is examine.

B. The Regression Model

Time series regression model is adopted and anchored in ad hoc specifications within the structure of the Nerlovian supply response models. The particular model is borrowed from [16]; [19] and [20]. As observed by [9], that the structures of the Sierra Leone economy, like any other poor nation, the model is modified to incorporate other variables, seen most influential on rice output supply for the developing nations. The functioning model is expressed as:

$$(QDRP)_t = \beta_1 + \beta_2 (QDRP)_{t-1} + \beta_3 (RP)_t + \beta_4 (AURC)_t + \beta_5 (F)_t + \beta_6 (DUV) + \varepsilon_t \quad (1)$$

where t = is the current year, t -1= is the previous years, QRDP = is the quantity of domestic rice produce, RP= rural population, AURC = Area under rice cultivation, F = Fertilizer

consumption, DUV= Dummy variable for the civil conflict in Sierra Leone, ε= error term, is assume to have zero expected value, β_i= a vector of the parameters.

(QRP)$_{t-1}$ is the previous years' production level (creating an autoregressive model) the coefficient of which enables us to decide the rate at which actual production adjusts to the preferred production. (RP) is rural populace and it is expected to have a positive coefficient. (AURC) is area under rice cultivation and it is expected to have a positive impact on rice production. The variable (F) is the quantity of fertilizer use and it is expected to have a positive effect on rice output. (DUV) is a dummy variable for the effect of the civil conflict in Sierra Leone. The model is estimated in log form to enable us understand the results as elasticities.

C. The Model Estimation Methods

The estimated model is an autoregressive distributed lag (ADL) in which the OLS method is used. In an attempt to capture the dynamic behavior of rice productivity in Sierra Leone, the model is estimated in a number of ways using different lag lengths to reach a more economical estimates. The SPSS version 19.0 is used for the estimation. Various econometric tests are carried out to ascertain the reliability of estimates. The tracking power of the actual estimated model over real values is examined. A sample size of 32 years is used (1980-2011).

III. RESULTS AND DISCUSSIONS

A. Population and Other Trends in Sierra Leone

From Figs. 1 and 2, although the yearly increase in nonagricultural population (312,000 persons) is less than that of the agricultural population (448,000 persons within the same year) for the period 1980-2011, yet the performance of the agricultural sector is still not satisfactory. It appears that most people shifting towards non-agricultural sector are more energetic than the majority of people shifting to the agricultural sector. This would have stern implications as energetic population-lead of nonagricultural sector in most underdeveloped nations usually implies a decrease in the energetic labor force from the farming or the agricultural sector towards the urban as well as other sectors in search of better income or jobs, and hence, there will definitely be a reduction of farm produce including rice crop. Furthermore, the rise in the population of those who stayed in agriculture (Fig. 2) without expansion in acreage is an extra problem causing unnecessary pressure on land. Another suspicion for the poor performance of the agricultural sector is that the method and the type of instruments used by most farmers are very rudimentary. Fig. 3 (urban population) and Fig. 4 (rural population) are relatively the precise replica of Figs. 1 and 2. The former (Figs. 1 and 2) indicates that transformations in non-agricultural as well as agricultural populations respectively match changes in urban (Fig. 3) and rural (Fig. 4) populations as they show identical trend behavior although with different gradients.

Furthermore, from Figs. 3 and 4, it appears to that more people are living in the rural than the urban areas, but this difference (which is negligible) is not sufficient to bring about positive performance in the agricultural sector in the country. As stated above, the reasons include the type of labor force, methods and tools used in the agricultural sector.

