

AGRICULTURAL RESEARCH FOR DEVELOPMENT

CURRENT STATUS AND FUTURE PERSPECTIVES

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1. INTRODUCTION

This presentation is prepared at the request of the Ethiopian Economic Association (EEA) for its Vision 2020 series of seminars. I am delighted to give this presentation prepared largely based on my own experience but also based on data and information gathered from various sources relevant to the subject.

Natural resource experts tell us that Ethiopia is endowed with abundant natural resources (land, water and a significant number of major and minor agro-ecological conditions, huge reserve of biodiversity) that have huge potential for agricultural development. It is indicated that at least 60 % of the total area, estimated at about 1.12 million km² (112 million hectares), is suitable for some form of agricultural activities. It is also indicated that some 30 million hectares of land is potentially cultivable, although no more than 10-12 million hectare of this is used for crop production in any one year. Ethiopia's livestock population is varied and consists of cattle, small ruminants, poultry, equines and camels. In fact, Ethiopia's cattle population is supposed to be the largest in Africa. It is also important to mention the large number of lakes and rivers in

the country that have huge potential for the development of various agricultural activities such as irrigation and fisheries. In speaking of natural resources, one needs to mention the potential for forestry and agro-forestry. Needless to say, this natural resource endowment situation may explain why about 84 % of the Ethiopian Population, estimated at about 73.044 million by mid-2005, is rural and agricultural (CSA, 1998). It is also used as one of the main justifications for the Government's strategy of Agriculture Development Led Industrialization (ADLI).

Despite such huge natural and human resource potentials, Ethiopia remains among the poorest countries with annual GDP of less than \$100 (Human Development Report 2005). Poverty is rampant (ca. 44 % of the population) accompanied by serious food insecurity (ca. 42 % of the population) on a sustained basis. Ethiopia's natural resources are in serious decline with lakes and rivers drying out, and forest and land resources depleted at a rate that can't be sustained. Agricultural production and productivity, although showing a slight improvement in recent years is absolutely inadequate to meet the

food, feed and industrial needs of the country. In fact, food insecurity is so chronic that between 5 and 6 million people need food assistance on any average year. Some times the number of such destitute people would increase dramatically as in 2003 when some 13-14 million people required food assistance.

The current as well as the past government regimes in Ethiopia have put strong emphasis in giving agriculture high priority in the development agenda of the country. There are adequate justifications for taking such a position. As indicated above, agriculture is not only the main source of employment but also the main source of livelihood for the overwhelming majority of Ethiopia's population. It produces food and feed for the country's rapidly growing human and animal population, respectively. It plays an important role as a foreign exchange earner. It also saves foreign exchange by providing raw materials for the country's industries in the areas of food, textile and others. Thus, efforts at transforming Ethiopia's agriculture could pay major dividends.

So, what is wrong with this country and its people? It appears quite ridiculous that we are starving in the midst of plenty. We are in an age

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where advanced knowledge on the use of resources, both human and natural, is readily available for use to enhance production and productivity in various sectors. Ethiopia, as member of the international network of communities, could be beneficiary to this flood of knowledge and experience. Obviously, one of these sources of knowledge and experience has to do with agricultural research for generating improved agricultural technologies that play an indispensable role for raising agricultural production and productivity.

Therefore, this presentation is focused on agricultural research for development in this country. The presentation is divided into sections dealing with various aspects of agricultural research in Ethiopia. The first part briefly summarizes the objective of agricultural research in the Ethiopian context followed by a description of the beginning and current status of agricultural research in Ethiopia. In the following two sections, the outputs of and development impacts from agricultural research will be described and analysed. This will be followed by a section focusing on my vision of what can be done to improve the situation and make agricultural research a significant contributor to national development.

2. GENERAL COMMENTS ON THE LINKS BETWEEN RESEARCH AND DEVELOPMENT

There are two key points to note in the title of this presentation, i.e., Agricultural Research for Development. The first point is

"Research" which can be defined as "careful, systematic, patient study and investigation in some field of knowledge undertaken to establish facts or principles" (Webster's New world dictionary). The second point is "Development" which, according to Webster's Dictionary, can be defined as "growth, change in status, etc". Therefore, the title I am given to address could be interpreted to mean at least the following: what is the role of agricultural research in the economic development of the country, in general, and agricultural development, in particular? I should also note that since agriculture is an economic activity, I assume that the word "development" refers to economic development.

Another issue that could be raised with the title of this paper is the link between research and development. It would be noted that the ultimate end of agricultural research is the generation of knowledge and skills in the form of new or improved technologies and practices that can be deployed to raise production and productivity of resources. In the context of agriculture, these resources include human, animal or machinery labor; capital in the form of purchased inputs such seeds, fertilizers, etc and non-purchased inputs such as land and irrigation water; and time inputs where management knowledge and skills are applied. The issue here is "does the availability of generated/adopted technologies and practices constitute sufficient condition for adequate economic development of Ethiopia, or any other country for that matter"?

I am sure this topic has been a subject of discussion in many

quarters, but I wonder whether or not there has been clear consensus on the pros and cons of the issue. But based on the experience of this country over the last half-century since the initiation of agricultural research in Ethiopia, technologies in general and agricultural technologies in particular have not been proved to solve the economic backward status of this country. But then, some could argue that there have not been adequate technological inventions to reach the farming, herding and agro-processing communities in the country. That could be true to some extent, but there can be counter arguments. One could assert, with a degree of confidence, that there have been at least some proven technologies and practices that could make a difference if made available and adopted. This assertion would be substantiated later on in this presentation. For the time being, I would like to focus on Ethiopia's agricultural research as well as on its achievements, impacts and constraints.

3. OBJECTIVES OF AGRICULTURAL RESEARCH

Basically, the general objective of research in the agriculture sector, as is the case in most other socio-economic development sectors, is to acquire knowledge, tools and skills aimed at raising the production and productivity of natural and human resources. However, the specific objective of research varies according to the level or category of research undertaken. Agricultural research can be categorized into the following levels:

- **Basic or fundamental research:** the main objective in this type of research is to acquire knowledge and information without any specific benefits or industrial applications in mind. Traditionally such research is undertaken by higher learning institutions or upstream research centers. This definition may not be exactly accurate in the sense that much of such research is being undertaken in high tech industries that are already engaged in the development of products or processes for pre-determined targets. In the Ethiopian context, such kind of research, particularly as related to the agriculture sector, is very limited.
- **Strategic research:** this type of research is aimed at developing products or processes for a generalized situation rather for a specific set of conditions. Results from such type of research will have to be contextualized by other bodies. Once again, strategic research is carried out by dedicated research or higher learning institutions for the benefit of organizations that have development objectives under their mandate.
- **Applied research:** as the name implies, is more of an applied nature and is better targeted to specific needs. Knowledge, skill and tools resulting from the former two categories of research are converted into useable products that can be transferred to development organizations and/or workers. In the Ethiopian context, it is undertaken by many of the agricultural research institutions, particularly those at federal level and at higher learning institutions.
- **Adaptive research:** outputs from applied research and, sometimes,

from strategic research programs are further developed or refined under a specific set of environmental and production conditions where they will be applied. It needs to be tested at environments for which they are intended to ensure their suitability. Thus, adaptive research must be undertaken particularly by development organizations, farmers/herders or their extension agents before recommendations are made for their release for use.

