AGRICULTURAL RESEARCH AND POVERTY ALLEVIATION: LESSONS FROM EASTERN AND SOUTHERN AFRICA

BY
PONNIAH ANANDAJAYASEKERAM[1]
MANDIVAMBA RUKUNI[2]

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[1] Methods Specialist, Farm Level Applied Research Methods for East and Southern Africa (FAO-FARMESA) Zimbabwe, and Professor Extraordinary, University of Pretoria, South Africa.

[2] Program Director, WK Kellogg Foundation and Professor of Agricultural Economics, University of Zimbabwe

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P. ANANDAJAYASEKERAM AND M. RUKUNI

'Everyone has the right to a standard of living adequate for the health and well being of himself/herself and his/her family, including food, clothing, housing, medical care and necessary social services ……. Everyone has the right to education ….. to work ….[and] to social security'

Universal Declaration of Human Rights 1948

1. INTRODUCTION

Despite the decades of development assistance delivered through complex systems of lending institutions, multilateral agencies, international agricultural research systems, non-governmental organisation, nations of the south still remain in the grip of grinding and persistent poverty. Countries in Eastern and Southern Africa (ESA) are not exception to this phenomenon, where large number of people continue to live in conditions of absolute poverty. Rural poverty is acute throughout the region and is proving intractable, even in the relatively rich countries. Food security, poverty alleviation and a sustainable environment are interrelated and mutually reinforce each other. Absolute poverty will not be overcome by piece-meal tactics or marginal add-on projects. Poverty alleviation has, therefore, re-emerged as a central agenda for national, regional and international development.

Smallholder agriculture in ESA remains the major source of livelihood for most of the rural poor. Agriculture is still the mainstay of the economies and engine of economic growth for majority of the countries. Agriculture in ESA is in a state of transition with rapid population growth, urbanisation, introduction of various technologies and rapid changes in the overall political, institutional and economic environment. Sustainable intensification of agriculture, can provide sustainable livelihood[1] given the right combination of technologies, community organisations and external environment. It is important to realise that sustainable smallholder agriculture[2] is a key component, but not the only component, of ending poverty in different environments in ESA countries. This should be complemented with targeted policies such as education and healthcare for the poor and employment creation policies at large.

The paper examines the incidence and causes of poverty in ESA and proceeds to outline the commitment of various governments to erradicate poverty. Then the linkages between agricultural research and poverty is revisited. A conceptual framework to assess the impacts of agricultural Research and Development (R&D) activities are presented. The results of the various impact studies and the lessons learned are summarised. The reasons for the limited impacts of R&D institutions are examined. And finally, some suggestions are made to address poverty alleviation through agricultural research in the immediate future.

2. INCIDENCES AND CAUSES OF POVERTY IN ESA

Eastern and Southern Africa is a region of tremendous contrast and diversity, be it in terms of country's physical geography, their economies or the characteristics of the poor. People in sub-Saharan Africa are among the poorest in the world both in real income and in access to social services. In most of the ESA countries one third of their inhabitants are live in poverty. A good proportion of the population is affected by absolute poverty. Their income is so low that 60 percent of it cannot procure minimum household diet. The degree of absolute poverty varies widely. The Human Development Reports confirm what many, outside of the official development institutions have known for a long time; that the ranks of the poor continue to grow, in both relative and absolute numbers and that the benefits of economic development are rarely distributed equitably throughout the societies.

The notion of poverty may change over time; but its core is the inability to fulfil fundamental needs of human beings. Poverty has both absolute and relative dimensions. Sen (1984) argues that poverty is an absolute notion in the space of capabilities, but very often it will take a relative form in the space of commodities and characteristics. Across the board, poverty studies which apply gender desegregated analysis has shown that women more than men are subject to relative as well as absolute poverty. Poverty is much deeper than what is indicated by a poverty line. Deprivation, vulnerability and powerlessness are what the poverty is all about. Poverty is often defined as a lack of productive resources, income and capabilities; which contributes to individual and/or group isolation, vulnerability, powerlessness, economic political and social discrimination and participation in unsustainable livelihoods (UNDP, 1996). It has various manifestations including hunger and malnutrition, ill health, and

limited or no access to education, health care and safe residential and/or professional environments. Government defined poverty lines identify absolute levels of poverty while relative poverty refers to one's position in relation to another. Distinctions are also made between structural or chronic and transient poverty. Structural poverty is rooted in socio-economic and political institutions; is experienced over the long-term and is often transferred across generations. In contrast, transient poverty is due to cyclical or temporary factors and is experienced over shorter periods of time such as with seasonal unemployment , inflation, macro-economic policy shifts and/or natural disasters[3].

Poverty is a product of a multiplicity of factors, climate, values, resources, interrelationships and history - which are fundamentally contextual and as such vary from place to place (Salman, 1992). There are four groups that make the poor in the region: the endemic poor, the economically displaced, political refugees and the environmental refugees (Kumar and Sweet, 1996).

Endemic Poverty

These are the poor - the assetless, underemployed or destitute. By endemic we mean that the poverty of this group has long been entrenched in their lives. This group can be found in both rural and urban settings. The causes of endemic poverty are both social and economic; rigid class structures and limited economic opportunities trap people in this group, often for generations.

The Economically Displaced

This group is made up the 'new poor' - former middle or well paid working class people who have lost their jobs through government or corporate down sizing. The cause of their poverty is almost exclusively economic. This group is largely urban based, often literate and well educated, ignored by many poverty alleviation efforts, but need assistance to re-establish.

Political Refugees

This group is made up of refugees, who have been displaced as a result of political persecution, ethnic strife or civil war. They are either settled in cities or are forced to live in rural encampments. The cause is entirely political. The group is very heterogeneous, often made up of members of all social classes from former elites to the endemic poor.

Programme targeting this group must be multi-faceted and address specific needs of each refugee communities.

Environment Refugees

This is another growing group of poor people forced to leave homes and property because of environmental degradation. The causes can be technical, political as well as economic. Poor environmental and natural resource management policies at the national and local levels, contribute to this. The leading cause of environmental dislocation is agricultural land so badly over-used that it is no longer productive. This group is largely found in cities, although, their origins are usually rural. In the most dramatic instances, environmental refugees are also housed in emergency camps, such as feeding stations that served those fleeing drought in Ethiopia, Somalia and Sudan. In most cases environmental refugees are poor to begin with and have become even more vulnerable and destitute as a result of their displacement.

Although, each group deserve some attention, endemic poverty however, based on long standing socio-economic structures, should be the focus of the national governments in partnership with local and international NGOs, multilateral agencies and the donor community.

UNDP measures the incidence of poverty using two indicators. The Human Poverty Index[4] (HPI) and the Human Development Index[5] (HDI). The HPI provides an aggregate human measures of the prevalence of poverty in a community. This measures the extent of deprivation, the proportion of the people in the community who are left out of progress. The HDI on the other hand measures progress in a community or a country as a whole. The HDI and HPI, when disagregated along the rural-urban divide also highlight the rural-urban disparity in human progress and deprivation. The poverty related indicators for the ESA countries are summarised in Table 1. For Ethiopia, Mozambique, Burundi, Malawi, and Madagascar the deprived population is almost 50 percent. Zimbabwe has only 17 percent poor which is remarkable considering its low development ranking. This proves that development and poverty alleviation do not necessarily go hand in hand. Thirteen out of the 20 countries listed has a HDI of less than 0.5; and they fall within the bottom 25 percent of the countries in terms of HDI ranking. Countries such as Lesotho, Kenya, Zambia, Tanzania, Madagascar, Malawi,

Ethiopia and Burundi have failed to translate their economic prosperity into correspondingly better lives for their people[6]. In Zambia, Tanzania, Madagascar, Malawi, Ethiopia and Burundi, the percentage of underweight children under the age of five have increased between 1975 and 1990/97. The daily per capita supply of calories have also declined between 1970 and 1995 in the following countries: Zimbabwe, Kenya, Zambia, Madagascar, Malawi, Mozambique, and Burundi. These are indicators to show that the incidence of poverty is on the increase in most countries of ESA.

Rural vs Urban Poverty

In some countries, particularly among the donors, there has been a shift in concern from rural poverty to urban poverty. This is largely due to the fact that the urban poverty is on the increase as a result of rural urban migration and the structural adjustment have made urban living more difficult for many households. In addition, urban poverty tends to be more visible - with slums, beggars, increased crime and riot. Thus poverty not only constitutes an inefficient use of society's resources but, also causes social and political instability.

However, statistics and surveys throughout Eastern and Southern Africa show that the incidence of poverty is higher in rural areas (see table 3), the absolute number of poor people is also higher, and extreme poverty is concentrated in rural areas. At the regional level well over half of the rural population live below the poverty line. Rural poverty is acute throughout the region and is proving intractable even in the relatively rich countries. In Lesotho 91 percent of the poorest households are found in the rural sector; in Malawi, Zambia and Zimbabwe this figure is 95, 76 and 92 percent respectively (SADC 1996). An estimated 16 million South Africans live in poverty, with its incidence being highest in rural areas and among female headed households. It is estimated that 72 percent of the people live in rural areas, and about 70 percent of the rural people are poor (Ministry of Agriculture and Land Affairs, 1998). Thus one of the major challenges facing ESA countries is the tragedy and persistence of rural poverty which has left the region's population locked in a vicious cycle of human suffering.

All rural poor share some common characteristics (SADC, 1996).