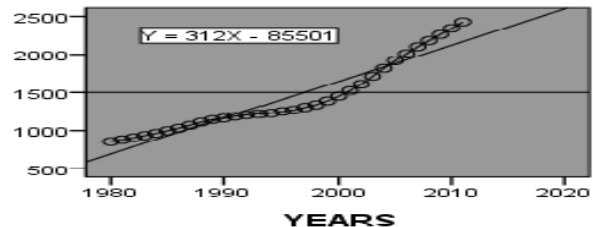### B. The Sectorial Population Movement in Sierra Leone, 1980-2011

Fig. 1 Non-Agricultural Population (1000)
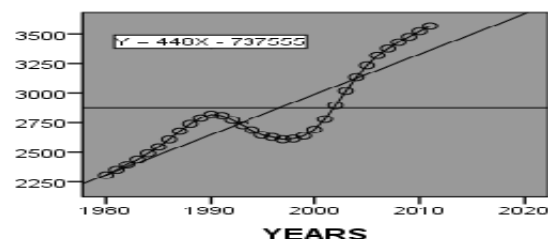

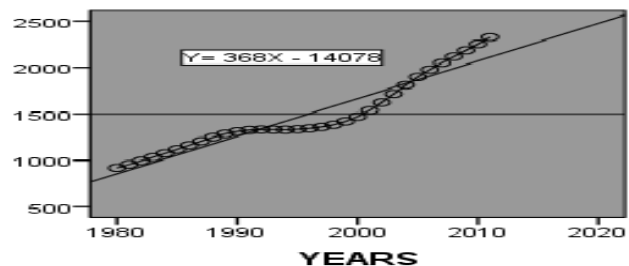Fig. 2 Agricultural Population (1000)
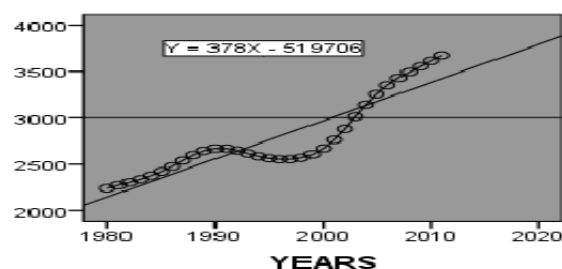

Fig. 3 Urban Population (1000)

Fig. 4 Rural Population (1000)

C. Share of Labor Force in Agricultural Sector as Compared to That of the Industry and Service Sectors
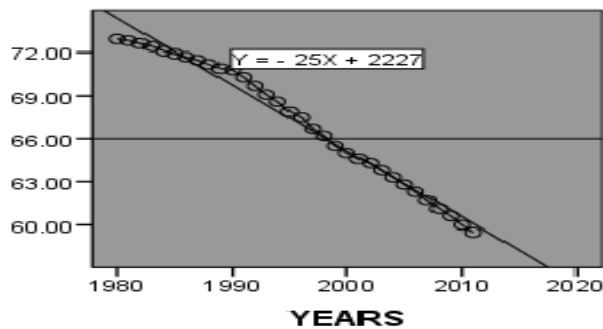

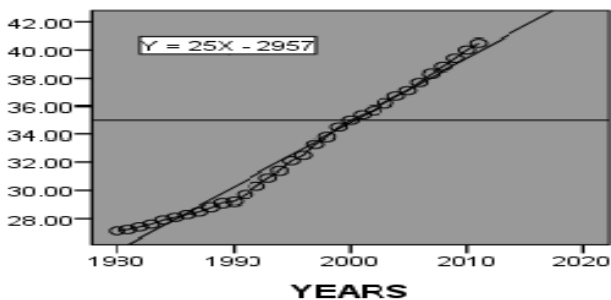Fig. 5 Labor force in agriculture
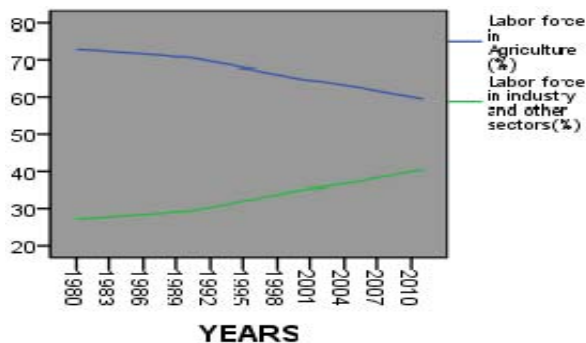

