Ethiopian Journal of Economics, Volume V, No. 1, April 1996, PP. 27-38

MEASURING INEQUALITY: AN EXPERIENCE USING INDIAN DATA

Bedassa Tadesse*

Abstract: This paper discusses the effect of a social welfare programme initiated to mitigate absolute poverty using data collected from the Southern Indian state of Tamil Nadu. It utilised one of the modern techniques developed for measuring inequality using coefficients of Lorenz curve derived by an Ordinary Least Squares (OLS) method. The study indicates that Integrated Rural Development Programme (IRDP), in the state, has helped not only in mitigating absolute poverty but also in reducing the disparity in income distribution among the beneficiary households.

1. INTRODUCTION

It is not uncommon to see discussions on income distribution and poverty in Ethiopia with little or no distinction made between equity and equality (see, for instance, Hadgu, 1995; IFAD, 1993; MOPED, 1993; and Solomon, 1993). Given the current market oriented economic policy of the country, measuring the disparity in asset position and income distribution will comprise the prime areas of research. This is because there are areas where policies have been made without any yardstick for measuring whether, as a result of policy action, conditions are getting better or worse (Baker, 1996: 20).

The distinction between equity and equality is based on the fundamental fact that the former is a matter of ethical judgement and thus is a subjective concept, whereas the latter is for the most part, a mathematical and/or statistical matter and thus is basically an objective one (Bronfenbrenner, 1973: 10). When we say equity with respect to income, it refers to a just distribution of income. But, justice does not necessarily mean equality. However, due to the subjective nature of equity (which has no acceptable measure) economists use measures of inequality to reflect inequity.

*Assistant Professor and Head, Department of Agricultural Economics and Extension, Jimma College of Agriculture, P. O. Box 307, Jimma, Ethiopia.. E-mail: jca.ncic@padis.org. *The article is based on an M.Sc. thesis submitted to the Tamil Nadu Agricultural University (TNAU), India, 1996. The author would like to thank the Jimma College of Agriculture, Prof. Dr. S. Krishnamoorthy, Head, Department of Agricultural Economics (TNAU), Prof. Dr. S. Varadarajan and Amsalu Ayana. The anonymous referees of this journal have also contributed much for improving this work and thus deserve special thanks.*

It is impossible to overcome all the limitations of using Gini coefficient. Nonetheless, it would be necessary to understand them in making welfare or policy judgements based on this statistics. Various techniques have been suggested to reduce some of the shortcomings (see Gastwirth, 1972 and Pyatt *et al*, 1980). Moreover, Kakwani and Podder (1976), Kakwani (1980) and Datt and Ravellion (1992) have suggested several efficient methods of approximation which reduces the bias in Gini ratio that may arise due to aggregation by taking into account the dispersion within class intervals. With empirical justification, they have introduced a curve linear approximation of several class of Lorenz curves[1] using regression technique, from the coefficients of which the Gini ratio and relative mean deviation could be estimated by integration method. The coefficients also provide information about the dispersion of the distribution. The only drawback of this method is that it is costly in terms of the researcher or computer time as it involves mathematically complex procedures (Reimenschneider, 1983:14).

This study has the prime objective of showing how to use Gini Coefficients derived through an econometric technique. It employs the methodology suggested by Kakwani and Podder (1976) and Pyatt *et al* (1980) for estimating the Lorenz curve and thereby assess the distributional impact of major anti-poverty programmes initiated in India. It is believed that, besides the application of the method, the paper will help to assess social welfare programmes and the impact of policies that may be useful to interested researchers in Ethiopia.

2. BACKGROUND INFORMATION

India has a wide geographical area, agro-climatic diversity and abundant forest. However, with more than 70 percent of its population living in rural areas, poverty, unemployment and underemployment are common problems among the rural poor in general and weaker sections in particular. Of the 520 million poor in South Asia, 420 million (80.76%) are concentrated in India (World Bank, 1993: 20).