- They confront social, legal and economic barriers that limit their access to more productive farming techniques and block their access to fertile land and natural resources.
- They are often physically isolated from economic infrastructure and markets.
- They are least likely to keep their children in school or benefit regularly from even the most basic of primary health services.
- The very poorest households are headed by women
- The rural poor are most vulnerable to drought and other natural and man-made disasters.

Causes of Poverty

That the causes and effects of poverty are not universal and are not always seen easily. Poverty cannot be effectively addressed unless these causes and effects are distinguished and understood. While the poor themselves must be the principal target for development activities, these same initiatives will carry greater long-term impact if they can begin to address the underlying economic, social and political structures that create and perpetuate poverty. Therefore, improved understanding of who the poor are, and how they became poor is of prime importance if we are to meet their needs through development interventions.

The World Bank Poverty Task Force (World Bank, 1996) identified the following as the main causes of poverty in Sub-Saharan Africa:

- Inadequate access to employment opportunity
- Inadequate physical assets, such as land and capital, and minimal access by the poor to credit even on a small scale.
- Inadequate access to markets, where the poor can sell goods and services
- Low endowment of human capital
- Destruction of natural resources, leading to environmental degradation and reduced productivity
- Inadequate access to assistance for those living at the margin and those victimised by transitory poverty

- Lack of participation: failure to draw the poor into the design of development programmes

The rural poverty is caused by a combination of factors (Whiteside, 1998). These factors include domestic policy mismanagement (urban bias, inappropriate or insufficient investment in rural infrastructure, weak rural institutions, political culture and government) externally imposed constraints arising from subordination to international capital in a global economy (condititionalities, terms of trade, debt repayment), dynamic agrarian change as determined principally by the interaction of population growth and resource base. In some countries war/political unrest and harsh climatic conditions also contribute to rural poverty.

Poverty and the environment are caught in a downward spiral (Human Development Report, 1998). Past resources deepens today's poverty, while today's poverty makes it very hard to care for or restore agricultural resource base to find alternatives to deforestation, to prevent desertification, to control erosion, and to replenish soil nutrients. Poor people are forced to deplete resources to survive: this degradation of environment further impoverishes them. When this reinforcing downward spiral becomes extreme, poor people are either forced to move in increasing numbers to ecologically fragile lands.

The poverty-environmental damage nexus in developing countries must be seen in the context of population growth. Population growth, in relation to limited and often fragile resource base is both a cause and consequence of poverty. The high rate of population growth will offset any reduction in the number of poor in most countries. All the more so, because the rate is higher among the poor than among the non-poor. Survey data from 12 countries in SSA representing 60 percent of the region's population reveal, that for the lowest income quintiles, average household size is about 7.0 with little difference between rural and urban areas, whereas, for the top quintile, average household size is 3.5. in rural areas and 2.8 in urban areas. (World Bank, 1996)

National environmental action plans, now completed for 25 countries in SSA clearly documented the extensive environmental damage in Africa caused by poverty (World Bank, 1996 p6). In many SSA countries the combination of distorted economic policies,

population pressure and low incomes are leading people to cultivate fragile lands in their struggle for survival. As a result, environmental damage is increasing and agricultural productivity is declining. Continued high levels of rural poverty and high rate of population growth will severely affect SSA's fragile and increasingly depleted natural resource base. The nexus of poverty, population and environment is the most important social and economic issue for Africa's future.

Currently, the availability of social services in most sub-Saharan African countries are lowest in the world (World Bank, 1996). Malaria and acquired immune deficiency syndrome (HIV/AIDS) are increasing in many countries. Since most people who die of HIV/AIDS are in their most productive years, the epidemic affects the sustainability of households and the socio-economic prospects of communities. The progress in improving life expectancy over the past three decades is under threat in many countries as HIV/AIDS reduces the expected life span (Human Development Report, 1998). Households headed by children have begun to appear in some African villages, and in an increasing number of communities, the strain is proving too great for the traditional coping systems. Just as poverty fuels the epidemic, the epidemic intensifies poverty.

Most countries in ESA are undergoing economic structural adjustments. Policy reforms in Africa started in the early 1980s with Eastern African states of Kenya and Tanzania and has expanded to majority of the countries to-day. The nature of policy reforms has been rather uniform throughout ESA. SAPs appear to have somewhat ambiguous effects on smallholder farming. The current liberalisation programme in theory should bring improvements to smallholder farmers, however, in reality it is not so simple (Whiteside, 1998; Marquette, 1997).

- The adjustment is extremely painful for some farmers- the poorer and remote smallholders are often least well placed to take advantage of new opportunities, while still feeling the pain.
- Agricultural benefits for smallholders are sometimes swamped by other ramifications in ESA, such as increased school fees, health charges, food costs and reduced off-farm income as household members are retrenched.
- Commercial alternatives to parastatal input and marketing channels be slow to develop, may be monopolistic or may be concentrated in the most

profitable areas. The market oriented environment does not necessarily create sustainable long-term incentives.

Structural adjustment is really an extension of the kind of development thinking that has prevailed since the 1950s - that with enough tinkering at the macro-level, countries can develop. The benefits of development will inevitably 'trickledown' to the poor. This thinking - the whole premises of development planning in the second half of this century - is the real failure of development. A few programmes that has succeeded in targeting the poor - such as subsidies, free education, immunisation and community health services were the first to be sacrificed in the name of structural adjustment. Therefore, structural adjustment, despite its anticipated long-term effect on economic growth, has quickly became recognised as the latest development initiative to have a direct, negative impact on the lives of the poor especially in rural areas.

A number of countries in ESA have anti poverty policies and especially formulated poverty reduction strategies (See Table 2). Recently, Kenya formulated a National Poverty Eradication Plan (NPEP 1999-2015) that provides a national policy and institutional framework for action against poverty in Kenya. In Uganda efforts are being made to redirect public expenditure in favour of social sector development. In Botswana the government has used mineral revenues to invest in human, social and economic infrastructure. In Zimbabwe much attention is being paid to expanding public services to the poor.

The strategies proposed to eliminate rural poverty include; development of alternatives to agriculture (industry, mining, tourism etc); commercialisation of smallholder agriculture, specific actions to address the needs of the poorest smallholders. It is not either or situation and a combination of approaches are required to address poverty. Commercialisation of smallholder agriculture is increasingly a policy objective of governments throughout the region, this may adversely affect poorer smallholder farmers i.e. less resourced households in less favourable environment. Commercialisation in practice usually means the increase in use of purchased inputs, an increased concentration of sales rather than production for consumption. The commercialisation strategy often relies on the implicit assumption that agriculture alone needs to provide a complete household livelihood. In fact for many households,

agriculture complemented by off-farm income can make the difference between abject poverty and an acceptable level of standard of living.

3. THE LINKAGE BETWEEN AGRICULTURAL RESEARCH AND POVERTY

'Since most Africans are farmers, raising the productivity of farmers is a sin qua non of raising the African standard of living.

W. Arthur Lewis (1955).

One of the most serious post-independence errors of judgement by African nations is the lack of political wisdom to give priority to agriculture and rural development. The needed long-term public sector investments into this key sector are still lacking. As a result it is projected that Africa in the year 2000 will be the remaining region in the world where the number of the undernourished will still be on the increase (FAO, 1995). Poverty is the major cause of hunger and malnutrition, and Africa continues to have the highest levels of relative poverty. The number of poor and hungry people in Africa is expected to increase three fold to 300 million by the year 2020. It is also generally agreed that economic growth is the long-term solution to poverty. In this regard, the food, agriculture and natural resources sector in Africa is strategic to the long-term growth and development of the economies. Since the majority of the population in ESA lives in rural areas, (see table 3) and their livelihood is directly or indirectly tied to agriculture it follows, that this sector will continue to be the back-bone of the African economies for decades to come. This sector contributes an estimated 35% of the region's GNP, employees up to 80% of the total labour force and accounts for up to 40% of the total foreign exchange earnings. In countries that are not dominated by mining, agriculture is the largest contributor to total foreign exchange earnings. The stage of transformation and the role of agriculture in ESA countries is summarised in Table 4.

The contribution of agriculture to the economic development in individual countries differ according to the resource base, comparative advantage, institutional capacity, capital resources and the phase of economic transformation process. (Van Rooyen and Sigwele, 1998). Even in countries such as South Africa, where the national income statistics suggest that the sector presently accounts directly for 4-5 percent of the GDP, it has been recognised that agriculture's contribution to the overall economy is much

greater than is suggested by its share in GDP. More than 25 percent of employment in the South African economy is sustained by agriculture; more than 13 percent of the GDP depends on agricultural production; agricultural products accounted for 9.2 percent of South Africa's export earnings in 1994; agriculture accounts for 32 percent of the total inputs used by the food manufacturing sector; food products constitutes 32 percent of private consumption expenditure; and the national economic growth rate is substantially linked to agriculture (Discussion Paper for Green Paper on Agriculture 1998; Ministry of Agriculture and Land Affairs 1998, Spies 1996, Van Rooyen *et, al.,* 1996). Thus agriculture plays a crucial role in the economies of all countries including the middle income countries in ESA. The majority of the people live in rural areas and derive their livelihoods from small scale farming or related activities. Smallholders is estimated to account for about 75 percent of the agricultural production in this region. The economic growth in this region is therefore based on agriculture i.e. agriculturally led growth. Thus smallholder focussed and production-oriented investment in the agricultural sector is crucial in any strategy to address poverty in the region.

