LINKAGES BETWEEN AGRICULTURAL RESEARCH AND AGRO-INDUSTRIES IN AFRICA
The Case of Ethiopia

Food Security and Sustainable Development Division
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Introduction

The problem

Agriculture is the mainstay of Ethiopia’s economy. According to the Food and Agriculture Organization (FAO) and the World Food Programme (WFP) (2001), it contributes about 45 to 50 per cent of GDP and provides employment to nearly 80 per cent of the country’s population. Its growth is vital to the national economic development and well being of the population. It produces a wide variety of products, thanks to the diversified nature of the country’s ecological system. In fact, the major climatic zones found in the tropics are also found in the country. These are the arid, semi-arid, sub-humid, humid and highland zones.

Ethiopia grows 146 types of crops and raises 70 million heads of livestock. It produces about 15.6 million pieces of hides and skins every year, representing 20 and 10.5 per cent respectively of the total productions of the Common Market for Eastern and Southern Africa (COMESA) and Africa. It is home to 1552 species of wild animals, 96 of which are not found anywhere else. In quantitative terms, it ranks first and eleventh respectively in the production of livestock in Africa and in the world. It also ranks first in Africa and fourth in the world in the production of honey and wax.

The Government of Ethiopia drew up a long-term industrial strategy in 1994 known as Agricultural Development-Led Industrialization (ADLI). The Government is convinced that agriculture is the engine that can propel the socio-economic development of Ethiopia by providing the basis for industrialization and necessary surplus for the expansion of other sectors of the economy. The ADLI strategy gives priority to the development of agriculture as a primary stimulus for the sustainable growth of agro-industry and is expected to raise productivity in both agriculture and agro-industry through appropriate linkages between the two sectors, management, technology, human resources and various incentive mechanisms. Unfortunately, seven years after the ADLI strategy was formulated, agriculture remains essentially undeveloped. Agricultural research, in particular, which is the backbone of the development and sustainable growth of the sector, does not seem to benefit from the support it needs from agro-industries.

Objectives of the Study

The present document is produced in conformity with the work programme of the Food Security and Sustainable Development Division (FSSDD),
currently renamed the Sustainable Development Division (SDD), of the Economic Commission for Africa (ECA), for the biennium 2000-2001. The objectives are to assess the degree of interaction or co-operation between the agro-industries (AIs) and agricultural research institutions (ARIs) in Ethiopia, identify the key constraints that impede this cooperation, and propose solutions to help solve the problem, with the aim of increasing agricultural productivity.

The document is organized into five chapters, in addition to the current introduction. An overview on the industry – research relations is covered in chapter I. A brief background on Ethiopia is included in chapter II. The state of linkages between Ethiopia’s agro-industries and agricultural research institutions is presented in chapter III. Chapter IV covers the conclusions and chapter V the recommendations.

Limitations of the presentation

The document has three shortcomings:

1. The findings reported are, by and large, the outcome of a survey carried out at the level of the agro-industries. While 75 per cent of the AIs involved in the survey have filled and returned the questionnaires of the study to SDD, none of the agricultural research institutions which received the same questionnaires have yet done so. The responses from the AIs were, however, supplemented by those obtained through an interview conducted at the level of the Ethiopian Agricultural Research Organization (EARO) in Addis Ababa. This interview generated very useful results which were used to alleviate the problem.

2. The findings are also the outcome of the analysis of data collected from a limited number of AIs. Though the sample of these AIs contains more than 30 observations, its size is relatively small. As a result, observations in the cells of some key variables are limited to 7 or 8. This situation is, to some extent, a constraint to the in-depth analysis of the effect of these variables on the co-operation between AIs and ARIs.

3. The findings are, finally, not an outcome of a statistical analysis of data which will be performed in the future on a larger sample. They are, thus, preliminary.
I. Research Institution – Industry Relationships

The concept

The National System of Innovation

In any nation, industrial production takes place at the firm or enterprise level. However, a firm does not operate in a vacuum, isolated from other agents in the economy. It is only one component of the National System of Innovation (NSI), which is the system of interacting private and public firms, universities and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social and financial in as much as the goal of the interaction is the development, protection, financing or regulation of science and technology (S&T).

The NSI comprises four elements which are the institutions, the State, the incentives and the national technological capabilities.

The institutions among which interactions take place are firms, universities, private and public research institutions (RDIs), and training and vocational education agencies. The State, which is regarded as a distinct and separate element because of its national policies and actions including regulatory and promotional activities, tends to generate interactions throughout the system.