The mitigation of poverty has thus been the concern of planning in the country. As a result, a number of general as well as specific agricultural and rural development programmes were implemented in the country for improving the living conditions of the poor, raising their productivity levels and providing them higher employment opportunity. These include: the Grow More Food Campaign (1943), Community Development Programme (1952), Intensive

Agricultural District Programme (1961), Intensive Agricultural Area Programme (1964), HYV Programme (1966), Small Farmers Development Agency (SFDA) and Marginal Farmers and Agricultural Labourers Development Agency (MFALDA) (1971-72) etc. (Bedassa, 1996: 2-14). However, despite the growth and expansion of these programmes in size, they remained fragmented, less integrated and less comprehensive and tackled the problem of poverty from one angle or another (Grag, 1992: 5). Further, they resulted in inequalities in regional development and income which were not consistent with "Growth with social Justice" objective of the plan (Grag, 1992: 3) and hence left much of the problem of rural poverty unresolved (Lawania, 1992: 11).

As a result, the Government of India conceived a sectoral, spatial and a target integration of the on-going programmes and launched a direct attack on rural poverty by identifying all members of the target groups under the name Integrated Rural Development Programme (IRDP) in the year 1976 (Dhillon, 1992: 41). Since its inception till 1990, 34.9 million families were assisted and Rs 134,511.2 million were spent on the programme (World Bank, 1993).

The basic objective of IRDP is the creation of productive assets by way of subsidies and loans, and skill training for enabling the rural poor to generate self employment and thereby income for crossing the poverty line. At present, IRDP is one of the largest anti-poverty programmes underway in the world, with a budget of Rs 66,500 million, accounting for 18.5 percent of the Eighth Five Year (1992-97) Plan's rural development budget of India (Yojendra, 1994: 8-9).

Despite this huge expenditure, 21.68 percent of the population of rural India lives in poverty (Sen, 1981: 13) and various micro-level studies conducted over the past one and a half decades dispute whether the programme has not brought about significant reduction in poverty.

Two things, therefore, emerge: how far has the programme helped the poor to be above the poverty line and what was its distributional impact. The present paper is an effort to assess the second problem with the aim of sharing the experience of measuring the impact of such policies with social researchers in Ethiopia.

3. SAMPLING PROCEDURE AND THE DATA

As IRDP is underway in all development blocks[2] of the country, any region, district or block could be considered for the study. In this context, the Coimbatore district of the Southern

Ethiopian Journal of Economics, Volume V, No. 1, April 1996, PP. 27-38

MEASURING INEQUALITY: AN EXPERIENCE USING INDIAN DATA

Bedassa Tadesse*

Abstract: *This paper discusses the effect of a social welfare programme initiated to mitigate absolute poverty using data collected from the Southern Indian state of Tamil Nadu. It utilised one of the modern techniques developed for measuring inequality using coefficients of Lorenz curve derived by an Ordinary Least Squares (OLS) method. The study indicates that Integrated Rural Development Programme (IRDP), in the state, has helped not only in mitigating absolute poverty but also in reducing the disparity in income distribution among the beneficiary households.*

1. INTRODUCTION

It is not uncommon to see discussions on income distribution and poverty in Ethiopia with little or no distinction made between equity and equality (see, for instance, Hadgu, 1995; IFAD, 1993; MOPED, 1993; and Solomon, 1993). Given the current market oriented economic policy of the country, measuring the disparity in asset position and income distribution will comprise the prime areas of research. This is because there are areas where policies have been made without any yardstick for measuring whether, as a result of policy action, conditions are getting better or worse (Baker, 1996: 20).

The distinction between equity and equality is based on the fundamental fact that the former is a matter of ethical judgement and thus is a subjective concept, whereas the latter is for the most part, a mathematical and/or statistical matter and thus is basically an objective one (Bronfenbrenner, 1973: 10). When we say equity with respect to income, it refers to a just distribution of income. But, justice does not necessarily mean equality. However, due to the subjective nature of equity (which has no acceptable measure) economists use measures of inequality to reflect inequity.