There is overwhelming global evidence that general economic growth has to be preceded, or at least accompanied by solid agricultural growth (Timmer, 1998). Typically countries with rapid agricultural growth have also had rapid industrial growth. Agriculture has historically played this central role since the English Agricultural Revolution, which paved the way for the Industrial Revolution. This transformation process still applies today. ESA will not be an exception, neither is it likely that ESA will be able to jump this vital stage of development[7]. The traditional roles of agriculture are essential in overall economic growth and these include: providing adequate and affordable food for increasing populations. The process of industrialisation and urbanisation is more efficient when food is cheaper for the growing industrial labour force; supplying raw materials to growing and diversifying domestic industrial sectors; releasing labour for the growing industrial sector; enlarging the size of the effective market for the products of the domestic industrial sector; providing employment and livelihood as well as alleviating poverty for a large percentage of the rural population; earning and saving foreign exchange through exports; and accumulating domestic savings for investment and capital formation.

Agricultural transformation may be said to occur when a substantial number of rural households for example, have income exceeding poverty level, operate farms commercially by selling a substantial portion of their output, specialise in production at farm level, invest more heavily on farm, purchase commercial inputs including hired labour in significant quantities and adopt new technologies on a regular basis. At this point, a dynamic growth process may be in place with the modernisation of the agriculture sector. Agricultural transformation is therefore the process of converting household oriented subsistence type of structure to a commercial unit.

Timmer (1998) provides a conceptual framework for agricultural and economic transformation, which shows four stages of development. In the first stage, agriculture has been adequately nurtured and starts growing and creating new wealth at a rate that allows direct or indirect taxation and this feeds into other major public assets and infrastructure. In the second stage, agricultural growth becomes a direct contributor to overall economic growth through greater links with the industry, improving efficiency of product and factor markets, and continued mobilisation of rural resources. In the third stage, agriculture is fully integrated in the market economy. Prices of food and the share of food in urban budgets continue to decline. In the fourth stage agriculture is part of an industrial economy. Productivity and efficiency of agriculture is a major issue, and environmental and other concerns assume greater significance. As agriculture goes through these stages, its share in the national accounts figures diminish, and increasingly the population becomes more urbanised. African politicians and policy makers have unfortunately misinterpreted this as a decline in the importance of agriculture. In reality, agriculture is politically alive in industrial economies, even where farmers and rural people represent only 2-3 percent of the population, they still command the attention of governments.

One unfortunate situation in Africa today is the premature movement of large number of rural people into urban areas. This rural to urban migration is unfortunate and premature because most of these people do not have jobs in the urban-industrial sector. Most of them do not possess the life and economic skills to be gainfully employed in the urban centres. As a result, urban decay is on the increase as the over-stretched infrastructure breeds ill-health, crime and social breakdown of family structures. Moreover, the

movement is largely by youth. This drains the rural areas of the young and energetic force that is desperately needed for agricultural development in these areas.

Although, historically debated (Timmer 1988), the emerging consensus tends to suggest, for most African countries agricultural growth as a pre-condition for industrialisation and general economic growth (Townsend, 1997; Van Rooyen *et, al.,* 1996; Ruttan and Hayami, 1990; Cella, 1984; Johnston and Mellor, 1984; Eicher, 1999). Past development efforts have been predicated on the firm belief that strong economic performance was a key pre-requisite for poverty alleviation; that the growth would lead to the creation of employment, increased household incomes and wider availability of goods and services in the market place to meet the basic needs of the masses. Achieving a high rate of sustainable growth is undoubtedly the most important strategy for reducing poverty in ESA. Yet, high aggregate growth in itself will not reduce poverty. The pattern of growth must benefit the poor either directly through increased employment and incomes or indirectly through improved social services. Growth rates of at least 6.5 percent per year are necessary if typical ESA countries are to reduce poverty at an acceptable rate (World Bank, 1996). In the last three decades agricultural production in Eastern and Southern Africa increased significantly in terms of total production. However, the population has generally grown more rapidly than the agricultural production resulting in declining per capita production, declining food intake, and increased dependency on food imports and food relief. In majority of the countries, there has been a decline in average annual growth over the period 1990-95 as compared with the period 1980-1990. Mozambique and Uganda are exceptions where there was increase in growth. The root cause of this poor economic growth were ill-conceived policies which had a serious negative impact on employment opportunities and social development as well as low production in agriculture.

The per capita growth rate of agriculture determines the multiplier effects on other sectors. The empirical studies (Mellor, 1995) show that agricultural growth has a stronger impact on service sector and light manufacturing and construction than it does on what is more traditionally described as manufacturing. The Kenyan case study quoted by Mellor (1995) reinforces the multiplier effect and also shows that if agricultural growth is restricted to particular region, the multiplier will be so restricted as well. The Kenyan experience also makes it clear that the extra ordinarily high population growth

rate that characterised much of Africa can substantially nullify the effect of a high agricultural growth on the overall economic growth.

Growth rate of most African economies is simply not high enough to reduce poverty significantly. World Bank (1996) forecasts that the Growth in GDP in SSA will average 3.8 per cent per year in the next decade implying a per capita growth rate at best of approximately 1.3 per cent per year. In order to alleviate poverty, this growth needs to benefit the poor directly. Emphasising growth in agriculture in remote (poor) regions, or urban slums could improve the extent to which various groups including the poor benefit. In addition, primary social services need to become much more available - especially for the poor. The proposed pattern of growth that favour poor without sacrificing overall growth performance - so called 'win-win' approaches include: (World Bank, 1996)

- Macro-economic policies that achieve stabilisation and provide incentives for employment - creating production for both domestic and export markets
- Sectoral policies that encourage employment of the poor and improve social services
- Rural development, including strategic rural infrastructure, agricultural research and extension, pro-poor public expenditure patterns and investment policies that do not discriminate against labour.

In developing strategies to achieve this pattern of growth a number of strategic and tactical issues must, however, be addressed. They include: the need for cross sectoral approach that takes into account the important linkages and synergies involved: the empowerment of rural communities; improved access to tenured, a better recognition and mainstreaming of the critical role of women; the putting in place of an enabling policy environment; and a more serious commitment to the opportunities offered by regional co-operation and integration (Abalu, 1999). However, it is important to keep in mind that commercialisation and sustainable smallholder agriculture is a key component, but not the only component of ending poverty in Eastern and Southern Africa.

Why research and technology is key to addressing poverty

It has been argued that improving farming methods through technological innovations not only result in more food, but also in more jobs both on-farm, in villages and towns

where new agro-business arise to provide farms with necessary inputs, as well as agro-industries to store, process and market the surplus produced. The poor benefit directly, if they are farmers, and they benefit indirectly from growth in demand for farm labour and for products of the rural non-farm sector. Productive agriculture reduces poverty not only to the extent that it supports rural livelihoods, but also by keeping the food prices low, both for urban households and the many rural households who are net purchasers of food. The reduction in food prices and increases in real rural wages observed in favourable agricultural areas (where irrigation is available and rainfall is good and reliable) suggest that yield gains have played an important role in reducing poverty (Singh, 1990; David and Otsuka, 1994; Datt and Ravillian, 1998); although admittedly the link between yield increases and poverty reduction have not been analysed exhaustively (Heisey and Edmeades, 1999).

It would appear that many countries in Eastern and Southern Africa, are only entering the first stage of transformation (Table 4). Some countries in Asia and Latin America, on the other hand, seem to have entered this first stage where some are in the second and third stages. In the 1950s it could be argued that there was little difference in the level of development among the three regions. Since then, Asia and Latin America have seen yields of staple crops more than double (to about 3 tons/ha in Asia, and about 2.6 in Latin America). In Africa the yield increases of staple crops have been modest at about 1 ton/ha (World Development Report, 1998/9). Despite the impressive experimental results the average yield of maize for the 1995/97 period for ESA is only 1.5 tons per hectare (CIMMYT, 1999). This alone explains the significant difference in overall economic growth between, particularly Asia and Africa. In the fight against poverty, hunger, malnutrition and unemployment, Africa has to get its agriculture moving and focus squarely on productivity and competitiveness with appropriate diversification.

Over the last three decades, productivity increases in agriculture have largely been through increases in cultivated areas and not through yield increases. Productivity increases are therefore needed in terms of increases in yield per unit area, as well as per unit of labour. In addition, the per unit cost of production have to decline. Competitiveness in terms of efficient and effective supply of local and export markets, however, requires additional capacities and competencies. The quality of produce at the production end is key for enhancing the product quality, particularly for niche markets.

The ability to penetrate and maintain market share requires timely access to knowledge and information on markets trends and traits, as well as technology to allow cost-effective production, processing and packaging. All these efforts require the development and adoption of improved technology. Africa, therefore needs, more effective R&D systems in order to meet the twin target of getting its agriculture moving, at the same time integrating the rural with the industrial economy, and thereby accelerating overall economic growth, incomes, employment, and food security.

While developing technologies, one needs to recognise that there is a conscious effort by smallholder producers to maintain subsistence food production (including indigenous crops, varieties and livestock species) along with new commercial production despite higher returns to land and labour from the cash crops (Von Braun*, et.al.,* 1999). This can be largely viewed as an insurance policy of farm households towards risky income environments. The higher transaction costs in food markets and the closer the households are to food insecurity, the stronger the preference for subsistence production. Given the risky economic environments and missing insured markets, maintaining own food supplies can be an economically best bet strategy. Agricultural policy can effectively support it by promoting technological changes in staple (subsistence) foods. Small ruminants and local poultry are important parts of this strategy. Research and extension policies as well as input supplies such as seed and fertiliser for subsistence crops are critical for a viable commercialisation strategy that meets smallholders' demands and will improve both the productivity in staple food as well as in cash crop production.