Incentives which promote interactions and technical change are government support for basic and applied research, procurement policies, tariffs and quotas that induce change. National technological capabilities are those technological competencies that account for differences among firms and for much of the observed differences in trade, growth and international competitiveness.

Relations between RDIs and the industry

The linkage between the industry and RDIs is only one of the many interactions that take place within the NSI to produce innovations. Here, industry refers to the group of firms engaged in the processing of natural resources in their raw or partly processed form, and the manufacture of
marketable goods. It excludes agriculture production but includes the processing of agricultural raw materials.

The need for promoting and maintaining the above linkage cannot be overemphasised. Some of the key reasons why relationships between RDIs and the industry are needed and why these relationships have evolved and should be planned, encouraged and strengthened are:

a. Utilization of research results by the industry;
b. Exploitation of RDIs’ repositories for up-to-date technical information and skills by the industry;
c. Technical personnel in the industry can bring new and practical perspectives to the work of RDIs and thus create an awareness of the actual needs of the industry;
d. RDIs also have the technical competence and skills for undertaking analysis of competing products and advising the industry on actions to be taken;
e. RDIs solve problems generated by modern industries which must be in a constant state of change in order to remain competitive;
f. Access to RDIs’ research facilities, which are not easy to duplicate, helps the industry to undertake specialized tasks;
g. RDIs may need to use specialized materials or technology available in the industry;
h. RDIs can provide small industries with the introductory training courses they need on specific technologies, especially at their initial stages (e.g., palm wine bottling and hygienic preparation of specific foods);
i. RDIs can also organize training to provide specific technical skills for the staff of medium and large industries;
j. RDIs have technical skills that industries need for trouble-shooting; and
k. Industries can provide RDIs with a substantial financial support.

It is clear from the preceding that interaction between RDIs and industries can generate considerable and mutual benefits and that both these units of NSI stand to lose a great deal by functioning in isolation. No wonder there has been, in various parts of the world including Africa, a long tradition of mutually beneficial and direct collaboration between RDIs and the industry known respectively as producers and users of technology. Models used vary from the simplest to some of the most sophisticated ones. Among the simplest mechanisms are consultancies, industry-funded research, joint R&D programmes, transfer of technology from RDIs to industry and exchange of technical and research personnel (see box 1). More complex mechanisms (box 2) are technology consultancy centres, technology incubators and science parks, export processing zones (EPZs), and trade fairs.
Box 1. Simple Mechanisms for Industry – RDI Relationship

1. **Consultancies** in which an RDI is contracted by an enterprise on an *ad hoc* or more sustained basis to identify and solve a specific problem. The nature of the problem may vary widely from maintenance to the need to overcome competition from a number of competing products or to substitute local raw materials.

2. **Industry-funded research** by RDIs in areas relevant to the industry. The design and fabrication of essential oil extraction equipment for a soap-manufacturing firm is an example or a relatively short-term contract. On the other hand, the setting up of a special research institute which is completely funded by industry to work on problems of the industry is a more sustained relationship. The Institute of Mining Research at the University of Zimbabwe is an example of the latter.

3. **Joint R & D programmes** between firms and between RDIs and firms. Such programmes exist in other parts of the world and involve firms which have limited research capabilities. No African examples come readily to mind.

4. **Successful transfer of technology from RDI to industry.** Some RDIs successfully extend their operations beyond R&D and pilot plant stage and then disseminate their innovations to small- and medium-enterprises (SMEs). Such success is possible only with the right order of magnitude of funding, usually provided by an external donor or medium to large industry which realizes the market potential of the invention. The work on the Sorghum Dehuller by the Rural Industries Innovation Centre (RIIC) in Botswana is a good example. With the financial and technical support of the International Development Research Centre of Canada (IDRC), the dehuller was identified as a high-priority project. It was aimed at relieving rural families of the drudgery of several hours of dehulling of sorghum by pounding. A foreign technology was adapted, fabricated and disseminated into industry. Local firms took up fabrication and so did some medium-sized firms outside Botswana, including some South African firms. The product of dehulling and milling is readily available on the market.

5. **Exchange of technical and research personnel** between a firm and an RDI. This particular mechanism is a response to the need for RDI staff to experience the environment of a firm and to be able to offer appropriate advice. It also responds to the need to introduce new perspectives on the problems of industry to the RDIs. Further, it forms the basis of a longer-term
Box 2. Complex Mechanisms for Industry-RDI Relationships

1. Technology Consultancy Centres. These organize a co-ordinated response to the problems of a wide range of industries and they are required in a university situation where expertise and skills are available. The interaction with industry, whether on demand or as a result of a proactive survey of needs, throws up specific problems. It is the responsibility of the Centre to put together the necessary technical information and skills to tackle each problem and to find a solution. In addition, individuals or units within the university may, by interaction with a firm, identify a problem for which the solution will require the administrative and technical backup of the Centre.