* *Assistant Professor and Head, Department of Agricultural Economics and Extension, Jimma College of Agriculture, P. O. Box 307, Jimma, Ethiopia.. E-mail: jca.ncic@padis.org.* *The article is based on an M.Sc. thesis submitted to the Tamil Nadu Agricultural University (TNAU), India, 1996. The author would like to thank the Jimma College of Agriculture, Prof. Dr. S. Krishnamoorthy, Head, Department of Agricultural Economics (TNAU), Prof. Dr. S. Varadarajan and Amsalu Ayana. The anonymous referees of this journal have also contributed much for improving this work and thus deserve special thanks.*

Economists have developed several yardsticks to measure the impact of policy on the distribution of income. Substantial improvements have also been made in these measures since they were formulated in the 1920s. Most common among them are various inequality measures (see Fields, 1980). The chosen measures, however, should satisfy five basic properties. These are (1) Pigou-Dalton transfer sensitivity; (2) symmetry; (3) mean independence; (4) population homogeneity and (5) decomposability (Foster, 1985).. These properties were considered desirable, although emphasis varies depending upon what the researcher wants to address, on account of the need to address issues such as: increase in poverty index as a result of the transfer of a fixed amount of money from a poor person to a rich person should be decreasing the income of the donator; rising poverty in particular subgroups could lead to an increase in total poverty index and vice versa; pooling two or more identical populations should not increase the poverty index; and, finally, a decrease in the income of the poor should increase the poverty index.

The most commonly used measure of inequality includes Theil's entropy index (T), Theil's second measure (L), the coefficient of variation (CV), Gini coefficient (G) and the Lorenz curve (LC). However, as the two Theil measures are not decomposable and the coefficient of variation is affected by extreme values, many economists have used the Lorenz curve and the Gini coefficient for measuring inequality. Further, the Gini coefficient has been used widely because it is a single statistic, conceptually easy to understand and compute. However, the usual linear approximation of Lorenz curve and Gini coefficient has the following limitations (Reimenschneider, 1983:4):

i) it is only a relative measure of income distribution and says nothing about absolute income. This leads to difficulties in comparing different groups with different levels of income.
ii) comparing distributions over a time where the universe has shifted significantly using Gini Ratio computed in the usual method introduces a bias (Benson, 1970: 446),
iii) it fails to consider the dispersion of income or benefits within each cell (interval) of the grouped data and aggregation of income receiving units. Thus, a change in the number of cells (intervals) used to group the data changes Gini coefficient (Reimenschneider, 1983: 21),
iv) the same Gini ratio can be obtained from Lorenz curves that cross each other. Thus, there is no way to determine which income class gets relatively lower or higher income shares (Reimenschneider, 1983:7), and
v) there is a problem of determining statistical differences between Gini coefficients (Reimenschneider 1983: 10) and thus direct comparison of the coefficients is inappropriate.

Indian state of Tamil Nadu was selected taking into account the logistics, accessibility and time constraint.

A two stage probability proportionate random sampling technique was adopted and 65 household beneficiaries were selected for the present study. In the first stage, Udumalpet block was selected at random from the list of beneficiaries under IRDP assistance in all sectors (primary, secondary and tertiary) during 1992/93; for the second stage, 65 households were selected at random taking the sectoral distribution into account . The year 1992/93 was selected because the beneficiaries covered by the programme were expected to cross the poverty line in two years time.

The primary data pertaining to various socio-economic characteristics of the selected households were collected using a pre-tested schedule using personal interviews. The 1995 household income[3] which was used in this analysis was arrived at through income accounting method. As each beneficiary possessed a loan book *(Vikas Patrikas)* details on loan, subsidies and repayments were easily obtained.

4. METHOD OF ANALYSIS

Three measures of income distribution pattern (inequality), namely, Lorenz curve, Gini coefficient, and relative mean deviation were computed following Kakwani (1976) using a computer programme called MSTATC. The usual method of linear approximation of Lorenz curve and Gini coefficient involves grouping the data into a number of cells. This, however, has drawbacks as discussed earlier and thus limits its application to the present situation. Therefore, using one of the approaches[4] suggested by Kakwani and Pyatt (1776), the equation of the Lorenz curve was derived and the coefficients were used to compute Gini coefficient (G) and relative mean deviation (R) that are free from some of the drawbacks.