Fig. 6 Labor force in non-agricultural sectors

Fig. 7 Combination of Figs. 5 and 6

Figs. 5 and 6 envisage the percentage of labor force in agricultural sector (Fig. 5) relative to those of the industry and other sectors (Fig. 6) collectively. As the labour force of the agricultural sector (Fig. 5 with a negative gradient) has been presenting a negative pattern within the period 1980-2011, that of the nonagricultural sectors has been showing the reverse (Fig. 6 with a positive gradient). However, this is astonishing since we expect to have a positive gradient or pattern for Fig. 5 (as the number of people living in the rural areas (Fig. 4) is slightly higher than those in the urban as Fig. 3 above shows). On the other hand, this supports the feeling of having energetic labour force shifting to non-agricultural sectors of the economy from the agricultural sector. This, however, support the stated hypothesis, that rural-urban energetic labour force shift negatively influences rice cultivation. With the

exception of the agricultural sector, it is difficult to find many females, children and old age in the industrial, mining and other service sectors of Sierra Leone, this implies increased labor force overall in nonagricultural sector of Sierra Leone highly comprises more of the active male persons leaving agricultural or rural regions seeking for better economic opportunities in other non-agricultural sectors. Another reason that may have caused this astonishing results has to do with the rudimentary tools employed by most cultivators of rice crop in Sierra Leone. Also, the positive trend showed by the nonagricultural sector during the period 1992-2001 is caused by the eleven years civil war that engulfed the entire nation. During the civil conflict, many agricultural activities in Sierra Leone were brought to halt. At that time, the only option or job opportunity for the energetic labor force was the industrial and other non-agricultural sectors that were located mainly in Freetown, capital city (the urban area, since it was not badly affected as the rural areas).

Fig. 7 (presenting a combination of Figs. 5 and 6), conversed that an increase in the energetic labor force in both the industry and other sectors implies a decrease in agricultural labor force, and hence, poor performance of the agricultural sector.

D. Regression Results

TABLE I
THE GENERAL MODELING OF RICE OUTPUT (QRP) USING OLS, 1980-2011

Variable	Coefficient	Std. Error	t-value	t-prob	Partial r^2
Constant	17.8060	8.0049	2.471	0.0870***	0.7111
LQRP_1	-0.7993	0.4001	-2.620	0.0710***	0.8013
LQRP_2	-0.2721	0.4001	-0.824	0.5004	0.2157
LQRP_3	-0.3004	0.2501	-1.440	0.2905	0.4003
LRP	14.4621	14.5010	1.021	0.4456	0.3001
LRP_1	-46.0032	42.1211	-1.212	0.4561	0.5012
LRP_2	76.4315	38.7541	1.781	0.2111	0.4345
LRP_3	-61.0515	20.1241	-3.312	0.0732***	0.3245
LAURC	-0.4211	0.3701	-1.151	0.3451	0.2998
LAURC_1	0.5092	0.3030	2.201	0.1200	0.5320
LAURC_2	0.2510	0.3095	0.653	0.5011	0.1824
LAURC_3	0.7989	0.3910	2.300	0.0091*	0.6521
F	0.0190	0.0301	0.798	0.5001	0.2011
F_1	0.1401	0.1396	-0.765	0.4032	0.2021
F_2	-0.0823	0.1153	-1.204	0.3692	0.2115
F_3	0.6001	0.3231	2.190	0.1097	0.6987
DUV	0.2509	0.1651	1.701	0.0181**	0.5101

$R^2 = 0.9781$ F (18,3) = 16.89 [0.0174]   DW = 2.37

Diagnostic Test

AR 1- 1   F (1, 2) = 0.8972 [0.4561]   SC = -4.62

ARCH 1 F (1, 8) = 0.00191 [0.9669] , Normality Chi^2(2)= 0.8921 [0.6511]

RESET   F (1, 2) = 0.00059 [0.9781]

SC=Schwarz information criterion, * Significant at 1**%, 5% & 10%; ** significant at 5**% & 10%; *** 10%**