The Centres may also establish a technical presence in an industrial complex or estate to facilitate day-to-day interaction. Such a presence enables a Centre to provide technical services and training and also respond to actual problems. This could be a more organized and complex form of industrial attachment in which there is interaction on a much broader front.

A group of non-university RDIs could also arrange a similar mechanism.

This model is similar to that of a University Outreach Centre which targets specific communities, discusses problem(s) in detail with members of the community, organizes a team from the university to undertake necessary research, arrives at solutions and applies them. Problems in the field of health or employment may be dealt with in this manner.

2. Technology Incubators and Science Parks. These may be regarded as an extension of the RDI presence in an industrial estate. However, there is the possibility of having many RDIs involved as well as a wider range of SMEs. The primary purpose is to facilitate the transfer of skills, ideas and inventions from RDIs to industrial SMEs and for RDIs to identify and meet the needs of the SMEs whether these are technical or training needs in specific skills. They provide the opportunity for RDIs to evaluate the commercial potential of their inventions and to set up pilot plants eventually, which can be developed into commercial ventures, through patenting, contracting with manufacturing firms, securing legal advice and venture capital. RDIs generate significant operating funds through such arrangements with industry, but it should be noted that interactions with providers of engineering and related technical services, legal and business management advice and venture capital, etc. are necessary.

The problem of initial funding for university involvement may be solved by the establishment of a University Research Trust which acts as an intermediary between the university and industry.
3. **Export Processing Zones (EPZs).** These are innovation centres. They are extended duty-free manufacturing zones which bring together on a permanent basis a multitude of establishments for manufacturing and services to benefit from excellent infrastructure and very attractive incentives. They create centres for technology and skills exchange, in which RDIs can participate. In Mauritius, there are some 4,500 such establishments in the EPZ.

4. **Trade Fairs** also present an opportunity for interaction, but the participation of RDIs is not significant.

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**Characteristics of African RDIs and Industry**

Detailed and systematic studies undertaken by African scientists and others, with external funding support, have confirmed the following:

1. Some linkages have developed over the past few decades, but they remain relatively few and weak mainly due to the fact that almost all the continent’s RDIs are publicly funded, which has made them a lot less aggressive and proactive than they should be. These RDIs largely operate outside the sphere of productive firms (i.e., industries) without regularly conducting surveys of user needs and lack funds to proceed beyond R&D. In addition, the RDIs are weak at targeting the distribution of their outputs appropriately.

2. Large- and medium-scale industries import their technologies. Most of them operate at a technical level beyond the reach of Africa’s RDIs. With the exception of South Africa and a few countries in North Africa, they hardly undertake local R&D and depend entirely on their technical partners outside the continent for technical support.

3. Large industries turn to local RDIs only when compelled by law or in response to threats to profit and capital. One example is the response to the raw materials crisis in the mid-1980s when the importation of barley into Nigeria was banned. The breweries turned to Nigerian RDIs to develop alternative processes and to design equipment that would use local maize and sorghum raw materials. Another example is the case in Ghana where similar pressure led a large soap manufacturing industry to approach one of the country’s universities to design and help to manufacture equipment for the extraction of essential oils from local raw materials.

4. The greatest number of linkages is between small industries and public RDIs. Though many of these industries initially import their technologies, they lack the financial resources to undertake in-house R&D or to pay for external technical support on a sustained basis.
Their technical level of operation is well within the competence of the RDIs, hence the more intense relationship that has been observed.

5. In general, small industries are widely dispersed geographically, and because of logistical constraints many of them do not reach the RDIs.

6. RDIs lack focus and spread limited resources over a wide area of intervention. They are plagued by serious financial problems, have low productivity and are rather inefficient. They are, however, capable of high productivity and efficiency when funding is available and when forced to focus.

7. RDIs do not have the technical capability or financial resources to commercialize their inventions. Only a few of them can develop ideas up to pilot plant stage, the prototype design and development being the most expensive stage of the innovation process.

8. There is an information gap between RDIs and industries in respect to the services available, competencies for trouble-shooting and training and research outputs.

9. Because of limitations of finance, personnel and engineering backup, RDIs tend to develop relatively simple technologies suited to the small industries.

10. Within small and medium industries, there is scope for incremental and adaptive technical change, rather than revolutionary change. There are also more process than product innovations.