- **Maintenance research:** this type of research is specific to biological materials such as crop varieties or animal breeds and is undertaken to ensure that released technologies are maintained more or less at their original condition. Improved crop varieties or animal breeds gradually lose their original nature due to genetic or physical mixing. As these materials are developed at high cost, it is prudent and cost saving to lengthen their usable life through continuous maintenance.

I found it important to clarify these points for several important reasons:

- First, research has many levels and is carried out for different objectives, although the end results are useable products or processes for use in the short, medium or long term period. It is also important to note that all research results are not directly and immediately useable and must be converted to a useable form. Even if in some cases where directly useable products and processes are developed, there is still the need to identify the socio-economic and environmental conditions under which it will be cost-effective to use.

- The second reason has to deal with the often heard comment that research scientists spend a lot of public money and time to serve their own interest. The reason for this criticism appears to emanate from the perception that socio-economic development such as food self-sufficiency, for example, does not result within a short period of time. It is important to note that the conversion of research results into socio-economic development goals is generally long-term.
- Third, the actual steps to be taken towards achieving the desired socio-economic goal(s) is not within the mandate of the research services, but rather it is largely determined by government or corporate policy on resource allocations and incentive mechanisms that encourage rapid multiplication and dissemination of research results. The mandate of research services is basically to develop the tools and processes that can be used to accelerate socio-economic development goals. This, of course should not be taken to mean that the research services are free of obligations to ensure that their products are known and popularized through various mechanisms such as field demonstrations, publications, seminars and through the mass media.

3. AGRICULTURAL RESEARCH IN ETHIOPIA

3.1 The Beginning

It should be noted at the outset that Ethiopian farmers and herders have been using agricultural technologies of one sort or another for

generations. These technologies, either locally selected or adopted from foreign introductions, have been developed not through formalized experimental programs as practiced by trained research scientists, but by trial and error by practicing farmers and herders through observations, selections and adaptations. Thus, the land races of various crops, the breeds of various domestic animals, the agricultural tools and implements as well as the management systems associated with crop and animal production in current use by the overwhelming majority of farmers and herders today are a product of many generations of effort. It is impossible to deny the usefulness of these technologies and practices as they have served their purpose very well in the past. In fact, our present day research scientists rely on many of these innovations to develop improved types.

However, current realities as well as future demands works against continued reliance on many of these traditional technologies and management practices. The performance of many of these technologies is very low and is largely aimed for "subsistence" form of agricultural production. The agriculture of today as well of the future needs to meet demands far beyond the capability of subsistence form of production. First and foremost, it must meet the food and feed demands of a rapidly growing human and animal population. It should also compete in a globalized market to supply industrial raw materials to earn or save foreign exchange needed for importing capital goods as well as for other purposes required to fuel the economic development of the

country. Finally, the inadequacy of traditional production practices lead to the degradation of the natural environment such as land, soil, water and forest. This must be stopped to ensure conservation and proper management of the natural environment which is our inherent production base. It is the realization of the inadequacies of subsistence form of agricultural production that formed the basis for transforming Ethiopian agriculture through the generation and application of improved agricultural technologies and practices that could be developed only through formal agricultural research and development (R&D).

Needless to say, the initiation of formal and science-based agricultural research has been very late in coming to Ethiopia, even by African standards. Agricultural research in Ethiopia is known to have started with the establishment of the former College of Agriculture and Mechanical Arts in Alemaya back in 1954, although some simple experimental activities used to be conducted in the agricultural high schools at Ambo and Jimma previous to that date. However, the experimental activities carried out in these higher learning institutions were undertaken by teaching staff and mostly in relation to academic activities. This, of course, should not be taken to mean that the effort of higher learning institutions in research activities is to be underestimated by any means.

However, the real quantum jump in the establishment of formal agricultural research service in Ethiopia was made when the former Institute of Agricultural Research (IAR) was created in February

1966. The IAR functioned in its original mandate and organizational structure until 1997 when it was reorganized and renamed the Ethiopia Agricultural Research organization (EARO). This was and still is the only national institution fully dedicated to agricultural research as its only task.

3.2 Current Status

3.2.1 Institutions

The number of research institutions has increased quite significantly over the last four decades. The main actor in this field has been the Ethiopian Government, although some international agencies have played a role to a certain extent. There are no private agencies fully dedicated to purely agricultural research activities *per se*, although some non-governmental organizations (NGOs) as well as some agencies engaged in agribusiness do get involved in simple adoptive research activities to further their production efforts. In modern lingo, the collection of institutions engaged in agricultural research within a country is known as the national agricultural research system (NARS). The word "system" used in this context must be treated with caution, as it implies units operating in a fully integrated manner. I am sure that those of us in close contact with the so called Ethiopian NARS know that there is still some ways to go before this status is fully achieved. As it stands now, however, EARO is the apex national body both for conducting research but also for coordinating research at various institutions within the Ethiopian NARS.

At the present moment, the national agricultural research system

(NARS) in Ethiopia is made up of the following:

- ◇ **Federal research centers:** there are 13 research centers or research laboratories fully under the management of EARO, while there are two other centers under the mandate of Regional Agricultural Research Institutes (RARIs) but deal with programs directed by EARO. These centers/laboratories are to be found in various regions.
- ◇ **Regional research centers:** There are ten already established research centers under the management of RARIs in the regional states of Oromia, Amara, Tigray, Southern Nations, Nationalities and Peoples' and Gambella. In addition, six new centers are under construction in all these regions except Gambella.
- ◇ **Higher learning institutions:** some types of research are undertaken in all of the universities or colleges where subjects in agricultural science are offered.
- ◇ **International agricultural research centers (IARCs):** currently, six international agricultural research centers (CIAT, CIMMYT, CFOR, ICRAF, ILRI and IWMI), operating under the Consultative Group on International Agricultural Research (CGIAR), have their operating branches in Ethiopia. There is also another international agricultural research center, not under the mandate of the CGIAR, operating in Ethiopia as well.

In terms of national coverage, these centers are located in most of the

important agricultural zones of the country. The main concern in the past has been the inadequate attention given to dryland areas, particularly those in areas of pastoral and agro-pastoral production systems. Although there are some efforts to address these issues, there is still room for further improvement.

3.2.2 Programs

EARO has organized its agricultural research programs under five directorates (Crops, Animals, Soil and Water, Forestry and Dryland Agriculture), and two departments (Socio-economics and Research-Extension, and Special National Research Programs). According to EARO, a total of 56 research programs are handled by these research directorates and departments. Although the naming and organizational set up could differ, the research programs in all the other institutions engaged in agricultural research is quite similar.

- ◇ **Crops research** deals with important crops such as cereals, food legumes, oilseeds, fruits and vegetables, root and tuber crops, fiber and stimulant crops. By far it is the largest in terms of programs and deals with crop improvement, protection and management.
- ◇ **Animal science research** includes programs dealing with animal improvement, protection and management of dairy and draft animals, beef cattle, sheep and goats, poultry, fisheries and honey bees.
- ◇ **Soil and water research** covers areas such as soil resources

characterization, soil fertility and plant nutrition, water management and conservation, irrigation and drainage

- ◇ **Forestry research** engages in research dealing with forest seed science and technology, agro-forestry/farm forestry, natural and plantation forest and forest products utilization.
- ◇ **Dryland agricultural research** covers research programs dealing with rangeland and livestock, camels, dryland rain-fed crops, dryland natural resource management and conservation and dryland forestry.
- ◇ **Socio-economics and research-extension** deals with research in production economics and farming systems, agricultural extension research and technology transfer and agricultural marketing and policy.
- ◇ **Special national programs research** deals with research in agricultural biotechnology, plant protection research, food science and post harvest, essential oils, farm power and machinery and agro-meteorology.