The employment effects for the poor that result from commercialisation are very crop specific (example cotton and horticultural crops) and are a function of the local labour market and the technologies introduced. Choice of crop and technology, therefore has a major influence on the actual outcome of the employment effects. Programmes and policy design in this field can go a long way to modernise the income benefits for the poor through agricultural development. Commercialisation of agriculture entails a substantial expansion in the demand for hired labour virtually in all rural environments, but particularly so when a high amount of processing is involved. To that extent, that hired labour households rank among the malnourished poor, this employment effect is expected to be of particular benefit.

Perhaps the most important among technologies for the poor are those for agricultural production in ecologically marginal environments. Byerlee (1993) summarised the arguments put forward by many development practitioners to increase the resources allocated to research issues relevant to the marginal environment. These include:

- Returns to research may now be higher in marginal environments than in favoured environments because the incremental productivity for additional resources in the favoured environments is declining;
- A large number of people currently depend on marginal environments for their livelihoods;
- The people who live in the marginal environments are among the poorest, therefore increased research investment is justified on equity grounds; and
- Many marginal environments are characterised by most fragile resource base which require appropriate production technologies that will sustain or improve the quality of resource base over the longer term.

Improvements in much of Asia and Latin America would not have been possible without the green revolutions - the scientific breakthrough that provides the high yielding varieties of rice, wheat and maize. As pointed out earlier, the world average yield of these crops has more than doubled over the past 20 years. But this did not happen in areas of lower rainfall and in the more fragile ecological zones, where people subsist on millet and sorghum and on cattle, sheep and goats. The world average yield of millet and sorghum increased by only 15 percent over the past decades (World Development Report, 1998). A green revolution is needed for these people, among the world's poorest. This revolution needs to aim both at increasing yields and incomes and at preserving and developing the environmental base.

The debate on technology and environment has shown interesting shifts in opinion during recent years. Technology is increasingly being viewed not as a source of environmental problem, but as a potential solution for various sectors of society (Freeman*, et.al.,* 1995; UNEP, 1995). Several innovations substituting practices associated with negative environmental effects are currently being developed or are in the process of adoption (OECD 1994; National Research Council, 1989, 1993). Examples include integrated pest management, intercropping, crop rotation, improved

manure management, more efficient use of fertiliser and pesticides, the regular release of new cultivars with improved resistance to drought and pests, as well as promising expectations from biotechnology (Abler & Shortle, 1996)

In general, in ESA, the average land holding is continuously declining; agricultural lands are being degraded at alarming speed due to urban or infrastructure development. It has been estimated that globally 40 percent of productive land now has diminished capacity to supply to humanity due to direct human impacts on land-use. Water for agricultural purposes is getting scarce almost everywhere, and there are hardly any land reserves to be brought into production to widen the agricultural base. Under these circumstances there is no alternative to increasing and improving production from existing land area. This can only be done through research, which find the best varieties/breeds, which will bring the highest yields at the lowest cost to the environment.

While technology is an acceleration of agricultural growth, effective support services and an enabling policy environment are essential complementary factors. These become critical factors as government support is gradually withdrawn from agricultural research. Farmers need seeds of improved varieties, specially open pollinated ones to reduce cost, finance to acquire inputs and functioning input and product markets. These inturn require a supportive policy and institutional environment.

4. IMPACT OF AGRICULTURAL RESEARCH IN ESA

Impact assessment is a special form of evaluation which measures the intended and unintended changes an intervention or technology can cause in the target population. The welfare changes measured should be a function of the intervention and that cannot be accounted for in other ways. Causality, attribution and incrementality are important considerations in measuring the impact of any technology. Impact assessments can be *ex ante* or *ex-post*.

Since most of the R&D programme produced both production technologies[8] and R&D technologies[9], in a comprehensive analysis both aspects should be included. Three broad categories of impact, form part of a comprehensive assessment. These involve the direct product of research, the intermediate impact as well as the people level impact

(Anandajayasekeram*, et.al.,* 1996). People level impact refers to the broader developmental impact on the target population and society at large. The various components of these impact categories are presented in Figure 1. Not all these components necessarily apply to all projects and are also not of equal importance in the projects where they do apply. Some impacts are difficult to quantify and assign a monetary value. Therefore, in empirical studies often a Multicriteria Analysis is used. The techniques and methods used in a comprehensive impact assessment are summarised in Table 5.

The direct product of research is the actual outcome of the research activity, could involve improved technology, (variety, breed) specialised information or a combination of the two. The direct research product is assessed by means of an effectiveness analysis. This measures the degree to which an intervention attained its objectives by comparing the actual achievement to the intended effects. A project logical framework is a useful starting point for effectiveness analysis.

The economic impact of a R&D programme is measured using what is known as an efficiency analysis where the costs and benefits associated with the programme over a period are systematically compared and are summarised as single measure of the project value, such as Rate of Returns (ROR), or Net Present Value (NPV) or Benefit Cost ratio. Both econometric methods and economic surplus approaches are widely used for this purpose. The choice between using the econometric or surplus approach to efficiency analysis is guided by the study objectives; availability of data and resources, level of aggregation, type of technology, as well as time frame of the analysis. The advantages and disadvantages of these approaches are well documented. (Echeverria, 1990; Anandajayasekeram*, et.al.,* 1996, Horton*, et.al.,* 1993; Marasas, 1999). 'Spill over'[10] effects are important in dealing with regional and international projects.

The intermediate impact or institutional impact refer to the effect of the R&D programme on the capacity of research and extension programmes to generate and disseminate technologies. This could involve organisational models and methods, scientific procedures, interdisciplinary team work and institutional strategies such as programme planning, evaluation, training and networking. Intermediate impact is often assessed by

means of simple comparisons or trend analysis over the relevant periods. This requires baseline information on the relevant indicators as well as careful monitoring.

Socio-cultural impact assesses the effects of research findings on the welfare distribution to various groups in the society. From an economic perspective, these could include equity in terms of income distribution, as well as security objectives such as income risk, self-sufficiency, food security and poverty alleviation. (Alston*, et.al.,* 1995, Eicher, 1990). However, the concept extends beyond economic principles to assess effects on attitude, beliefs, resource use patterns, gender issues nutrition etc. (Anandajayasekeram *, et.al.*, 1996). Methods in use to assess socio-cultural impact vary in their analytical complexity and robustness. Once again monitoring of selected indicators and follow-up surveys are very useful.

The adoption of agricultural technologies have often resulted in external costs and benefits through their effects on the environment. (Abler & Shortle, 1990; National Research Council, 1993). Environmental issues are increasingly emphasised by the growing concern for ecologically sustainable development. The relatively longer time frame over which environmental costs and benefits realise, necessitates predictions of potential scenarios over time. The evaluation should be based on an understanding of the true physical and biological effects of a research programme. This often requires a complex analysis of physical, chemical, biological, social and economic processes. Assessment requires bio-physical data and pose valuation problems. Because of the quantification and valuation problems, qualitative assessments are often used in empirical analyses. This proposed comprehensive assessment framework has been used in several studies in the ESA region. (Marasas, 1999; Wessels, *et.al.,* 1998; Niederwieser*, et.al.*, 1997; Mudhara*, et.al.,* 1995; Chisi*, et.al.,* 1997; Moshi*, et.al.,* 1997; Mazhangara *, et.al.,* 1997; Mudhara*, et.al.,* 1997; Murata*, et.al.,* 1997).

Empirical Studies

A number of impact assessment studies have been completed in the region looking at the impacts of specific technologies as well as R&D programmes. Majority of the studies have been undertaken since 1990. (See Tables 6 &7). Unfortunately most of the studies focused on estimating the Rates of Returns for investments in research and complementary services.

A number of regional studies have been carried out primarily to develop methodologies and procedures to assist with the regional planning and priority setting procedures as well as to assess the people level impact. This is an emerging area requiring considerable attention in the near future. Several studies provided evidence of the impacts of regional programmes (Anandajayasekeram*, et.al.,*, 1994, Ewel, 1992; Sanders, 1994; Evanson, 1987). However, the quantitative comparison of regional versus national activities has not yet received much focus (Oehmke*, et.al.,* 1997). Descriptive analysis argue that regional programmes increase efficiency over national programmes by means of regional synergy, reduced duplication and improved eco system management (Oehmke, et al.,1997). With the decreasing resources available to R&D, regional collaborative networks could be assessed as a means of addressing common priority problems. Spill over effects can substantially increase the total research benefit in appropriate circumstances.

Several country level studies have shown that, where the estimated ROR ranged from 4-100 percent (see tables 6 & 7 for details). Some studies (those using econometric methods) estimated marginal rates of return and others (those using surplus approach) estimated the average rates of returns. These ROR estimates, however, do not include some of the socio-cultural and institutional impacts identified in the previous section. Most of these studies recognise that institution building is a desirable step for effective technology generation, but do not take into consideration the benefit of improved institutional capacity, which occurred during the period of assessment. The costs are included but not the benefits. Only in a few cases, attempts have been made to study the impact of institutional effectiveness (Karanja, 1990; Kupfuma, 1994; Mudhara*, et.al.,*, 1995; Anandajayasekeram*, et.al.,* 1995, Marasas, 1999). In several of these studies, due to data problems, it was difficult to separate the effects of research from the impacts

of extension and support services. Therefore, the ROR was estimated for research as well as complementary services. It should also be noted that the case studies are biased in the sense they are concentrated on those commodities where a reasonable degree of accomplishment was evident or where a considerable amount of resources have been committed. Livestock related studies are limited in number.