The need for direct linkages between African ARIs and AIs

Our presentation has so far focused on direct collaboration between RDIs, the industry and the mutual benefits derived from the underlying collaboration. As our goal is to contribute significantly to food security through increased agricultural productivity, the questions as to how African farmers benefit from direct linkages between ARIs and AIs and why the focus is on ARI-AI relationships in lieu of AI-farmers linkages, become pertinent. Answers to these questions are provided below.

1. Many National Agricultural Research Systems (NARS) in Africa are beset with bureaucracy, politics and government control, a situation which stifles innovation, destroys creativity and diminishes productivity. Their research productivity, when measured in output per land, labour, and fertilizer, is the lowest of all the regions of the world (Pardey et al. 1991)\(^1\). Further, they lack adequate funding and cost-effective means of transferring technology to farmers. The transfer of technology is in the hands of extension agencies which are more responsive to the government than to the needs of the farmers.

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It is agreed that agricultural and rural development cannot be achieved under these conditions and that the situation could be reversed if ARIs have sufficient funds – not only for technology development but also for technology transfer. AIs can provide these funds, which are almost impossible to obtain from the government.

2. Farmers in many countries on the continent have little or no influence over research, extension, policy, or education matters that affect them. They are poor and thus cannot finance research of interest to them and to AIs. Many are also illiterate and cannot solve the problems generated by AIs, or produce technology for these AIs. Further, because the technologies that are available at the research stations rarely find their way to the farms where they are expected to be duplicated in sufficient quantities required by AIs, the latter can obtain these technologies only through ARIs; hence, the total lack of mutual linkage between farmers and AIs.

3. Many AIs purchase agricultural raw material inputs directly from local farmers but are less concerned about the quality of these inputs as long as there is high demand for their processed products. Under this circumstance, AIs have no other relation with the local farmers apart from buying the raw materials.
II. Brief background on Ethiopia, its agriculture sector, AIs and ARIs

Country Profile

Ethiopia is located in the Horn of Africa, north of the equator. It has a total area of roughly 1.1 million sq. km. (111.8 million ha) and a population of about 65 million with per capita income of $ US 100. Eighty-five per cent of the total population lives in rural areas. The population density is nearly 54 persons per sq. km. It is one of the poorest countries in sub-Saharan Africa. Skewed distribution of income leaves about 60 per cent of the population below the poverty line. Ethiopia ranks nearly at the bottom, 171st out of 174 countries, just above Burkina Faso, Niger and Sierra Leone. According to an FAO estimate, about 51 per cent of the population is undernourished and over two million people are considered to be chronically food insecure.

The health status is poor, with a health service coverage of 47 per cent (1999), life expectancy at birth of 47 years for males and 50 for females, infant mortality rate of 105-128 per 1,000 live births and maternal mortality rate of 500-700 per 100,000 live births. Only about 30 per cent of the population has access to safe drinking water (2001). The literacy rate is over 35 per cent.

The infrastructure consists of 23,812 km of road network, with an additional 30,000 km of unclassified tracks and trails, a 781-km run-down railway line, less than 200,000 telephone lines, and 1,600 GWh of annual electricity generation with about 400 MW installed capacity (1999). Biomass fuel accounts for nearly 95 per cent of the total energy consumption, with only 5 per cent coming from modern (commercial) energy sources.

The agriculture sector

About 66 per cent of Ethiopia’s land is potentially suitable for agricultural development, and only 8 per cent is currently under cultivation. Crop production land represents 14.8 per cent and grazing land 51 per cent of the total arable land area. The water resource potential is estimated at 110 billion cu.m of surface water and around 2.2 billion cu.m of ground water. Irrigation potential is estimated at 3.5 million ha, 5 per cent of which has so far been exploited. Hydroelectric potential is around 161,200 GWh per year, and only 1 per cent has been exploited.
With the exception of ostriches, civets and crocodiles, the various species of Ethiopia’s wildlife remain untapped. Fish resources in the country are around 43,000 tonnes, only 20 per cent of which is currently being exploited.

In spite of its vast agricultural resource potential, Ethiopia remains one of the most impoverished countries in the world. The productivity of the sector is very low and food insecurity is a real problem. Cereal production accounts for 80-90 per cent of the major food grains production, while pulses and oilseeds take the remaining share. Although some cash crops, such as coffee, pulses and oilseeds, produced by smallholder farmers are exported, the volume is very small relative to the potential. Cotton is mainly grown on commercial plantations and is directed towards the domestic market for use by the local textile mills.