As would be noted from the above, the area of research coverage is quite extensive and deals with conventional research areas as well the newly emerging fields such as biotechnology.

3.2.3 Resources

Resource, in this context, refers to physical, human and financial resources available to the Ethiopian NARS. It is very difficult at this time to obtain a complete picture of the total resources available to all the research programs in the various institutions within the NARS in Ethiopia. Traditionally, EARO gets

the lion's share of the resources available to research in Ethiopia and I assume that this is also the case at the present moment. Therefore, the data and information presented here is strictly limited to EARO. It should also be noted that EARO funds national programs carried out by regional research centers which get the bulk of their research budget from their respective regional states.

◇ **Physical resources:** As mentioned under 3.2.1 above, the EARO operates 13 research centers and research laboratories located in various parts of the country. In addition, six other research centers are under establishment. Some of these older centers (e.g., Bako, Holetta and Werer research centers) have been in existence even long before the former IAR was established. However, these and the more recently established research centers have been rehabilitated on several occasions and the necessary research equipments and other necessities have been purchased through government and other foreign agency funding. Although there is always room for improvement, it can be said that the research centers are in reasonably good shape.

◇ **Human resources:** The total human capital employed by EARO can be categorized into

three groups: research, technical support and administrative support staff. In 2005, the total number of staff in EARO is 2,914 made up of 591 researchers, 1,119 technical support staff and 1,204 administrative support staff. Of the research staff, those with Ph.D. degree, M.Sc. /M.A. degree, DVM and B.SC/B.A degree were 98, 214, 9 and 270, respectively.

The data on human resources available to research at regional levels is not complete. However, the data I could get at this time seems to indicate that there is a sizeable number of staff at least in some of the institutes. For example, currently the research staff in Amara, Oromia, Southern Region and Tigray is reported to be 187, 167, 68 and 53, respectively.

Again, it was not easy for me to get the human resource status of the higher learning institutions known to engage in agricultural research. Needless to say, the number and quality of staff at these institutions could be quite significant. But, we should note that the primary task of this staff is teaching and agricultural research constitutes only a small part of their responsibility. Thus, the number of staff in full time equivalent terms is quite small.

Financial resources: Data and information on research budget is even harder to get from regional and higher learning institutions. However, we have complete data for EARO over the last six years. The research budget of EARO ranged from a low of Birr 167.8 million in 2000/01 to a high of Birr 260.6 million in 2001/02, averaging at about Birr 230.1 million/year over the six year period (see below). The EARO budget comes under two categories, i.e. "capital" and "recurrent" which comprises "operations" and "salary". The capital budget, averaged over the six years under question, was Birr 186.7 million accounting for 81.1 % of the annual budget while the remaining 18.9 % was given as recurrent. Of the recurrent budget, over 65 % was used for salary while the remaining was for operations on a yearly basis. It would also be noted from the Table that the average "Capital" budget exceeded the average "Recurrent" budget by a factor greater than 4. Similarly, the average budget for "Salary" exceeded the average budget for "Operating" by a factor of almost 2. The cause for the high "Capital" budget is the construction and equipping of six new research centers and rehabilitating a number of existing ones.

EARO budget allocations for 2001-2006 (000 Birr)

Year	Capital	Recurrent			Total
		Operating	Salary	Total	
2000/01	135,340.8	11,010.7	21,450.9	32,461.6	167,802.4
2001/02	223,341.9	13,000.0	24,306.4	37,306.3	260,648.2
2002/03	167,479.7	15,451.0	32,163.8	47,614.8	215,094.5
2003/04	250,759.0	15,451.0	32,163.8	47,614.8	298,373.8
2004/05	178,349.5	13,019.7	32,307.4	45,327.1	223,676.7
2005/06	165,050.7	16,931.7	33,203.7	50,135.4	215,186.1
Average	186,721.0	14,140.0	29,266.0	43,410.0	230,130.3

Source: Unpublished EARO data

The sources of funds for research in Ethiopia have been and continue to be government treasury, loans from financial institutions and Grants from various sources. In terms of proportion, the government's share of the average annual budget accounted for about 41.41 % while that from loan was 58.45 % (see Table below). As can be surmised from these figures, the grant part is extremely low. It should also be noted that the "loan" should also be considered as public money since, at least in principle; the Ethiopian public will have to repay it at some time in the future. This, in effect, means that government covers almost all of the research expenses in the country.

Average level of funding by source for EARO (2001-2006)

Source	Birr	%
Treasury	95,302,127	41.41
Loans	134,500,063	58.45
Grants	92,585	0.14
Total	229,894,775	100.00

Source: Unpublished EARO data

4. AGRICULTURAL RESEARCH OUTPUTS/ACHIEVEMENTS TO DATE

As indicated earlier, the main objective of agricultural research is the development of new technologies and practices/processes that can be used to improve agricultural production and productivity. These improved technologies and practices/processes, if used appropriately and within an acceptable time-span, would result in increased agricultural output that directly or indirectly contributes to the national economy. Improved

national economic status could be beneficial in reducing poverty and improved food security through greater employment opportunities and improved incomes, health and other social necessities.

However, leaving the issues related to its contribution to the national economy for the moment; let us first focus on what have been the outputs or achievements from a half-century of agricultural research in Ethiopia. As may be appreciated, data and information is rapidly changeable. This problem is further aggravated by lack of timely information from the various institutions included in the Ethiopian NARS. Therefore, I will briefly summarize what is available to me at this point. Once again, I would have to rely on recent documents from EARO. To a certain extent, this is justified mainly because most of the research activities are undertaken by EARO which, thanks to the 1997 reorganization, has put many of the research centers/laboratories that were previously under the Alemaya University and the Ministry of agriculture and Rural Development within EARO's mandate. Therefore, a recent unpublished document by EARO indicates the following outputs from the NARS:

◇ In the areas of crops research, about 400 new or improved varieties of 29 different crops have been released for use by farming communities in various parts of the country. The crops include many of the cereal crops like wheat, maize and teff; food legumes and oilseeds as well as the important foreign exchange earner coffee.

- ◇ 17 technologies specifically targeted to dryland areas have been identified and recommended for use.
- ◇ In soil and water management, 18 technology packages have been formulated and released.
- ◇ 86 packages of technologies and farm practices related to livestock production have been recommended. These include improved animal breeds for dairy and meat production and poultry for egg and meat production, animal feeds and feeding practices, etc.
- ◇ Various improved species and their management systems have been identified and recommended in areas of forestry and agro-forestry.
- ◇ In the areas of agricultural mechanization, the aim was to test and develop improved farm tools and implements suitable for small-scale farmers. Thus, improved animal drawn plows, row planters, weeders, tie-ridgers and maize shellers have been tested and recommended.
- ◇ Findings and knowledge in the areas of farm management and production economics, package testing, farming systems research, agro-ecology characterization, on-farm trials and agricultural surveys, adoption and impact of technology development and transfer and agricultural marketing have been registered.

The important point to raise here is whether or not these so called improved technologies and management practices have better performance than the traditional ones. Obviously, the answer varies depending upon local circumstances. It should be noted

that, for example, crop related technologies are released for a specific set of production conditions, be it the amount and frequency of rainfall, the length of the growing period, and the land and soil characteristics such as soil fertility. Similarly, animal production is characterized by a set of production conditions such as disease and parasite prevalence, feed quality and availability, management systems, etc. It would, therefore, be important to note that, except for very few cases, improved technologies must be used at recommended levels and in environments for which they are recommended. Unfortunately, this is rarely the case in the country and thus complaints about their poor performance arise quite frequently.