4.1. The Econometric Model

The coefficients of the Lorenz curve at time (t) were estimated through Ordinary Least Squares (OLS)[5] method as follows:

$$Log Y_t = a + \alpha \log r_t + \beta \log\left(\sqrt{2} - r_t\right) + v_t \qquad [1]$$

$r_t = (p_t + q_t)/\sqrt{2}$ $Y_t = (p_t - q_t)/\sqrt{2}$ antilog a = A

$P_t = \sum_{i=1}^{k} f_i$ $f_i = n_i/N$ $q_t = \frac{1}{Q}\sum_{i=1}^{k} X_i f_i$

$Q = \sum_{i=1}^{k-1} X_i f_i$

Where:

A, α, β > 0

i = income class interval (1,2,....k)

n_i= number of households in income class i

N = total Sample size

p_t = cumulative frequency of households

q_t = cumulative frequency of households mean income

X_i = mean income of households in income class i

v_t = random error term

t = time period:

1 pre IRDP (1992/93)

2 post IRDP (1995/96)

a, α & β are parameters to be estimated. All the classical assumptions of OLS regression were made in estimating the parameters.

The values of α and β provide an insight into the nature of income distribution. If $\alpha = \beta$, the income distribution is symmetrical, i.e., it is normal. If $\alpha > \beta$, the Lorenz curve is skewed towards (0,0), i.e., the highest and lowest income groups receive large income share. If $\alpha < \beta$, the Lorenz curve is skewed towards (1,1) i.e., middle income groups get the highest income.

Given the Lorenz curve equation at time t in (1), the Gini coefficient (G_t) in period t was estimated (see Kakwani, 1976:134-148).

$$G_t = \int_0^{\sqrt{2}} A(r_t)^{\alpha} (\sqrt{2} - r_t)^{\beta} \delta r_t$$

Which basically is,

$$G_t = 2A(\sqrt{2})^{1+\alpha+\beta} \beta(1+\alpha, 1+\beta) \qquad [2]$$

Where:

$(1+\alpha, 1+\beta)$, is a beta function and all other parameters are as defined earlier.

In the absence of Beta distribution table, the Beta function was estimated from Gamma (G) function as follows:

$$\beta(m,n) = \Gamma m \Gamma n / \Gamma mn,$$

That is,

$$\beta(1+\alpha,\ 1+\beta) = \Gamma(1+\alpha)\Gamma(1+\beta)/\Gamma\{(1+\alpha)(1+\beta)\} \qquad [3]$$

Further, another measure of inequality, relative mean deviation (R), was also estimated by using the coefficients of Lorenz curve (1) as

$$R_t = (\sqrt{2})^{1-\alpha+\beta}\,(A\alpha^{\alpha}\beta^{\beta})/(\alpha+\beta)^{\alpha+\beta} \qquad [4]$$

Moreover, following Pyatt *et al* (1980) an alternative Gini coefficient was computed without grouping the data into income classes so as to check the consistency of the Gini coefficient estimated from the Lorenz curve coefficients, as follows

$$G_{pt} = 2/N\mu_t\,(Cov\ Y_{it}\ Z_{it})$$

Where ;

N	= *total sample size*	m_t	= *mean income*
Y_{it}	= *income of household I*	Z_{it}	= *Rank of household i's income*
Cov	= *covariance*	t	= *time period*
G_{pt}	= *Gini coefficient (by Pyatt)*		

4.2. Statistical Tests Results

All statistical tests were conducted using `t' and `F' distributions at one and five percent level of significance.