Ln = natural logarithm, QRP = quantity of rice produced (dependent variable), RP = Rural Population,

QRI = quantity of rice imported, AURC= Land area under rice cultivation, F=Fertilizer consumption,

DUV = dummy for the civil war in Sierra Leone

These results are autoregressive distributed lag (ADL) model output using OLS technique, with each variable lagged thrice in an effort to detail the dynamic behavior of rice cultivation in Sierra Leone. The social package for social scientists (SPSS 19) was used for the estimation. From Table I, rural populations (RP) positively affects rice cultivation but with the extreme lag (RP_3). The first two lags in addition to the current value of RP are not significant.

However, given the positive and significant effect produced by the third lag, it suggests that, a reduction in labour movement from farming areas would significantly increase rice output gradually. This increase in rural population would not instantly bring about an increase in rice output, since they would first need to be trained technically or by obtaining particular requisite inputs which could not happen immediately. For area under rice cultivation (AURC), both the current acreage expansions with those of the last two years failed to have significant effects on current rice production. Though, its increase three years back (AURC_3) emerges with a positive as well as a significant effect. The insignificant of rice response to current and the last two years increase in acreage might result from the reality that the area cultivated might have increased, however, if there were not improved rice varieties or adequate fertilizers use, rice output would not be significant; especially with upland rice cultivation system that has a low natural nutrients. Rice output might have significantly responded to increased acreage after a substantial lapse of time as complementing factors, such as those mentioned above, are acquired. Conversely, under no circumstances, current or lag, has fertilizer use (F) established significant in affecting rice cultivation (Table I)

However, this may not also be astonishing, since fertilizer is not procured freely. Considering the low-income position of most cultivators in the country as replicated in the dominance of small-scale farming activities in Sierra Leone, the use of fertilizer on farm lands would be on a small-scale, while the expenditure of the inputs is increasing with increase in exchange rate levels. Many researchers also establish insignificant result for fertilizer utilization partly as a result of the reason given above, and because the inputs were being acquired by cultivators in many developing countries from the black market.

The dummy variable (DUV) that captures the effect of the civil conflict in the early 1990s and early 2000s comes out significantly with the expected negative impact on rice cultivation.

R^2 and F-test statistics illustrate significant goodness of fit of this model. No problem with the normality of the error term according to the diagnostic tests, thus, the model is well specified.

IV CONCLUSIONS

Increased rice production in Sierra Leone is establish to follow expansion of acreage under rice cultivation, with 5% and 10% significance at current level and 10% with the first lag (RACR_1). Increased rural population is also established positive and significant in affecting rice cultivation. The implication is that rice cultivation increases with increase in the rural population (with a lag) as the reverse is also true in confirmation of the hypothesis that, the shift of energetic rural labour towards non-agricultural sector reduces rice cultivation, and hence, the output in Sierra Leone. Nevertheless, the reverse implication proposes that the disproportionate concentration of government attention on non-agricultural sectors may have been a huge source of ruins in the agricultural sector toward rice cultivation, as majority of the Sierra Leonean population regards other sectors such as mining as the fountain-head of huge money, thereby shifting energetic rural labour away. The Low Farm Household Model, recounting cultivators' time allocation between off-farm and farming service in Southern Africa, appears to hold in the Sierra Leone situation; cultivators seeing better earnings in off-farm employment in relation to consumer prices compared to on-farm income are likely to shift them over, thereby leaving little or absolutely no time on farming.

Although not establish significant from the regression results, but the trend description in the literature shows that fertilizer utilization have been insignificant and this would add to arresting cultivators' response to price of the grain; this could be as a result of the low-income position cultivators are trapped in as the input's consumption is absolutely dependent on importation. The civil conflict in Sierra Leone was a strong obstacle to rice cultivation, and agriculture generally. The dummy variable included to capture this devastation comes out significantly in confirmation of the expected negative effect of the civil conflict on rice cultivation. The preceding findings, should nevertheless, be taken with caution since they should be responsive to the nature of the data that were acquired for this study, a common occurrence for developing economies studies. Most Data collection activity in developing nations encounters numerous constraints making figures incomprehensive; and this affects reliability of researches that are based on secondary data for empirical analyses.