Technology development is carried out in well managed experiment stations and by highly trained staff. But, such technologies will have to be tested under real or simulated production conditions before they are recommended for release. This takes time and resources. So, research workers have learned through hard experience that more effort is need in testing their technologies outside of the experiment stations by working directly with farmers and herders. This has come to be known as on-farm trials.

I am sure many of you would have heard about the Participatory Demonstration Extension and Training System (PADETS) that is being implemented by the national extension service at regional state levels since the mid-1900. This was spearheaded by the Saskawa Global 2000 program which was also found useful in several African countries

such as Ghana and Tanzania. The pilot scale operations initiated by SG2000 was taken over by the government and expanded to cover over four million farmers by the end of 2005. Field results from these demonstrations show that improved technology ("package") application under appropriate conditions could raise yields of selected field crops by two to three times over the traditional technologies and practices ("Farmers") used by farmers (see Table below). For example, over a six-year period from 1996-2001, the improved packages of maize and wheat gave mean yields of 47 and 28 quintals per hectare, whereas the traditional practices yielded 16 and 11 quintals per hectare, respectively.

Performance of improved technology packages of crops

(Yields in kg/ha)

Year	Maize		Wheat	
	Package	Farmers'	Package	Farmers'
1995/96	36.8	11.8	29.0	9.3
1996/97	51.7	17.6	25.9	10.6
1997/98	42.0	16.5	35.0	10.4
1998/99	51.8	15.5	24.6	10.8
1999/00	57.6	17.6	29.9	12.2
2001/02	40.5	16.5	25.5	12.0
Mean	46.7	15.9	28.3	10.9

Source: SG2000

Similar impressive results are registered from research in animal production. Reports from the Debre Zeit Agricultural Research Center, for example, indicate that improved dairy cattle (Friesian X local breeds) could give a milk yield of over 2,000 liters during a lactation period of some 300 or so days. In comparison, local breeds could give

a milk yield of 200 to 300 liters over a much shorter milking period. The center has developed poultry breeds with higher egg and meat production characteristics than the local breeds.

5. TECHNOLOGY ADOPTION AND DEVELOPMENT IMPACTS

5.1 General Comments

Although the above results could be considered significant, one has to judge whether or not the research effort to date has been cost-effective. Unfortunately, it is not possible to draw such conclusion at the present moment, as there are no comprehensive studies undertaken on the subject. I take expenditures on agricultural research as an investment on the development of agriculture as a business endeavor. Naturally, I would expect an investor to be greatly interested in knowing whether or nor his/her investment is productive. And, therefore, I would expect close monitoring of gains and losses to ensure that technologies are properly used in a timely fashion to ensure maximum efficiency. However, the public investors in Ethiopia's research efforts seem to have different ideas. It seems that research is seen as a public service rather than as a way of maximizing returns from investment in technologies.

5.2 Technology Adoption

Sustainable impacts from agricultural research could be expected when the technologies and practices resulting from such efforts

are adopted by intended beneficiaries. Therefore, technology adoption is the key factor in obtaining benefits from research. The limited information available to date clearly indicates that the great majority of the technologies, practices and survey results generated so far have not been adopted. For example, of the 300 or so crop varieties released by the Ethiopian NARS to date, only 56 varieties are under "certified" seed production by the Ethiopian Seed Enterprise. According to agricultural sample surveys by the Central Statistics Authority, improved seeds, chemical fertilizers and pesticides were applied on about 3 %, 39 % and 8 % of the cropped area (ca. 9 million hectares) during the 2000/01 cropping season. The same source also indicates that improved dairy cattle and sheep represent less than 1 % of the cattle and sheep population in the country.

There have been a number of technology adoption studies on various crops in many parts of Africa, including Ethiopia. The studies in Ethiopia have been summarized and indicate that technology adoption could range from very low to very high depending upon the characteristics of the technology, the profile of the users and the degree of incentives and infrastructure available in the community. For example, a technology adoption study carried out in 1989 in Bako area indicated that some 67 % of the surveyed farmers have adopted improved maize varieties, 64 % have adopted raw planting and 60 % have adopted chemical fertilizers. A similar study undertaken on maize in Sidama area in 1991 showed a much lower rate of adoption, particularly in lowland

areas where rainfall was very reliable. There are similar studies on other crop varieties as well as on the use of other inputs such seeds and fertilizers. The point here is that technology adoption by small-scale farmers in Ethiopia is very low and varies greatly from area to area and from season to season. A good case in point is the sale of improved seeds by the ESE. In some years, sale of seeds improved varieties could go as high as 90 % and in other years goes to below 30 % of the enterprise's annual seed production.

Experiences in the country, as in other less developed countries of the world, clearly show that particularly small-scale farmers/herders are very reluctant to adopt new technologies in the absence of motivating factors. In fact, the major adopters are commercial farmers who have the knowledge and capital that enable them to take risks, imagined or real, associated with new technologies and management systems. In support of this fact, many of you in this hall may remember the former "integrated" rural development projects such CADU, WADU and SORADEP that spearheaded technology adoption in Arsi, Woliata and Sidama areas, respectively. Also, the large private commercial farmers that were later replaced by state farms were ardent technology adopters.

A recent unpublished paper presented at the 50th Anniversary of the Alemaya University talks of some success stories of the research effort. It mentions the improved varieties of crops as well as the improved animal breeds that led to the success. CADU, WADU and

SORADEP used these technologies to raise agricultural production and productivity under small-scale farming conditions. The success of these rural development projects, albeit in very limited rural areas, can be attributed to the strategies they used to encourage technology adoption. As their name implies, they integrated the provision of various technological inputs such seeds and chemical fertilizers, the application of an effective technology transfer systems including training, the development of infrastructure such roads and storage facilities, guaranteed market outlets and remunerative prices. However, their success lasted only so long as the project was alive. Although there are traces of their efforts in these areas today, their effort was not sustained with the passage of time.

Several private commercial farmers invested in modern machinery and implements as well as in other improved inputs to transform their agricultural practices with very discernable outcomes. However, the Derg Regime killed their initiative. They were replaced by the state farms that continued to use these improved production approaches. However, they were not as successful as the private producers. As a member of the state farm labor force for a number of years, I can enumerate reasons that contributed to its ineffectiveness. In general terms, their problems mainly rest with the political objectives of the state as well with the management system adopted. In hind sight, I can conclude that the state farms were envisioned by the state as a social service rather than as business enterprises.

5.3 Developmental Impacts from Agricultural Research

Despite the availability of improved technologies, Ethiopia's agriculture remains backward and very unproductive. So much so, in fact, that the country is unable to produce enough food and feed to meet the needs of its human and animal population. There is also the issue of producing enough agricultural raw materials to meet the demands of some agro-industries as well as increasing the quantity and quality of products for export markets. So, one could ask has agricultural research resulted in increased production and productivity at national level? As indicated above, improved production and productivity have been registered in selected localities, but this has very little impact at production and productivity at national level.