The result shows that poverty is positively correlated with inequality in the distributional pattern of productive assets in general and the family income in particular. Though relative inequality cannot be avoided, its escalation can be checked (Sen, 1981: 47). Thus, the productive assets provided to the poor under social welfare programmes, like IRDP, in an attempt to alleviate absolute poverty should play a positive role in minimizing the disparity in income distribution between the poor and the non-poor. If such welfare programmes are incapable of reducing poverty, they should not aggravate the disparity among the poor themselves (for example, between the poor and the ultra poor (the destitute). If this is to take place, such programmes must be designed, taking into account the initial income position, the household resources and other socio-economic factors for determining the level of assistance to different households. This implies the ultra poor (destitute) households need to be provided with more opportunities and does of assistance than the poor if they have to cope up with the poor. IRDP takes into account these factors and thus the effect on income distribution depends on how efficiently the asset was used and the resultant income generated. This general abbreviation is substantiated using the information summarized in Table 1.

Table 1: Descriptive Statistics of some Socio Economic Characteristics of the Sample Households

	Variables	Unit	Mean	Standard
1	Base (pre assistance income)	Rs	4270.00	1584.93
2	Net income from operation of IRDP	Rs	2663.74	3627.33
3	Income from other (non IRDP) sources	Rs	3977.22	2088.55
4	Current (Post assistance total household	Rs	6640.96	2299.25
5	Family size	No.	4.35	1.36
6	Level of education	Years	3.30	4.00
7	Age of beneficiary	Years	41.14	8.74
8	Working members in the household	No	2.76	1.04
9	Value of fixed productive assets possessed	Rs	6805.38	1847.09

A summary of the means and standard deviations of some of the socio-economic characteristics of the sample households is presented in Table 1. It could be seen from the table that a beneficiary household with an average family size of 4.35 persons, of which 63.44 percent (2.76 persons) are working, was able to realize a net income of Rs 2,663.74 by operating an IRDP asset. Owing to this fact, the pre-assistance income of the household, which was Rs 4,270.00 on an average, has shifted to Rs 6,640.96 at present (Nov., 1996). Although the mean current income is above the previous poverty line of Rs 6,400.00, only 11 percent of these households have an income level above the revised poverty line of Rs 11,000 (at 1992 prices). A mean test of equality between the pre-assistance and current total

household income has shown that the current household income is significantly greater (at $t_{0.99}$, df = 126). This shows that the change in the absolute income level of the beneficiary households attained due to the programme was considerable. However, this change might not be uniform across all income groups . This raises the question whether the programme enhanced or reduced the disparity in income distribution between the beneficiary households (which was the main theme of this paper). This was analyzed through Lorenz curve coefficients and the associated measures of inequality (Gini coefficient and Relative Mean Deviation) at two time periods using the base (pre-assistance) household income and post-IRDP (current total household income). The Lorenz curve coefficients and the values of the Gini coefficients and relative mean deviation at the two time periods are presented in Table 2 below.

Table 2 shows that with highly significant ($P < 0.001$) F values and 99 percent multiple coefficient of determination (R^2), the function estimated was a perfect fit. Therefore, the coefficients could be used to estimate a reliable measures of inequality. As could be seen from the coefficients of the Lorenz curve in period I, i.e., prior to availing IRDP loan, the highest share of income was received by middle income groups ($a < b$, at $t_{0.99}$, df = 12) and the Gini coefficient (G_1) and relative mean deviation (R_1) are computed to be 0.205 and 0.1476, respectively. This shows that there was a skewed income distribution even among the poor households selected. On the other hand, the Lorenz curve coefficients for post-assistance period revealed a symmetrical income distribution ($a_2 = b_2$, at $t_{0.99}$, df = 12). This shows a shift towards an egalitarian distribution of income. Consequently, the Gini coefficient and the relative mean deviation have declined by five percent to 0.193 and 0.140, respectively. Further, Gini coefficient, computed alternatively, has declined from Gp_1 = 0.203 in pre-assistance period to Gp_2 = 0.193 in the post-IRDP assistance period, revealing the consistency of the first estimate.

From the results in Tabel 2, it could be inferred that the income generated through IRDP assistance contributed in reducing the disparity in income distribution among the beneficiary households[6]. This is in line with the desired objective of 'Social Justice' which aims not only at mitigating absolute poverty but also reducing income inequality.