Almost all studies measured the productivity gains at farm level and based on these gains and costs (research development cost, research transfer cost and technology adoption cost) estimated the ROR for society's investment. They did not explicitly look at the impact of technologies on poverty alleviation. The studies clearly demonstrate that the society at large is benefited, but the benefits accrued to the various income groups were not analysed. Thus, based on these studies it is difficult to establish any causal effect relationship between agricultural research and poverty alleviation. Some of the technologies focussed on commodities such as cassava, pigeon peas, sweet potatoes, sorghum and millet grown in harsh environments, where many of the rural poor live would have had definite impact on poverty. The positive social impact to R&D through employment creation have also been indicated in two technology specific case studies in the Republic of South Africa (Wessels*, et.al.,* 1997; Niederwieser 1997). The Protea study (Wessels*, et.al.,* 1997) demonstrated that during 1996, the additional employment created through the R&D activities was 858 full time and 309 part time jobs. This number is expected to increase up to 1,006 full time and 457 part time jobs in the Year 2000. Given the labour intensive nature of the fynbos industry, the Protea R&D initiatives for organised cultivation contribute to significant job creation. Simultaneously, since the organised Protea industry has high establishment costs and annual recurrent costs, this will prohibit the small harvesters from entering the organised production. Given the increased competition in the export market, and the demand for better quality products (for the fresh flower market), establishment of organised cultivation may work against the harvesters who have restricted access to land and capital. This will have negative effect on income distribution and may widen the income gap between the harvesters and cultivators. Since the harvesters are the poorest group, the R&D initiative, if appropriate corrective policy action is not taken may have an adverse effect on this group. In the case of Lachenalia, the study concluded that at full capacity, the propagators will employ 260 full time labourers and 624 seasonal labourers annually. If the expanded market potential is considered, then at full capacity the propagators will be

able to employ 440 permanent and 1,054 seasonal labourers annually. This is a significant contribution to the labour market which will have a direct effect on the poor.

It has been observed, for instance, that a combination of appropriate technology, extension, credit and marketing policies have increased yields and production of maize in Kenya, Malawi, Zambia, Zimbabwe and some parts of Tanzania. Positive effects in coffee and horticultural production has also been observed in Kenya; in cotton and tobacco in Tanzania; in cotton and horticultural production in Zimbabwe; and in Irish potatoes in Rwanda and Burundi. In Botswana and to a smaller extent in Namibia, Swaziland and Zimbabwe efforts to improve livestock productivity have shown positive results (Rukuni, 1995). The 1998, estimates of adoption rates (ICRISAT, 1999) reveal that the new sorghum varieties occupy 35 percent of the total sorghum area in Zimbabwe, 30 percent in Zambia and 28 percent in Botswana. New Pearl Millet varieties cover an estimated 39 percent of the pearl millet area in Zimbabwe, 25 percent in Namibia and 20 percent in Zambia. The Mosaic resistant varieties of cassava is also spreading rapidly in the region.

The only other study which looked at the relationship between agricultural productivity and poverty was conducted in KwaZulu-Natal Province in RSA. This study (Townsend, 1997; Kirsten*, et.al.,*., 1996) looked at the relationship between agricultural production and the nutritional status of rural households. Anthropometric indices were used to estimate nutritional status of rural population. The results have demonstrated a positive relationship between improved agricultural productivity and nutritional status of households and children. A 'starter pack' (consisting of 2 kg of hybrid maize, 15kg of fertiliser and a small amount of grain legume seed) programme in Malawi, a targeted effort at the poor resulted in a three hundred thousand tons of surplus maize (Todd Renson, 1999).

Almost all the studies focused on bio-physical research. It is important to note that socio-economic research can also contribute to appropriate policy, institutional and infrastructural changes which may contribute significantly towards alleviating rural poverty. A good example of such work is the policy change with respect to cashew nut industry in Mozambique (SADC, 1996). In Mozambique smallholders account for over 90 percent of cashew production. Most of these producers are poor and close to

poverty. In 1995, there was a tariff of 25% on the export of raw cashew nuts and prior to that there were quantitative restrictions amounting to a near-total export ban. If the tariff is reduced to zero, (during the period 1996-2000), as the government has undertaken to do, the impact on the poor could be considerable. Using conservative assumptions, based on technological improvements and higher prices, Mozambique's foreign exchange revenue could rise by U.S. $230 million in ten years - more than the country's total foreign exchange receipt of U.S. $164 million in 1994.

Some of the major conclusions from these studies are:

- Agricultural technology development and transfer activities have had impacts across a variety of countries, commodities and agro-climatic conditions.
- While there may be grounds for questioning individual study findings, a careful assessment of this body of evidence should not change the main results: the rates of return to both private and public sector R&D are high. The data support the view that such investments are a particularly productive use of research resources. Although, the effects on poverty alleviation is not explicitly addressed, the farm level productivity gains and /or cost reductions reported in the studies have had some effect on food security and rural poverty alleviation.
- Technology investments are essential for agricultural productivity and economic growth, but not sufficient to generate the people level impact.
- *Ex-post* impact studies have limited use in planning and *adhoc* impact assessments can be costly. There is a strong need for research planning and priority setting where *ex-ante* impact assessment can be used as an effective planning tool, as research resources are becoming increasingly scarce. To be cost effective, monitoring, evaluation and impact assessment should be an integral part of research planning and implementation.
- Several factors affect the people level impact of technology development and transfer process. These include:
    - Agro-climate conditions
    - Political instability/civil unrest
    - Research systems performance (enabling environment)
        - appropriate priorities
        - scientific leadership

- favourable incentives
- adequate human and financial resources

- Delivery system - effective extension services, seed and other inputs
- Appropriate policies - credit, input, prices
- Efficient markets

- Institutional innovations could greatly increase the efficiency of investment in agricultural TDT but in the past very little attempts have been made to assess the impacts of institutional innovation.
- Adoption of off-shore technologies can be cost effective and regional research networks can increase the benefits of research investment.
- The literature is very thin on the impact of socio-economic research, although socio-economic research within the agricultural sector could contribute significantly to poverty alleviation.

As noted by Heisey and Edmeads (1991) sweeping pronouncements about poverty and research resource allocation are usually not very helpful. Useful policy information can come only through detailed analyses of specific cases - analysis that can break the impact of different research strategies on different groups of interest, without necessarily assuming that research will single handedly lift many of these groups out of poverty.

A recent study in Zimbabwe (Mutangadura, 1997) looked at Agricultural Research Priority Setting under multiple objectives in Zimbabwe. This study used economic surplus analysis and Multiple Objective Mathematical Programming (MP) to develop optimal research portfolios and illustrate opportunity costs in a situation characterised by multiple objectives, farm types, agroecological zones and levels of funding. Using efficiency as the criteria the study concluded that maize research is the highest priority for large and small scale farmers, research on commodities such as groundnuts, goats and sunflowers and bambara nuts are important for smallholders, but not for large scale farmers. Differences were also evident between low potential and high potential areas. Turning to priorities by discipline area, agronomy is ranked highest for smallholders, followed by plant breeding in both high and low potential areas. Chemistry and soils ranked higher in low potential areas than in high potential areas. For large-scale producers, plant breeding ranked highest in both low and high potential areas; while agronomy ranked second in low potential areas and plant protection ranked second in

high potential areas. Ranking of research disciplines for livestock is similar for smallholder and large scale farmers.

When the overall budget constraint was allowed up to 50% more funding than the current budget and all weight was placed on efficiency, maize, cotton, and groundnuts emerged as top ranked commodities for smallholders, while cotton, dairy, beef and maize are the highest commodities for large scale producers, (see table 8 for further details). When additional weights were placed on the smallholders, the results are similar but communal beef and goats rose on the list and large-scale dairy was dropped. The rankings were similar when the weight on smallholders was increased gradually to even higher levels. One reason for the similarity was because the overall budget constraint was not that tight. When the overall budget constraint is reduced to the current level, and the weight on the smallholders is increased to a very large number, the total efficiency gains (discounted future economic benefits) sacrificed was only about 3%. This 3% efficiency cost of focussing on smallholders is an interesting result because it implies that the Department of Research and Specialist Services (DR&SS) in Zimbabwe can follow its expanded mandate to serve smallholder farming sector without a huge drop in total economic benefits from its research programme. When runs were made in which the total budget was reduced to 30% below the current level, efficiency losses increased to 20% as profitable large-scale activities were forced out.