The shift of rural labour towards non-agricultural sector reduces rice cultivation and hence the rice output in Sierra Leone.

REFERENCES

[1] N. Van Nguyen and A. Ferrero, "Meeting the challenges of global rice production," *Paddy and Water Environment,* vol. 4, pp. 1-9, 2006.
[2] B. Bouman, *et al.*, "Rice and water," *Advances in Agronomy,* vol. 92, pp. 187-237, 2007.
[3] S. Khan, *et al.*, "Can irrigation be sustainable?," *Agricultural Water Management,* vol. 80, pp. 87-99, 2006.
[4] M. Frei and K. Becker, "Integrated rice fish culture: Coupled production saves resources," in *Natural Resources Forum,* 2005, pp. 135-143.
[5] D. Headey, "Rethinking the global food crisis: The role of trade shocks," *Food Policy,* vol. 36, pp. 136-146, 2011.
[6] K. Saito, *et al.*, "Enhancing Rice Productivity in West Africa through Genetic Improvement," *Crop Science,* vol. 52, pp. 484-493, 2012.
[7] A. Touré, *et al.*, "Response of lowland rice to agronomic management under different hydrological regimes in an inland valley of Ivory Coast," *Field Crops Research,* vol. 114, pp. 304-310, 2009.
[8] M. Haile, "Weather patterns, food security and humanitarian response in sub-Saharan Africa," *Philosophical Transactions of the Royal Society B: Biological Sciences,* vol. 360, pp. 2169-2182, 2005.

[9] Y. Jingzhong, "Left-behind children: the social price of China's economic boom," *Journal of Peasant Studies,* vol. 38, pp. 613-650, 2011.

[10] B. A. Miheretu, "Causes and consequences of rural-urban migration: the case of Woldiya town, North Ethiopia," 2011.

[11] M. Timmer*, et al.*, "EU KLEMS Growth and Productivity Accounts: Overview November 2007 Release," *Groningen: University of Groningen. Online at www. euklems. net/data/overview_07ii. pdf (accessed 10th July 2009),* 2007.

[12] M. P. Todaro, *Urbanization, unemployment, and migration in Africa: Theory and policy* vol. 104: Population Council New York, 1997.

[13] D. Goulet, "What is a just economy in a globalized world?," *International Journal of Social Economics,* vol. 29, pp. 10-25, 2002.

[14] [14] F. Ellis, *Agricultural policies in developing countries*: Cambridge University Press, 1992.

[15] [L. Sun*, et al.*, "Incorporating Technology Diffusion, Factor Mobility and Structural Change into Cross -Region Growth Regression: An Application to China*," *Journal of Regional Science,* vol. 50, pp. 734-755, 2010.

[16] M. Wen*, et al.*, "Neighborhood effects on health among migrants and natives in Shanghai, China," *Health & Place,* vol. 16, p. 452, 2010.

[17] D. Ogunmola, "Socio-Economic Injustice and Cronyism: Warlordism and Tayloryism in the Sierra Leone Civil War," *Journal of Alternative Perspectives in the Social Sciences,* 2009.

[18] J. Negin*, et al.*, "Integrating a broader notion of food security and gender empowerment into the African Green Revolution," *Food Security,* vol. 1, pp. 351-360, 2009.

[19] K. K. Touré and D. Clavel, "Theme 1: Developing a Mixed Knowledge Innovative System of Technical, Institutional and Traditional Information for Capacity Building and Empowerment of Multi-Stakeholders Networks in Rural Africa [Article and Abstract]," *Agricultural Information Worldwide,* vol. 3, pp. 65-72, 2010.

[20] A. Salam, "Distortions in Incentives to Production of Major Crops in Pakistan: 1991–2008," *The Journal of International Agricultural Trade and Development,* vol. 5, pp. 185-207, 2009.