Crop production sample survey by the CSA over a 14-year period (1990/91-2003/04) shows that cropped area has almost doubled from a low of 5.3 million hectares in 1990/91 to a high of 9.4 million hectares in 2000/01 (see Table below). By the same token, crop production has grown from a low of 73 million quintals in 1990/91 to a high of 117 quintals in 2003/04. However, crop yield has only ranged from a low of 9 q/ha to a high of 14 q/ha... This clearly means that, taken at national level and across all food grain crops such as cereals, food legumes and oilseeds, the increase in production is almost accounted for by increase in cropped area. The conclusion here is clear, i.e. all the efforts in developing improved technologies through expensive agricultural research have not materially improved crop productivity at national level. I am aware that this is a harsh conclusion, but it appears

to be true. Worse still, the production per capita, although showing some improvement, is still far below what is required to meet the average food consumption needs of the population.

Area, production and yield of field crops over a ten-year period

Year	Area (mill. ha)	Production (mill. q)	Yield (q/ha)
1990/91	5.3	7.3	14.0
1995/96	7.7	10.2	13.0
1996/97	8.9	10.6	12.0
1997/98	7.5	9.8	13.0
1998/99	8.0	8.6	11.0
1999/00	8.2	9.3	11.0
2000/01	9.4	10.6	11.0
2001/02	7.8	9.9	13.0
2002/03	7.9	7.3	9.0
2003/04	8.5	11.7	14.0

Source: CSA for indicated years

6. VISION FOR THE FUTURE

The government acknowledges that Ethiopia's economic performance is firmly linked with the performance of the agriculture sector. I suppose this is also the view of development economists, both national and international. Many years of agricultural production and productivity data from CSA and other sources (FAO, WFP and The World bank) clearly show that agricultural production and productivity is not only low but also highly unstable. The instability is associated with a number of natural and man-made factors such as the vagaries of weather and social unrest, respectively. Although there has been some significant improvement in agricultural production (not agricultural productivity though) in recent years, whatever gains are made in agricultural production is

completely wiped out by the rapidly growing population, thus production per capita today is measurably below what it was two decades ago. It seems we are fighting a losing battle. So, what does the future hold for this country and its people in terms of further enhancing agricultural production and productivity?

Although things have not been rosy for us in the past, I believe that this unhappy status is not God ordained, but rather man made. I believe we have the potential to do better, but only if we adopt a more objective or target-oriented approach. As our approach to transform Ethiopia's agriculture has proven unsuccessful so far, it is important that we try something different. In this context, it is instructive to briefly mention the path followed by some South-Asian countries to transform their agriculture. Most of us here have heard of the Green Revolution that helped many of these countries to attain higher agricultural production and productivity. I believe there were three components to the realization of GR: improved crop varieties and their respective management systems, rapid development and deployment of cheap irrigation system and, most importantly, greater government commitment to use improved agricultural technologies. The improved varieties such as wheat and maize from IARCs (mostly from CIMMYT) were introduced to Ethiopia at about the same time as in India, for example. While India got up and running we stagnated. I would like each one of you in this hall to ponder this phenomenon and come up with your own conclusions.

As has been repeatedly emphasized during the course of this presentation, one of the main causes for lack or reduced impact of agricultural research on Ethiopia's economic development, in general, and agricultural development, in particular, is quite clearly associated with the inadequate adoption and utilization of improved agricultural technologies. So, the issue boils down to the question of why adoption is lacking or so low. It is, therefore, necessary that we must do better to encourage increased adoption and utilization of improved agricultural technologies, at least in areas where they are shown to work, if we want to transform agriculture into an efficient and effective production system. This assertion holds that the contribution of agricultural research to national economic development will be considered worthwhile as well as cost-effective if only its outputs are used as rapidly and as widely as possible.

The adoption studies mentioned above indicate a number of problems that constrain the adoption of improved technologies. It would seem that these constraints need to be removed if we wish to guarantee our future in terms of increased agricultural production that is, and has been, the back bone of the national economy. I must, of course, say that a lot has been done in these areas over the past several years but there is still a lot more to be done, especially in view of the dire situation we are in at the present moment. We should remember that it is almost 40 years since a fully dedicated research service, i.e. the former IAR, was established and we should have been in a better position by now, especially in

relation to system organization, human resource development and research program prioritization.

Based on above observations and assessments, I believe that we can visualize the future in terms of what we can do to improve the contribution of agricultural research to national socio-economic development. Such vision of the future can be encapsulated in terms of action plans that can facilitate future growth. Therefore, my vision for the future are summarized as follows:

◇ **The capacity of the Ethiopian NARS will be improved**

In the discussions so far, it is possible that I have given the impression that there is enough supply of improved agricultural technologies made available to user communities, i.e., farmers, herders, agro-industry and traders (exporters). If this is the case, this has to be corrected. All of us know that we have only a limited supply of technologies. The NARS today deal only with a limited number of commodities that target only a limited number of agricultural production systems (agro-ecologies). Our research system need to be strengthened to do more, among other things, on horticultural crops including spices, root and tuber crops; more productive animal breeds as well as their management and protection (health) systems; farm mechanization; post-harvest commodity management including storage; processing and packaging; irrigation water development; and management, market and pricing policy. Research will have to more

aggressively target dryland areas particularly pastoral and agro-pastoral systems. This, in effect, means that our supply of improved technologies has still a long way to go to meet the needs of all beneficiaries.

What are the implications of these demands on the Ethiopian NARS? There is a lot to be done, particularly in the following areas:

- strengthen existing research facilities and build new ones in agricultural production areas that have not been adequately covered so far
- increase human resources both in quantity and quality
- introduce better systems to identify and prioritize research areas and programs
- create better organization set up and coordination mechanism among the Ethiopian NARS
- improve research funding not only in quantity but also in its timely availability.

◇ **The supply of improved technologies will be enhanced**

The generation of improved agricultural technologies is only part of the problem associated with low agricultural technology adoption. One of the other constraining problems is associated with the timely delivery of such technologies in adequate quantity and quality. There is no question that the national improved agricultural inputs supply system is wholly inadequate to meet the demands of the agricultural community. This includes the multiplication of seeds and planting materials, the supply

of chemical fertilizers as well as pest control products, the supply of improved animal breeds, the supply of improved farm tools and implements, the supply of improved bee hives, etc.

Currently, the multiplication and supply of these technologies is mostly handled by agencies that are under the government in some form of organizational arrangements. Private sector participation in these areas is quite limited indeed. The causes for this weak private involvement are varied and include government policy constraints, lack of awareness and/or interest in such ventures, lack of capacity in terms of skills and/or resources, lack of encouragement particularly in terms of incentives and risk coverage, etc. Government involvement in certain inputs supply situation may be necessary since such venture may not be attractive to the profit-motivated private sector. But, there is a strong need for the government to encourage private initiative and investment if we wish to transform the sector. I am aware that there are some steps taken towards such encouragement, but the fact remains that the level of private participation in these areas is low. This obviously means that there are still constraints that need to be addressed.

◇ **The capability and demand of beneficiary communities will be strengthened**

The inadequate level of technology adoption by user

communities could be partly accounted for by the low capability of the small-scale farming and herding communities that make up the majority of agricultural producers in the country. Such capability can take the form of small and highly fragmented land holdings, lack or limited farming resources such as plow oxen and farm tools/implements, inadequate cash to procure required agricultural inputs, shortage of labor particularly during peak seasons, etc. These constraints are aggravated by mismanagement of natural resources such as forest and grazing lands leading to its sever degradation that further lowers land and other resource productivity. These limitations need to be reversed through at least the following steps:

- resolving the land holding issues to ensure tenure security and economic size.
- formulating and enforcing land use laws and regulations that facilitate appropriate land use.
- formulating and implementing more conducive credit availability, including outright grant or subsidy to needy farming/herding communities. This is particularly relevant in relation to minimizing environment degradation as well as the procurement of needed inputs such as chemical fertilizers that are getting more expensive yearly. For example, the cost of 100 kg of DAP and Urea fertilizers was around Birr 320 and Birr 280 in the last cropping season, which can

be considered very high and forces farmers not to use or use less amount of these yield enhancing inputs, especially under conditions where rainfall conditions are unreliable.