Table 2: OLS Estimates of the Coefficient of Lorenz Curve and Associated Values of Measures of Inequality.

Period I Pre assistance L_1 (1992/1993)		Period II Post Assistance L_2 (1995/1996)	
a_1	-0.743		-0.742
α_1	0.7664**		0.8665**
	(0.0158)		(0.1300)
β_1	0.8192**		0.8731**
	(0.0151)		(0.1630)
R^2	0.99		0.99
F_1	1503.288		2255.27**
	G_1=0.208		G_2=0.193
	R_1=0.1476		R_2=0.1400

(Figures in parentheses are standard errors)
** Significant at 0.001 percent

6. CONCLUSION AND IMPLICATIONS OF THE STUDY

It is necessary that social welfare programmes and related policy measures formulated for mitigating absolute poverty should not aggravate the disparity in income distribution among individuals and regions. In other words, maintaining a just improvement in income distribution should constitute an important component of an appropriate policy. The study has indicated that the government sponsored huge anti-poverty programme, IRDP, in India has helped not only to reduce absolute poverty levels but also contributed towards a just distribution of income among the beneficiary households. This is in line with the "growth with social justice" objective of the plan.

Given the efforts of various Non-governmental Organisations (NGOs) operating in different parts of Ethiopia, the current market oriented economic policy of the government which promotes individual efforts for investment in different sectors as well as the various regional governments initiatives to supplement these attempts, we should be cautious of the possibility of escalating disparity in income distribution among the have's and have nots as well as among regions. In the absence of any concrete report, social science researchers should assess the impacts of such situation and indicate their policy implications. This approach could therefore be considered for such studies.

NOTES

[1] Kakwani and Podder (1976) initially introduced an OLS approach and latter Kakwani (1980) formulated a Generalised Least squares method. Furthermore, Villasenor and Arnold (1989) used the General Quadratic specification while Kakwani (1990) as well as Datt and Ravellion (1992) suggested the use of parametrised Lorenz functions to understand not only poverty but also income inequality as well as the growth and redistribution effects.

[2] Block is the smallest level (unit) in the administrative structure of the Indian government.

[3] Income is defined as all earnings obtained by the household from the operation of both IRDP & non IRDP assets at current (1995) prices after deducting the cost of production.

[4] One of the referees suggested the use of the Generalised Least Squares method (GLM) suggested by Kakwani (1990). GLM is a method which involves the analysis of variance and covariances in unbalanced designs with the use of adjusted sum of squares and sequential sum of squares for observations with large standardised residuals or leverages. Thus, there must be enough data to estimate all the segments (terms) in the model. Further it requires balanced nesting. The current data, however, does not fully satisfy all the above requirements. This impaired the use of General Least square method of estimation suggested.

[5] Villasenor and Arnold (1989) claims a General Quadratic specification of the Lorenz function to have a better approximation. Nevertheless, this superiority holds when the class contains elliptical (i.e., when $a < 0$) and parabolic (i.e., when $a = 0$) Lorenz curves. On their earlier paper (1984), they have shown that for hyperbolic (i.e., when $a > 0$) Lorenz curves, OLS approximation yield true Lorenz curves. That is, they satisfy $f(x) = 1/mL''(F(x))$ conditions attributed to Gaffney and Anstis by Pakes (1981). The present paper thus, builds on the later, i.e., hyperbolic ($a > 0$) Lorenz curves. This is clearly indicated in the model specified and the resulting Lorenz curve statistics. On the other hand Datt and Ravellion (1992) have also shown that imprecision associated with the Lorenz curve estimation approaches used are unlikely to be of serious concern.

[6] Prior to the suggestion of the referees, the importance of using parameterised Lorenz functions to estimate poverty indices and break them into components of growth and redistribution (income inequality) developed by Kakwani (1990) and Datt and Ravellion (1992) for this type of study was considered. It is true that parameterisation of Lorenz curves enable the decomposition of the reduction in poverty among poor households attributable to the rise in mean income of the beneficiaries under IRDP and the decline in the disparity in income distribution. However, as the issue of decomposition was not the main theme of the present paper, those who want the details can consult the works of the author in the forthcoming issues of Journal of Rural development, India as the author has considered the same under another article. Further, Kakwani (1990), Datt and Ravellion (1992) as well as Fox and Morlay (1991) provide adequate evidences of value.