5. WHY R&D INSTITUTIONS HAVE HAD A LIMITED IMPACT ON DEVELOPMENT

Research and extension systems in Africa are not working as a system, and as a result the research is not as useful as it could be. Extension services are delivering largely stale messages and are unable to forge new business oriented partnerships with farmers. Once again, extension services are hardly accountable to farmers that they serve. Public research and extension personnel will need to have personal stakes in how farmers view their performance. But then the top-down, centre-periphery, linear and sequential view of the scientific process obscures the participation of smallholder farmers (Antholt, 1994). And the north-south flow of funds enables civil servants to avoid the trenches to secure participation of smallholders. The challenge is to increase the level of financing for these farmer services from local sources and develop managerial skills that build the confidence of and expectations of stakeholders and

clients (Hill, Toure and Weatherly, 1995). Agricultural organisations in Africa do not operate as a well integrated system. Research, extension and other institutions need to be adequately decentralised to allow decision making as close to the beneficiaries as possible. This is taking place to an extent in ESA. Extension system has been completely decentralised in Uganda and Tanzania and the research services have been decentralised in Tanzania, Kenya, Zambia and Ethiopia to quote some examples. The process of stakeholder consultations and decentralisation of research and extension has been initiated in Zimbabwe. Second, the institutions have to be effectively inter-linked, have a common vision, and agenda for their farmer clients. Part of the answer to this puzzle should be through an understanding of the agricultural policy which does not empower smallholders to have a voice in the search for opportunities and solutions to their problems, in impact reviews, priority-setting of research programmes, and restructuring institutions to meet their needs. If agricultural institutions are not guided by the needs of the rural majority, then it follows that individual agricultural institutions must have increased incentives to be creative and responsive and to interact and function as a system. Agricultural service organisations have the challenge to examine their operational inter-institutional relationships, and public servants do not appear to have incentives for collaborative action. Farmer organisations representing smallholders are generally unable to institutionalise collective action on special interest bias. The balkanisation of smallholders, with limited capacity for collective action has created a political and institutional vacuum in rural areas of Eastern and Southern Africa.

Institutions in Transition

Since independence African research managers have been forced to grapple simultaneously with five complex transitions which ultimately will influence the productivity and sustainability of NARSs:

- Managerial transition from colonial to local research administrators;
- Scientific transition from expatriate to indigenous scientists;
- Financial transition from dependence on financial support from colonial governments and large scale farms to mobilising support from governments and donors;
- Political transition from commercial farms to smallholders in dual agrarian societies; and

- Transition from public to private research and new forms of public/private research partnerships.

The development economics literature provides little guidance on institutions in transition and how to develop effective smallholder-driven farmer support services, including research. North (1990) stresses the importance of "time" in institution building. Bonnen (1990) underlines the time dimensions by chronicling the U.S. experience in pragmatically piecing together a system of interactive development institutions over a period of sixty years, (1860-1920). The induced innovation literature of technology development utilises a comparative statistics framework where farmers "press the public research systems to develop the new technology and also demand that agricultural firms supply modern technical inputs… and perceptive scientists and science administrators respond…" (Hayami and Ruttan, 1971, p.57). But smallholders in most African countries have historically been politically marginalised; today they are so widely dispersed and unorganised that they are simply not in a position to "press the public research systems. NARS are unable to respond according to the induced innovation model and turn theory into practice. Because of the lack of smallholder participation in the political arena and in research priority setting, foreign aid has provided a short-term substitute for the lack of domestic political and financial support for research.[11] But the project approach to foreign aid has exacerbated the co-ordination of donor assistance. For example in 1996, 180 different agricultural projects in Zambia were being supported by 10 major donors.

Evolution of Agricultural Research in Africa

(a) Colonial Period, 1900-1960

Despite many shortcomings[12] of colonial research models, Africa's colonial experience in general has several valuable insights for addressing the managerial, scientific and financial problems facing NARSs in Africa today.[13] During the colonial period, small commodity research teams with continuity of funding were highly effective in carrying out research on export corps. Also, scarce resources were pooled and co-ordinated through global research networks e.g., the Empire Cotton Growing Corporation), and regional commodity research institutes (e.g., West African Cocoa Research Institute; (Eicher,

1989). Another colonial research innovation was the pursuit of research on agriculture and forestry in the same regional research program in East Africa in the 1960s.[14]

(b) Independence: 1960-1980s

Pardey, Roseboom and Beintema (1997) have documented the major trends in agricultural research in Africa from the beginning of independence in the early sixties to the mid nineties:

The total number of full time equivalent African researchers climbed more than four fold - i.e., from 2,000 in 1960 to 9,000 by 1990. Ten percent of the agricultural researchers in the early 1960s were Africans and 90 percent were expatriates. Vigorous training programs were launched after independence and, by the early 1990s, 90 percent of the scientists were African. The size of most NARS increased dramatically following independence. The number of agricultural scientists increased from 1 in Botswana in 1961 to 54 in 1991. The number of extension workers in SSA increased from 21,000 in 1959 to 57,000 in 1980 (Judd, Boyce and Evenson, 1986). The number of Universities increased from around 20 in 1960 to 160 in 1996 (Beintema, Parday and Roseboom, 1998). Domestic financial support for research increased in the 1960s and early 1970s, peaked in 1981 and declined throughout the eighties and in the nineties. The research spending intensities (Agricultural research spending as a share of agricultural Gross Domestic Product) for the 19 countries in SSA on an average increased throughout the 1960s and much of the 1970s, and then declined steadily from a peak in 1981 of 0.93% down to 0.69 by 1991; below the level of intensity that prevailed two decades earlier. In contrast South Africa's research intensity ratio trended upwards for much of post 1961 period and remained at 2.6% in 1991 (Parday, Roseboom, Beintema, 1997). Foreign aid increased dramatically in the seventies and eighties and slowed in the nineties. The number of research scientists and research budgets per researcher grew in tandem from 1961 to 1981, but real research expenditures stalled after 1981 while the number of researchers continued to increase in the eighties (Pardey, Roseboom and Beintma, 1997, p.413). Donor funding currently accounts for 61 percent of total agricultural research expenditures in francophone countries and 26 percent in anglophone countries (36% if South Africa is excluded).

While African nations have more scientists and greater numbers of African engaged in agricultural research today than in the 1960s, numerous factors have undermined the creation of a scientific culture in NARS and the delivery of useful technology to smallholders. The quality of human capital has been eroded in many NARS because of low salaries and poor incentives (Idachaba, 1991). Most NARS have a modest local constituency and long-term consistent funding is problematic (Howard, 1997; Kumwenda, *et.al.*, 1997).[15]

(c) Post 1980s

In the 1980s most of the research systems in Africa were dominated by donor dependent centralised public sector, perceived to be underfunded and underperforming. Currently there is growing interest in finding alternative models due to:

- Global re appraisal of the role of state. There is a shift towards economic efficiency and market based solutions to resource allocations and service provision.
- Fiscal crisis facing the African states - prospects for increased resources appears to be limited.
- Perceived failure of the African agricultural technology system in spite of the considerable expenditure in Research and Extension.

A distinction is also made between financing and service delivery as two separate components. There is a growing awareness, that while some aspects of R&E presents significant public good attributes, the private good characteristics of much R&E are probably greater than commonly perceived. This calls for a greater public and private sector participation in technology development and transfer. Research in ESA is conducted by public sector, private or commercial sector, civil societies and NGOs. The NGOs and the commercial sectors are increasingly involved in research in the region. In terms of private funding ISNAR estimates a figure of 3% is more likely for most SSA countries. It has been estimated that in Kenya the private sector funding accounts for 15 percent and in Zimbabwe around 30 percent (Beynon, 1998). The quality of NGO research in the region is variable. Occasionally NGO research is being conducted in collaboration with the public sector and IARC, which can result in useful synergy

between NGOs oriented towards poorer smallholders and the public and international institutes technical competencies.

As NARS went through financial hardships and staffing problems in the 1980s, IARCs in ESA played a supportive role and through project funding and capacity building assisted in maintaining some of the research programmes. According to Puetz*, et.al.,* (1992); however CGIAR may not be able to maintain a strategic leadership role it has enjoyed to-date. Within ESA there has been a drastic decline in the presence of IARCs coupled with a decline in donor funds and latent in this decline is more competition between IARCs, RACs, NARS and NGOs for donor funds. The traditional division of responsibility has been to assign strategic research to IARCs and RACs while NARS give priority to adoptive research. Though this division of responsibility appears to be logical, in practice NARS need to have considerable capacity in order to barrow technology intelligently. If NARS have to reform and operate more efficiently it may be that NARS, RACs and IARCs now have to form a new and more effective partnership, and CGIAR in Africa has to develop innovative ways of assisting in the development of location specific technological packages.

Today most NARS in the region are constrained by[16]:

- Recruitment freezes or lack of finance to hire new staff or retain existing staff.
- Budget highly committed to staff salaries and benefits i.e. existing establishment costs.
- Due to budgetary constraints focus on limited short term activities.
- Lack of strong national or rural development policy in favour of resource poor smallholders and sustainability.

Currently there is considerable emphasis on strengthening the public management capacity within the research system i.e. strengthening governance. The three factors underlying the current changes in Governance of Agricultural research are public sector reform, decentralisation and participation and broadening the agricultural research agenda (ISNAR, 1994). The new environment of R&E systems in ESA are characterised by pluralism in service provision, global liberalisation and globalisation, and emergence of a strong civil societies. Under this new environment the expectations of the public sector institutions have changed. The public funded institutions must now

show clearly how they contribute to well-being of the populations and sustainable economic growth. They are expected to reduce cost and demonstrate accountability. This means broader inclusive mode of decision making and increasingly clients and other stakeholders are taking active roles in monitoring and where necessary, changing the way research services are provided.