- restarting the earlier farm mechanization scheme so that some of the machinery and labor constraints, particularly during peak farming seasons, can be minimized.

◇ **The awareness level and risk taking capacity of beneficiary communities will improve**

Although difficult to appreciate, the awareness level of farmers/herders to the availability and benefit of improved agricultural technologies is quite low. The availability and benefit of improved agricultural technologies is made known to beneficiary communities through various means including direct contact by field Development Agents (DAs), field demonstrations and regular training and through the mass media. Nowadays, the establishment of a large number farmer training centers and improving the farmer to DA ratio should go a long way to directly contact and influence the farming communities. As mentioned elsewhere above, it is reported that the PADETS program alone has reached over four million farming households. To this must be added the effort of a large number of NGOs and agricultural training schools and colleges.

Despite this, however, the increase in technology adoption is such that it has not

significantly raised agricultural production and productivity at national level. Obviously, there are constraints that still need to be addressed. First of all, it should be appreciated that the current effort has reached only a small segment of the agricultural communities. Secondly, even those that are made aware have still reservations on full acceptance of the recommended technology packages. For example, they apply less than the recommended amount of improved seeds and/or chemical fertilizers. This could be due to lack of cash or credit for procurement of improved inputs. It also seems that another cause could be the need to avert risks associated with crop failures due to weather or other factors. This last point deserves greater attention by the government and requires the introduction of mechanisms that protects farmers/herders from such risks.

◇ **The national infrastructure and market set up will be further developed and improved**

Needless to say, agricultural producers will be willing to invest in improved technologies if they are confident that their products will have markets and remunerative prices. At the moment, though, the most reliable markets offering reasonable prices for their goods are in urban areas where only 16 % of the country's population resides. Because of poor urban-rural linkages, most small-scale producers are "forced" to continue the age-old subsistence form of production,

mainly producing enough to meet their household needs. The major cause for this isolation of rural communities is the poor development of the country's infrastructure related to roads, transport and market information. Although the road and transportation networks in the country are improving, their current status is far from meeting requirements.

◇ **Greater linkage and cooperation among researchers, farmers and users will be encouraged**

When the former College of Agriculture and Mechanical Arts was established at Alemaya through the support and collaboration of the Oklahoma State University, its mandate included education, research and extension in agriculture. This arrangement is depicted as a three-edged triangle, each angle representing one of the three functions. Therefore, the College was considered as a centre for developing trained human resources, which could be used, among other things, to generate agricultural technologies which, in turn, would be transferred to users through its extension program. Thus, education, research and extension were systematically linked.

Unfortunately, this holistic arrangement was shattered in the 1960s when research was transferred to the former IAR operating under a board of directors and extension was transferred to the former Ministry of Agriculture. This separation has persisted even at

the present moment and has been the cause of lot of misunderstanding and frustration on all sides. To be sure there have been efforts to forge improved linkage and coordination mechanisms among the three functions, but success is limited, if any.

To further complicate matters, the emerging agri-business community is quite a world on its own, thus using agricultural raw materials mostly imported from abroad at prices higher than can be produced at home. Good examples of this can be seen in the case of flour mills that import wheat (both bread and durum types), the only winery in Ethiopia importing resins from abroad, and the only malt factory that, until recently, imported most of its raw barley from abroad. All these agricultural raw materials can be produced in the country in sufficient quality and quantity if a stronger linkage and collaboration could be forged among research services, producing farmers and agro-industries. Fortunately, awareness is now developing resulting in the desire for collaboration, even if in a limited scale. Thanks to the efforts of some of the research service managers and experts, there is a bright picture that may grow into a useful collaboration. This has to be encouraged and the government needs to back this effort through appropriate policies and financial incentives.

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INDUSTRIAL RESEARCH AND DEVELOPMENT

ETHIOPIA IN THE YEAR 2020

Asrat Bulbula*

Translated by: Yonas Admassu

I would like to begin by extending my hearty thanks to the Executive Committee of the Ethiopian Economic Association for having given me this opportunity to express my views and opinions on Industrial Research and Development in Ethiopia.

1. Introduction

In addressing the issue of industrial research and development, we need, first of all, to arrive at a common understanding of the concepts and terms involved. As commonly understood and used, the term 'industry' is applied or refers to the manufacturing sector of a given economy. However, the discipline requires that we also consider, as part of our broader definition, other sectors outside of the manufacturing proper sector¹ that have an important interconnection with it, either as beneficiaries of the sector or as suppliers of inputs to it. They also play a crucial role in the sector's development. Consequently, when we talk about industrial research and development in their interconnection, we need to adopt a broader definition that does not limit itself to the manufacturing sector alone.

¹The Ethiopian Industrial Development Strategy, 1994 E.C (2002).

'Research' refers to the conducting of careful studies or investigations to arrive at new facts or information. "Research is a legacy of the scientific method." It means the development of a culture or *modus operandi*, which entails the mapping out of strategies for identifying problems, scrutinizing the problems, exploring alternatives for solving or mitigating the problems, selecting those problems that can be solved within the limits of the financial resources, time and capacity available to us and lying down strategies for their implementation, and finally implementing them on the basis of the strategies so designed. Our notion of industrial research and development is seen from this perspective. And in the context of our country, selection of the appropriate technology and the attending technological transition is properly seen as part of the research project.

While the presentation has within its purview the industrial sector as a whole, central to our concern in this particular instance is the manufacturing sector.

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1. By way of introduction: Situation of the manufacturing industry in Ethiopia;
2. Profile of industrial research and development;
3. Vision 2020.

2. The situation of Manufacturing Industry in Ethiopia

- It is estimated that the population of Ethiopia, currently standing at 80 million, will reach 140 - million mark by the year 2020.
- In each of these years, no less than 2 million Ethiopians are expected to be brought into the world; even if we were to put down the figure for the existing jobless at zero, this would mean that the number of people in need of jobs in each of the years ahead is going to be close to 2 million;
- Half of the world's current population (3 billion) has a daily per capita income of less than USD 2.00; 1.2 billion earns less than USD 1.00. When we come to Ethiopia this figure is less than 30 cents ($\frac{1}{3}$ USD),²
- By any criterion or indicator, the gap between the industrially developed countries and the Third World, rather than

²The per capita daily income of USD 1.00 is taken as indicator of absolute poverty.

narrowing, is on an ever-widening course.³ In this situation, the survival of many countries, particularly the Third World, is at the mercy of the developed and prosperous countries. It is in the context of the existence of such shocking figures that we are forced to look the stark reality of our own situation in the face;

- One will not be that far from the truth to suggest exploring the state of the manufacturing industry in Ethiopia beginning with the Italian invasion and occupation of the country in 1935-41. What existed prior to the said period by way of the manufacturing business was limited to production of traditional materials carried out in isolation either at the individual or household level that was even less in scope than the cottage industry. We are thinking here of the production of such materials as plowshares, spears, cutlery, cloth, hides, parchment and writing ink, pottery, etc. After the end of the Italian occupation, the country's manufacturing sector was export-oriented, with the establishment of big industries in focus.⁴ As of the 1950s, the country's industrial development plan had as one of its core aims was the encouragement of foreign investment. Some of the incentives in this direction included allowing investors a 5- to 10-year tax relief [or, tax break]; a low level of tax on inputs; and very dependable low-

interest loan services provided by banks.