REFERENCES

Baker, R. A. (1966) 'Detection and Anticipation of Impact: The Nature of The Task', in Raymond A. Baker(ed.). ***Social Indicators***. Cambridge: Cambridge University Press.

Bedassa Tadesse (1996). ***Assessment of Integrated Rural Development Programme in Coimbatore District: An Econometric Approach***. Unpublished M.Sc. Thesis submitted to Tamil Nadu Agricultural University, India.

Benson, R. A.(1970) 'Gini Ratios: Some Considerations Affecting their Interpretations', ***American Journal Of Agricultural Economics***, 52: 444-447.

Bronfenbrenner, M. (1973) 'Equality and Equity', ***The Annals***, 409: 9-23.

Datt, G. and Ravellion, M. (1992) 'Growth and Redistribution components of Changes in Poverty Measures:

A decomposition with applications to Brazil and India in the 1980s, ***Journal of Development Economics***, 38: 275-295.

Dhillon, D. S. (1992) 'Integrated Rural Development Programme in India" in, M. Singh (ed.). ***Rural Development in India*** . New Delhi: Intellectual Publication House.

Fields, G. (1980). ***Poverty, Inequality and Development***. New York :Cambridge University Press.

Foster, J. (1985) 'Inequality Measurement', in Payton and Young(eds.) (1985). **Proceedings of Symposia in Applied Mathematics, In Providence, RI, American Mathematics Society.**

Gastwirth, J. L. (1972) 'The estimation of the Lorenz curve and Gini Index', ***The Review of Economics and Statistics***, 54:306-316.

Grag, A. 1992. ***Working and Impact of Integrated Rural Development Programme***. New Delhi: Deep and Deep Publications.

Hadgu Bariagaber (1995) 'The dimensions of Poverty in Ethiopia: Some Empirical Evidences' in Mulat Demeke, (eds.). ***Food Security and Poverty Alleviation in Ethiopia: Problems and Prospects***. Addis Ababa: Agricultural Economics Society of Ethiopia.

IFAD 1993. **The State of World Rural Poverty : A Profile for Africa.**

Kakwani, N.C. (1980). ***Income Inequality and Poverty: Methods of Estimation and Policy applications***. Oxford: Oxford University.

Kakwani, N. C. and N. Podder (1976) 'Efficient Estimation Of The Lorenz Curve And Associated Inequality Measures From Grouped Observations', ***Econometrica***, 44(1): 137-148.

Lawania, V. K. (1992).***Rural Development in India.*** New Delhi: Ashish Publishing Company,

Ministry of Planning and Economic Development (OPED) (1993), ***The Social Dimensions of Adjustment in Ethiopia: A study of Poverty Alleviation***, Addis Ababa.

Solomon Gebre (1993), ***The Conditions Of The Poor In Addis Ababa: A Social Problem Not Yet Addressed***, Addis Ababa University, Addis Ababa.

Pyatt, G., C. N. Chen and J. Fei (1980) 'The Distribution Of Income By Factor Components', ***Quarterly Journal of Economics***, 95 (3): 451-73.

Reimenschneider, C. H. (1983), ***The Use Of Gini Ratio In Measuring Distributional Impacts***, Michigan State University Press, Technical Paper 16.

World Bank (1993). ***World Development Report***. Washington, D. C.: Oxford University Press..

Yojendra, N. D. (1994) 'Rural Development: A Challenge for the Nineties" in .) D. K. Das (ed) (1994). ***Dynamics of Rural Development***. New Delhi: Deep and Deep Publications.

Sen, Amartya (1981). ***Poverty And Famines: An Essay On Entitlement And Deprivation***. Oxford: Oxford University Press.

_____, (1996) 'Plan Panel Releases Poverty Estimates', *The Hindu*, January 6,1996, P.13