Under this changed scenario allocation of public funds between different forms of R&E needs to be carefully examined to ensure that the public sector is not unnecessarily funding activities, that the private sector is able and willing to finance, thereby diminishing the availability of public funds for genuine public good activities. The two options considered by most R&E system are: reduce the scope of state financing and commercialise the others through levies, user charges and other revenue generating mechanisms including provision of contract research; improve the cost effectiveness of services that remains in the public sector. These include improving and institutionalising the priority setting techniques to give more efficient allocation of resources among research programmes; making R&E more user oriented and responsive to demand (i.e. more relevant and less wasteful), and improving both the management of existing resources and the efficiency of service delivery.

Although declining funding has forced institutions to consider other options, there is a case for reviewing them at all times in pursuit of greater efficiency and effectiveness of service provision. The scope for levy funding of basic staple food crops is much more limited compared to cash crops. In majority of the ESA countries (other than the mining economies) more than 50 percent of the population depend on agriculture, most are small scale producers who are poor and least empowered. This group have neither the institutional nor the economic power to ensure that their technology needs are met by the public sector. Driven by the market, research may tend to focus on the needs of the few with economic and political power. Well endowed groups are usually best able to form associations and benefit from them; making research more responsive to those more articulate clients, risks making it even further away from other less vocal group; a situation possibly working against the rural poor. In addition lack of government administrative and regulatory capacity, physical infrastructure and social services places further limitations on the viability of market process in many parts of the developing world including ESA countries (ISNAR, 1997).

Despite all these efforts, this review clearly demonstrates that after 40 years of independence, most African leaderships are still not assigning high priority to the first generation problem of getting agriculture moving (Mellor, 1998). There is a dearth of effective farmer organisation and good institutional environment to promote agricultural growth. Knowledge base on how to craft effective demand-driven organisations to help resource poor farmers, traders and owners of micro-enterprises is still seriously lacking (Eicher, 1999). The three core institutions in the agricultural knowledge triangle - Research-Extension and higher education - have been downsized and restructured, and new private institutions are now in stiff competition with their public counterparts. As Eicher puts it the overarching development challenge facing African agricultural professionals and policy makers today is how to help these nations to rediscover their agrarian heritage, bury agropessimism, take charge of foreign aid agenda, and mount a disciplined, long-term effort to develop a modern agriculture. Such a development strategy should adequately address the issues of the rural poor and the environment.

6. ISSUES TO BE ADDRESSED IN DEVELOPING A STRATEGY

The increasing concern with poverty had been generated by the apparent failure of the trickle-down strategy for development. Despite some impressive achievements in aggregate terms, the process of economic growth as it occurred in many developing countries, by passed the poor and even worsened their condition in some cases. Up to half of SSA's endowment of human capital is under utilised because the poor lack the necessary resources such as land and credit to contribute to productions and economic development. Poverty not only constitutes an inefficient use of society's resources especially the human capital, but also causes social and political instability. To alleviate poverty, clearly development policies and strategies in ESA should focus on growth but the distribution of growth must be thoroughly analysed to identify policies and strategies that will do most to increase growth elasticity and reduce poverty. Absolute poverty will not be overcome by *adhoc* projects.

Policymaking and implementation for poverty alleviation is still much more top down. Poor cannot be seen as passive agents in the R&D process. Participant 'ownership' of project has been shown to be the best guarantee that they will succeed and endure.

Successful assistance to small farming households must reflect their aspirations and mobilise the efforts of these same households. Programmes and project instruments must be driven by these households' defined needs, exploiting their material and managerial capabilities. They must address the obstacles to better integration into the market economy and social development. If poverty reduction is to reach the majority of the developing world, poor people must be recognised and must become part of the solution rather than regarded as a problem. The entire system should move away from seeing poverty alleviation as a development outcome and instead make it the principal goal of all development activities. Poverty targeting must become the central pre occupation of all actors in the development community. Poverty alleviation can only take place when the conditions and causes of poverty are the focus of policies, programmes and projects.

Given the multifaceted nature of poverty, a concerted action is needed in order to address the issue of poverty. No single model will necessarily provide the best approach. One needs to keep in mind that agricultural research is only one of many instruments that might be used to achieve distributional objectives including poverty alleviation. Some of the general principles in developing policies, strategies, programmes and project to alleviate poverty may also apply to agricultural research. If goals of poverty alleviation are to be realised then governments, donors, multilateral agencies, NGOs and community based organisations must share a common vision of development that targets poverty, through policies, programmes and projects that meet the needs of the poor and enhance their abilities for self advancement.

Priority should be given to policies, and institutional support which address the needs of the poorest households. Given the diverse and complex nature of their livelihoods, these policies and services must be driven from the bottom up. Poverty alleviation can only take place when the conditions and causes of poverty are the focus of policies, programmes and projects. These must be driven by a commitment to building community based solutions to the problem of poverty, that maximise the utilisation of resources and capabilities resident in the community. Planning and priority setting exercise should explicitly integrate poverty related criteria. Poverty targeting must become the central-pre-occupation of all actors in the development community. The new model of development that stresses poverty targeting will need to be internalised by

all institutions and agencies that make up the development community. All projects and programmes must be evaluated in terms of their contributions to employment, to earned income of absolutely poor households and provision of services to them. It is important to ensure that employment and poor household criteria are operationally accepted as important across the board. In practice, programmes that benefit absolutely poor households will also raise the income and service access to less poor and not so poor ones. That in itself, is highly desirable.

Everyone is convinced that for social, political, economic and humanitarian reasons, poverty alleviation should be a priority objective. That in order to be successful, the initiative and frame setting should be African. In implementing these strategies, outside agencies and national governments should establish, more sensitive, accountable partnership with African ' support groups' 'people organisations' and local governments. Building African capacity (institutional, human and financial) should be the prime purpose and justification for this partnership. The development field has experienced an important paradigm shift towards participatory development, which almost all donors and development agencies, whether government or non governmental organisations are now increasingly embracing. These methods emphasise changes in change agent's behaviour and attitudes. This calls for a new relationship between the various stakeholders and the 'beneficiaries' now become actors. The 'Action' and 'reflection' mode of behaviour keeps research relevant, initiates further research, implements research findings, guides actions and evaluate actions.

While most national governments in ESA have official policies that makes poverty alleviation a priority, those policies have yet to be carried out through effective, targeted programming. The resource commitment is still considered to be inadequate. World Bank lending to agricultural sector which does not completely capture the rural urban allocation of resources accounts for only 13 percent of the value of the Bank's total lending in SSA for the fiscal year 1992-97 (World Bank, 1996). The relatively small proportion of lending for agriculture goes mainly towards increasing the quantity and quality of agricultural services. The World Bank Task Force concluded that even though the banks operational cycle begins correctly with a poverty assessment, the poverty focus is often lost by the time a lending programme is implemented. Poverty reduction is rarely a central theme or motivating theme in business plan or country assistance

strategy (World Bank, 1996). This situation has improved in the recent years. The issue of resource allocation and programme planning need to be revisited to ensure adequate resource are being allocated to pro-poor programmes and projects.

Rural poverty is a predominant phenomenon in ESA even in the most urbanised countries. As discussed earlier smallholder agriculture remains the major source of livelihood for most of the rural poor. Publicly funded agricultural research and extension institutions and programmes need affirmative action in favour of poverty alleviation and sustainability. In addition research should focus on both introduced commodities as well as indigenous enterprises including veld products.

Institutions are central to sustainable and beneficial economic growth. They create the policies, mobilise and manage the resources, and deliver the services which stimulate and sustain development. Growth and prosperity are unlikely to be maintained if the institutions which guide them are dysfunctional. Institutional development concerns the creation of organisational competencies and values that are conducive and facilitate development. And if development is to be accompanied by poverty reduction, those organisational competencies and values must also be attuned to the needs of the poor. Poverty alleviation and service delivery to the smallholders should be internalised within these institutions. These institutions need a broad base of sustainable indigenous political and financial support. The service delivery should be effectively decentralised i.e. with adequate resources and human capacity to serve the needs of the rural poor.

Studies of the rate of return to investment in agricultural research in Africa show mixed but positive returns, ranging from negative for several cases to 135 percent for maize in Mali (Oehmke, *et.al.,* 1997). These studies support the proposition that the payoff to agricultural research in Africa is consistent with the positive returns in Asia and Latin America (Oehmke and Crawford, 1996).[17] But studies of the payoff to research in Africa have generally been of known successes while many failures remain unexamined.[13] Studies of the payoff to research have been useful in providing evidence of success of past investments in research and to make a case for increased resource allocation for research but they do not shed light on four problems:

- What explains the gap between the high payoff to research and the claims that most NARSs and farmer support organisations are not meeting the needs of the majority of smallholders;
- Why do most NARSs lack a broad base of sustainable indigenous political and financial support if the payoffs to research are high; and
- Why are most NARSs not fiscally sustainable:
- What makes some research systems successful and others unsuccessful.

After 40 years of independence in Africa, there are few hard data to show under what circumstances agricultural service institutions (teaching, research and extension institutions) can make the transition from a top down colonial technology development model to being highly responsive to, and answerable to smallholder clients. Research is urgently needed on how incentive structures shape the scientific discovery process, how to build political and financial support for relevant research for smallholders, and how to develop new partnerships between public and private research organisations.