- In the 1960s Ethiopia's industrial development was oriented, in accordance with the United Nations 10-Year Development Plan, towards saving the country's foreign currency by producing imported items within the country itself. The actors involved in the sector—both government and private—focused on the production of simple consumer goods and other items used as inputs. While, to be sure, a few industrial enterprises relied for raw materials on local resources, the majority of the inputs they used were imported. During the period we are talking about, the manufacturing industry was developed enough to cover 14 per cent of the country's Gross Domestic Product (GDP). Towards the end of the 1970s, however, the manufacturing industries were forced into a situation where they could not use 40-70 per cent of their productive capacity.
- In the 1980s, the building of new manufactories became the focus, until in the 1990s when, with the emergence of a new regime, the command economy that existed until then was replaced with a free-market system, which in turn gave birth to agricultural development-led industrialization (ADLI) as part of the country's overall development strategy.⁵

3. Industrial Research and Development

Industrial research and development exist where industrial activities are alive and well. The depth and progress of the research in the sector is determined by the level of growth of the industrial sector. Industrial development in Ethiopia is on a much lower level than one would have expected. Thus, industrial research and development is a reflection of this reality.

We have to look at the state of the research in the sector from the same angle from which we looked at the trend the industrial sector has been following. While research activities started on an enterprise level with the National Chemical Corporation, the scope of the research was extended to include the industrial sector as a whole and proceeded on a stronger platform as of 1987.⁶ Structurally speaking, the research program was so designed as to have research units in the various corporations and the manufactories operating under their management, starting, of course, with the Ministry of Industries itself. It was at this point that the nucleus for the research branch of the industrial sector was formed as a collaborative venture between the sector and Addis Ababa University.

Agricultural Sector: Turning to those sectors that have both direct and indirect relationship with the manufacturing industry, we find that the agricultural research component has made contributions that we can accept as considerably significant, though arguably

³ *Industrial Development Report, 2002/2003*, UNIDO.

⁴ *Sustainable Industrial Development and Competitiveness*, Ministry of Trade and Industry of Ethiopia and UNIDO, Vienna, 2004.

⁵ *Sustainable Industrial Development and Competitiveness*, MOTI and UNIDO, 2004

⁶ Bekele Bayissa, *Industrial Innovation Competitiveness in Ethiopia*, 2003.

minimal in extent. Some of the contributions made by the agricultural research component are as follows: the textile industry has benefited from improved cotton seeds; the food industry has benefited from improved wheat species (used in the manufacturing of pasta foods, bread, barley for breweries, etc.). With the exception of this minimal contribution, we might as well write-off the contribution of the research branch to the industrial sector as virtually non-existent.

Higher Education: On top of the manpower that institutions of higher education supply to the various sectors, there are also the research papers in the form of theses that their students write as part of the requirement for graduation, all of which admittedly have contributed to the increase in the general stock of knowledge. However, the contribution such papers have made to industrial research is not concretely visible. Things are the way they are perhaps because the papers were neither conceived nor designed with this purpose in mind. This does not mean, however, that no attempts have been made to solve the problems confronting the industrial sector.

Mining Sector: In the mining industry, mineral surveys and the attending results have contributed to the establishment of key cement factories. Although in reality there is no research institute specifically catering to the needs of the mining industry, based on the raw materials identified by the Geological Survey Institute, it has been possible to establish glassware [bottles, drinking glasses] factories, marble processing enterprises, quick lime,

ceramic, aluminum sulfate, caustic soda and pesticide factories.

Health sector: - The research conducted in the health sector has focused on nutrition, particularly concerned in the production of nutritious food for children. Based on this, a factory for the production of *fafa* foods and another for the production of iodized salt have been established. But this is considered more as a demonstrative, experimental undertaking. The Pasteur Institute, along with the Nutritional Foods Research Institute, has been established to carry out research that would help the pharmaceutical and food industries. With the addition of the Traditional Medicine Research Department, all three institutions (which have now been merged under the name of the Ethiopian Health and Nutrition Research Institute) are operating satisfactorily. But the contribution they make to the pharmaceutical industry is very limited, focused on the quality control and assurance activities in which they deal as part of their mandate.

Energy Sector: - although there is a research center set up for the purpose of conducting research in the area of energy development, its activities have been minimal due to the inadequacy of the attention given to it. Among the results of the research conducted in this area is the stove *laqech*.[▼]

Construction Sector: - there is no research institute of any kind in the

▼ The word *laqech* (feminine) means 'she [it—fem.] excelled'. Here it has the further connotation of 'outdoing others' in competition. It could safely be labeled as 'super-stove'.

area of the construction industry, where the only activity to speak of is quality inspection of certain inputs (such as soil and building blocks, ...). There isn't even a single institution designated to undertake research and development activities in the areas of water resources, transportation and communications technology.

Activities are underway to fill these gaps as much as possible, one result of which has been the formulation of a National Science and Technology Policy.

One of the ways by which the Ethiopian Science and Technology Commission intends to implement this policy is to map out areas of collaboration. One of the major activities undertaken in this respect is the effort made in the last 25 years to strengthen the research programs of Ethiopian institutions of higher education, for which the foundation has been laid in collaboration specifically with SIDA/SAREC.

Some research and development activities have been undertaken, in collaboration with the United Nations' International Atomic Energy Agency, in the area of developed technological inputs for the agro-industry, human health, geo-thermal energy and water resource development (IH) sectors. The time is not remote for these technologies to serve as direct inputs for the manufacturing and other related industries.

Efforts are underway to design a national science and technology policy and strategy, on the basis of which to mobilize support for, and bring about significant change in

various industrial sectors. Of particular interest is the contribution made by the Ethiopian Science and Technology Commission to foster the graduate programs of institutions of higher education by providing funds for research, as well as supporting, through similar funding, the publications of professional associations.

While granting that the said research activities is by and large undertaken as part of the fulfillment of requirements for graduation, the contribution—direct or otherwise—they make toward Ethiopia's industrial sector is equally recognized. It is clear that the research undertaken particularly in the area of science will be of benefit to the industrial sector—covering both the existing enterprises/institutions and those to be established at some future time—as these include attempts to disseminate knowledge about the plant (flora) resources of Ethiopia (taking those studies focusing on those species of particular value to the relevant industries), identify their chemical contents, conduct research in the area of solar energy and water resources, animal and plant resources, and strengthening research in the medical fields (BRTP). I think it would only be appropriate at this point to inform the audience that, in the last 25 years, the funds allocated and disbursed in support of the undertaking amounted to Birr 800 million.⁷ When this amount is compared with the research budget or expenses set aside by a small-scale industry in the developed countries, it accounts for only 5-10

per cent of the industry's annual income. The annual income of a small-scale industry in the developed countries could be as much as USD 1 billion. This shows that the annual funding set aside for research and development by such a company lies somewhere between Birr 450 and 500 million. It is very minimal as compared to the above figure. The figure for the total expenditure we put down for Ethiopia tells us that

It is with this present scenario of research and development for an Ethiopian reality in mind that we embark upon entertaining our vision of Ethiopia in the year 2020.

4. Vision 2020

In order to facilitate the ensuing discussion, the projection of my vision of Ethiopia in 2020 will assume two things: first, there are areas that the question of industrial research and development must take into consideration as matters of concern or focus; second, it is assumed that there will be adequate capacity and sufficient time to make the projections a reality.

The most important key to the realization of any development is the creation of qualified manpower. Accordingly, the centrality or primacy of the educational sector in the country's attempt to develop any sector must be recognized and taken into full account.

I, for one, am of the inclination that the educational sector will be able to supply the industrial sector with the necessary manpower that it needs—both quantitatively and

qualitatively speaking—that is capable of undertaking research.

In order to ensure the sustained development of the manufacturing industry, sufficient studies will be carried out within the research branch or component of the industrial sector. I am of the conviction that manufacturing enterprises that are presently undertaking their own research activities will be strengthened, while those without their own research wings will be equipped with same. Although the direct role the government currently plays in the manufacturing industry will diminish, perhaps even fade away altogether, the government will nevertheless continue to play an important role in the area of industrial research. Taking the present state of our development as a starting point, the journey we take towards 2020 must be fast and sustainable. One of the ways by which these leaps in growth can be realized is by giving the necessary and appropriate attention to industrial research and development.

I am particularly convinced that this leap in growth would be more effectively realized in the areas of textiles, leather and leather products, meat, vegetable and fruit, oil seeds, medicinal herbs and similar other commodities, in the production of which our country could successfully compete with the outside world.

The research-supported development of the other sectors aimed at supporting the manufacturing industry is crucial for the leapfrog growth we need. For this reason, I am firmly convinced that the

⁷ This estimate is based on the contributions of SIDA/SAREC and IAEA taken together.

development of the other sectors should be kept within range.

The following projections are those considered would be realized:

In the energy sector:- hydroelectric power generation and supply will increasingly maintain its operation; small rivers and waterfalls will be used to operate small turbines; technology transfer in the area of solar energy, photovoltaics, geothermal, coal and natural gas (bio-gas on a limited scale) energy generation will become a reality.

Because oil prices will increase even much faster than our capacity to pay for it (even with the exploration of oil reserve said to exist in Gambella, the Ogaden, Wollo and Afar), the research conducted in the area of bio-diesel energy will help strengthen agro-industrial research and development. The transformation of the oil production industry into bio-diesel production will be supported by industrial research and development. For this, favorable conditions will be created for the strengthening of research at institutions of higher education.

In the mining sector:- the drilling of oil in Gambella, the Ogaden, Wollo and Afar will become a reality; oil refineries will be established at selected strategic centers; natural gas resources will be developed; the extraction of coal, phosphates, iron and limonite will be undertaken. Based on industrial research the phosphates so extracted will be used for the production of fertilizers within the country. The development of Yayyu Biqilal will change the face of

western Ethiopia. A similar transformation will take place in eastern Ethiopia. The existing mining enterprises will continue to operate on an even higher level. Refining and mineral upgrading technology transfer will be effected through industrial research development.

In the construction sector:- extensive research will be conducted in the area of finding alternative technologies for construction materials. Research in architectural design will be conducted with a view to improving rural housing. Technology transfer in the area of construction materials—for instance, cement, chip boards, bricks, bamboo replacements for metals for smaller constructions, air conditioning and refrigeration for hot and arid climatic zones—will be effected. The contribution of industrial research and development to the selection and transfer of appropriate technologies will figure prominent in the development of the sector.

In this regard, research projects of institutions of higher educations will play a greater role. It suffices to demonstrate the interrelationship among the agricultural, mining, construction and manufacturing sectors by taking one small example. The process of using plant oils in the manufacture of Vernonia paint oil is a result of the combined effort of three sectors:- the necessary plants are identified through agricultural research, extraction of plant oil is done through industrial research, and the provision of other inputs is taken care of by the mining sector.

In the agricultural sector:- while the supply of raw materials to serve

as inputs for the manufacturing industry will be maintained, the research component of the industrial sector will focus on providing technological inputs for the agricultural sector. On top of providing fertilizers and pesticides, industrial research will have a big share in selecting, supplying, and improving appropriate technologies to serve the needs of the agricultural sector in the areas of irrigation, appropriate farming tools, harvesters, and vehicles for transporting agricultural products. Favorable conditions will be created for the production of rubber trees and oil palms. These are just a few of the things that we can mention at this point.

The contribution of the research institutes of the country's institutions of higher education will be extremely high in the sector under consideration.

It is possible to provide many more examples of the kind cited above. We mentioned only the ones we did because it is believed that, if the selected areas or sectors of development were to have the full support of industrial research, they would help in the adoption and implementation of the leapfrog strategy suggested above.

The above mentioned examples have touched upon the tangible and concretely translatable material aspects of industrial research and development.

However, as industrial development goes, there also happen to be other areas of intervention that need to be considered:

☞ **A comprehensive policy research:** Matters will be

- handled such that the different ideas generated through research would influence policy formulation so that the manufacturing industry would grow, contributing to the reduction of joblessness in its wake, etc.
- ☞ Ways and means of eliminating investment bottlenecks will be explored, along with the development of relevant implementation mechanisms, resulting in an acceptable policy document. This will directly help in increasing Foreign Direct Investment (FDI).
 - ☞ Unless favorable conditions are created in Ethiopia whereby the number of share companies would increase, it would be difficult to think of industrial development as an attainable object. The culture of collaboration, mutual support and mutual help among communities must be promoted and improved through systematic research. Consequently, the few share companies that are now operating individually will find a favorable situation for growing and developing in an integrated fashion.
 - ☞ Financial institutions will develop their financial capacity and look for more and more projects to finance.
 - ☞ There will be a system or mechanism of incentives for those who create and save foreign currency.
 - ☞ In order to strengthen the competitive capacity of our industries and upgrade them to the level of international standard, ISOP 9000, HACCP and ISO 1400 will be implemented in the majority of the enterprises.
 - ☞ Conditions will be created for Ethiopia's export industry to expand so as to extend its reach to the country's peripheral regions, such as Jijiga, Gode, Moyyale, Gambella, Kumruk, Metemma and Humera. More particularly, the conducive nature of the Gambella region for industrial development will be explored and concretely utilized with the view to catering to the market needs of Southern Sudan.
 - ☞ A special team will be named to monitor the industrial progress of China, India and Egypt to explore the strong and weak points with respect to their appropriateness to Ethiopia. The team will present an industrial development strategy to the Government.
 - ☞ Conditions for the increased participation in the country's industrial research and development for Ethiopians in the Diaspora will be created.
 - ☞ The genuine partnership of government institutions for the growth of the industrial sector will be assured; the culture of obstructing development will be replaced with that of removing existing constraints.
 - ☞ The artificial boundaries between us and our neighboring countries will be eliminated; restrictions on contraband trade will be limited to the controlling of hazardous products. Government revenue will rely on and be confined to the expansion of internal income generating activities. This will be effected through the production of many cows rather than doting on the solitary cow that we happen to possess. And this, in turn, opens the way activities that enhance major changes in our present outlook of complacency.
 - ☞ The possibility of generating income for industrial development from royalty accruing from use of our river basins by our neighbors will be proved a feasible venture through our industrial research program, and based on the findings, terms for the use of the resource will be presented for negotiation between us and our neighbors.
 - ☞ Patent offices and information technology will be set up as part of the structure of every industrial enterprise. The benefits accruing from them will be used for purposes of popularization on an extensive basis.

Thank you all for your attention!