Despite the poor performance of the food and agriculture sector enough success stories exist in most ESA countries to strengthen a case for an intensified smallholder based African green revolution (Rukuni, 1995). Such a revolution is more likely to take place through a comprehensive approach of investing in key prime movers (improved technology, human capital, rural infrastructure, effective institutions and enabling political and economic environment) for agriculture at the national level. For this to occur, agriculture has to be put back on top of the local political agenda and greater commitment must be made to invest in rural areas. In pursuing this strategy ESA countries have to acknowledge two important characteristics. First, no prime mover on its own can get agriculture to grow on a sustainable basis. The second characteristic of all prime movers is that long-term investment is necessary to strengthen them. Selective mechanisation, and smallholder irrigation are two additional areas which require research and investment. Technology development should focus on both production technologies as well as R&D technologies. Research should emphasise both bio-physical and socio-economic research. Regional and international research efforts should be complementary and not substitute for national activities. A clear need exists to:

- Increase agricultural productivity, through applied research, better ways of providing credit, and dissemination of production technologies and information about products and input markets. It is essential to ensure that the improved technologies are adapted for and made available to the poor.
- Explore prospects for fostering small scale agro based industries in rural areas, research shows that such enterprises can expand markets and employment for rural poor.
- Develop a better understanding of household level decision making especially, among poor rural households and integrate these insights into the design and implementation of R&D for rural economy.
- New models and partnerships need to be developed between NARS, RACs, IARCs, for effective service delivery to the smallholder farmers. This should recognise the pluralistic nature of service delivery, decentralised mode of Research and extension, the emerging roles of farmer organisations and civil services and innovations in the field of biotechnology. IARCs in Africa have to develop innovative ways of assisting NARS in the development of location specific, pro poor, technological packages.
- Need to establish M&E systems which could document the impact of R&D activities especially the impact of the agricultural research on poverty alleviation.

In addition calamity programmes need to be on a permanently structured stand by with programmes 'on the shelf' for fast implementation when calamity strikes. Primary social services need to become much more available - especially for the poor and - such services should be priority for public investment.

7. CONCLUSION

Solving poverty problems in low income countries require rapid growth in output, income and employment. Given the importance of agriculture in the national economies in ESA (even in medium income countries with low share of agricultural GDP), agricultural growth is a pre-condition to achieve this much needed economic growth. Better performance of agriculture also tend to be associated with better performance of the rest

of the economy. Smallholder agriculture remains the major source of livelihood for most of the rural poor. It is important to realise that sustainable smallholder agriculture is a key component but not the only component of ending poverty in the different environments in Eastern and Southern Africa. In the long run sustaining agricultural growth depends on cost reducing and yield increasing technologies. Research should explicitly target both 'poor' as well as 'well to do' farmers. Poverty reduction should be explicitly considered as a criteria in research priority setting.

A large number of Impact studies completed in ESA have clearly demonstrated a relatively high payoff for agricultural research, and also shown that in all cases farm level productivity has increased. However, these studies did not explicitly address the impact of agricultural research on poverty alleviation. Anecdotal evidence do suggest that in certain cases productivity gains have reduced the incidence of poverty and technologies have generated additional employment. Employment opportunities outside of agriculture will become increasingly important for reducing rural poverty. Available evidence suggest that agricultural research and technologies are necessary conditions but not sufficient to generate the required growth and to eradicate poverty.

The rural poor despite their vast number, have not constituted a major political force in decision making circles. Effective articulate demand for appropriate research from the poorest farmers is often weak. There is need to build the capacity and empower the smallholder farmers to become an effective force in determining the research agenda. Publicly funded research programmes need affirmative action in favour of poverty alleviation and sustainability. Priority should be given to policies and institutional support which address the needs of the poorest households. Given the diverse and complex nature of their livelihoods, these policies and services must be driven from the bottom up.

In conclusion we believe that a continuous development and transfer of appropriate technologies is vital for addressing rural poverty and broad based economic development in ESA. This paper to an extent has demonstrated that when such technologies are made available, they have impact on the livelihood of resource poor farmers. Several explanations were offered as to why such technologies are not widespread in the region. These include:

- Inadequate understanding of the Nature and causes of rural poverty by research and extension institutions.
- Research and extension institutions do not explicitly address the rural poverty issues in their policies, strategies as well as in research agenda.
- Research and extension institutions are not adequately equipped to address complex poverty related issues.
- The institutional and policy environment is generally not conducive to widespread adoption of these technologies.

If agricultural research is to address the poverty issue effectively, then we believe, that agricultural research institutions should have poverty as the central theme, to guide their agenda. This process should be internalised by institutions as an integral part of their institutional development and transformation. In addition these institutions need to develop the necessary capacity to deal with this complex agenda.

Almost all countries in the region have started these processes of institutional transformation, initially induced by external assistance programme. We also recognise that this process is evolutionary. In the long run, however, it will be the internally driven institutional change that is more likely to mobilise the local commitment and resources for effectively addressing the problem of rural poverty.

Poverty and inequality are issues of global magnitudes and thus cannot be tackled by nations single handedly. Because poverty is a multifaceted problem, poverty alleviation programmes require close co-ordination among donors, national governments, intermediaries and beneficiaries. No single model will necessarily provide the best approach. All stakeholders must share a common vision of development that targets poverty, meet the needs of the poor and enhance their ability to self-advancement. Opening up market opportunities for the poor, enhancing their access to land resources, information, skill development, credit, extension and input supply are all important services that must be supported by development programmes and projects.

ENDNOTES

1. A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain and enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation; and which contribute net benefit to other livelihoods at the local and global levels and in the short and long-term. (Singh 1996)

   Sustainable livelihoods are derived from people's capacities to generate and maintain their means of living, enhance their well being and that of future generations. These capabilities are contingent upon the availability and accessibility of options which are ecological, socio-cultural, economic and political and are predicated on equity, ownership of resources and participatory decision making (Singh 1996)

2. Sustainable agriculture is one which meet to-days livelihood needs, without preventing the needs of neighbours or future generations from being met. This is achieved by the continuous efforts of men, women and children to adopt complex rural livelihoods to a changing environment so as to protect and enhance the stocks of natural, physical, human and social 'capital' available to themselves and to future generations. (Whiteside 1998). Meeting livelihood needs implies agriculture contributing to ending of poverty. Livelihood needs go beyond food security, to include various components required for satisfactory living including costs and also it permits limited substitutions between the forms of capital. The changing environment in this context refers to the physical, economic and social environment.

3. For basic definitions of poverty see UNDP poverty report 1998.

4. Human Poverty Index focuses on the situation and progress of the most deprived people in a community, and gives the percentage of people living in Poverty. Deprivation in economic provisioning is measured by Percentage of people without access to water and health services, Percentage underweight children under five, and Percentage of people living below the income poverty line (50 percent of the median disposable income). The HPI is only given for 78 countries.

5. The most critical facts of human development are the live long and healthy life, to be educated and to enjoy a decent standard of living. These are translated into a Life Expectancy Index, Education Index and Gross Domestic Product Index, which together make the Human Development Index (HDI). HDI is quoted between 1 (excellent) and 0 (not developed). HDI is given for 175 countries (Human Development Report 1998).

6. The real GDP per capita rank minus HDI rank being +ve indicates that, HDI rank is lower than GDP ranking; suggesting that these countries have failed to translate economic prosperity into correspondingly better lives for their people. On the contrary -ve indicates that HDI ranking is higher than GDP ranking, suggest that they have converted economic prosperity to human capabilities very effectively.

7. For a good account of Africa's experience in trying to bypass these stages of development see Eicher 1999.

8. Production technology broadly refers to all methods that farmers, market agents and consumers use to cultivate, harvest, shore, process, handle transport and prepare food crops, cash crops, livestock etc for consumption. Includes bulk product and process innovation.

9. R&D technology refers to organisational strategies and methods used by research and extension programmes in conducting their work including scientific procedures, organisational modes, institutional strategies interdisciplinary team research etc.

10. The applicability of research results over a range of agricultural production conditions, commodities, and environments (even across geographical boundaries) are referred to as 'spill-over effects; also known as 'externalities' or 'multipliers'.

11. For example, USAID has funded 35 endowments ranging from $3 million to $118 million. The majority are in Latin America and the Caribbean (Horkan and Jordan, 1996)

12. The weaknesses of the colonial research system included the following: under investment in training local scientists, lack of smallholder voice in setting research priorities, and lack of attention to research on food crops.

13. For example, in the 1950s, the cotton research station at Namulonge, Uganda had guaranteed funding for five year periods, a large measure of autonomy in administration and a reasonable degree of continuity in staffing (Arnold, 1976, p.13).

14. Instead of setting up separate regional research institutes for agriculture, agroforestry and forestry in East Africa (Kenya, Uganda and Tanzania), the British colonial service established a regional research organisation, East Africa Agriculture and Forestry Research Organisation (EAAFRO) in 1960 and charged it with pursuing research on agriculture and forestry in the same organisation.

15. USAID slashed its global expenditures for NARSs and universities by 73 percent or from $205 million annually in 1984-86 to $56 million in 1994-96 (Alex, 1996, p.13).

16. See Anandajayasekeram and Rukuni for a discussion of issues, policy and institutional challenges confronting the research managers in ESA.

17. Maize is now Africa's most important food crop and it is the food staple in eastern and southern Africa. Recent diffusion studies have documented the rapid spread of improved (hybrid and open pollinated) varieties which are now grown on 40 percent of the maize area in Africa, a figure comparable to that of Asia and Latin America (Blackie, 1994; Byerlee and Eicher, 1997).