In most rural areas, subsistence rain-fed agriculture prevails and 95 per cent of farmers operate in a small-holder, low-cost, low-input farming system with land holdings of less than one hectare. Traditional methods of cultivation involving simple hand tools and oxen are used. The contribution of the pastoral-nomadic and modern commercial farming systems to total agricultural production is very small (5 per cent). Agricultural production is sensitive to periods of drought, which generally occurs at high frequency – three drought periods in 10 years.

Livestock productivity is very low despite its large number and important contribution (30 per cent) to agricultural GDP. Average carcass weight per animal is only 100 kg for cattle, 10 kg for sheep and 8-9 kg for goats. Milk yield even under improved management conditions does not exceed 500 litres per lactation (MOA/FAO, 1995). Hide and skin production suffers from small animal size and poor quality ascribed to scratches, skin diseases, inappropriate branding and poor collection techniques.

**ARIs in Ethiopia**

In Ethiopia, the public sector is mainly responsible for agricultural research and dissemination of research results. Currently, there are 3 full-time research institutions in the country. These are the Ethiopian Agricultural Research Organization (EARO), the Biodiversity Institute of Ethiopia (BIE) and the International Livestock Research Institute (ILRI).

The Institute of Agricultural Research is the major agricultural research institution in Ethiopia. It undertakes research in crops, livestock, natural resources, farm tools and socio-economics.
BIE, previously called Plant Genetic Resource Centre/Ethiopia (PGRC/E), is involved in collecting, characterizing and conserving plant germplasm.

ILRI concentrates its R&D activities on livestock, animal feeds and nutrition, and other disciplines related to livestock production.

Other establishments involved in agricultural research include higher education institutions, including agricultural universities and colleges. These are teaching institutions carrying out agricultural research as a part-time activity. Some development–oriented organizations, with research centres and advisory services, are also engaged in experimental work in support of their own development activities.

Thirty-three research centres/stations and sub-centres/sub-stations function under the EARO. In addition, there are several trial sites scattered across the country. EARO runs many of the established research centres and sub-centres, some of which have already been handed over to regional administrations. EARO provides technical support to the regional research centres as required.

**EARO research programmes cover:**

- Crop research: field crops, horticultural crops, stimulant crops, agronomy and physiology, crop protection, soil science and water management, and food science;
- Livestock research: animal production, animal feeds and nutrition, and animal health;
- Agricultural mechanization research; and
- Agricultural economics/farming system research. It has adopted a 3-tier process in the generation and transfer of technology, namely, on-station research (OSR) to develop new technology and improve traditional technology, on-farm research (OFR) to verify appropriateness of the technology developed, and pre-extension demonstration (PED) to familiarize and popularize proven technologies.

As in most African countries, ARIs in Ethiopia are under-staffed, under-funded and under-equipped. They also lack cost-effective mechanisms of transferring technology to farmers.

**Ethiopia’s AIs**

In Ethiopia, industry accounts for only 11 per cent of GDP, while services in general contribute 37-40 per cent of the total GDP. According to the Ethiopian Central Statistical Authority (CSA, 1997), the total number of small,
medium- and large-scale industries is 3373, of which 1963 (58.2 per cent) are AIs.

Eighty-four per cent of AIs are located in Addis Ababa, Oromiya and Amhara, while 15.3 per cent are found in the Southern Nations and Nationalities Regional State, Tigray, Dire Dawa and Harar. The remaining 0.7 per cent is located in 4 other regions. This clearly shows an unbalanced distribution of AIs and the concomitant inequalities in development. The major AIs are engaged in food, leather, textile and beverage production. Food industries are the most significant AIs in terms of the number of establishments. Thus, special attention will be given to food-related industries in this study.

In general, Ethiopia’s AIs suffer from limited financial resources and a lack of trained technical human resources and facilities.
III. Relations between Agricultural Research Institutions and Agro-industries

Particulars of the surveyed AIs

A survey involving 66 agro-industries (AIs) of Ethiopia was conducted by ECA with the assistance of the Ethiopian Ministry of Trade and Industry in 2000-2001. Table 1 provides the names and types of these AIs. The sample distribution of the responding AIs by type of industry is shown in table 2. Food and beverage industries represent 56 per cent of the responding AIs. Some 71.4 per cent of AIs referred to as leather industries are tanneries and the remaining 29 per cent are industries that produce leather products.

Of the responding AIs, 52 per cent are located in Addis Ababa and its outskirts, 28 per cent in Oromiya region, 6 per cent in Amhara region, 4 per cent in the Dire Dawa administration, 6 per cent in the Southern Nations, Nationalities and Peoples Regional State (SNNPRS), and 4 per cent in Tigray and Harar regions.

The age of the responding AIs varies widely from 2 years for Algeta Leather and Leather products Plc to 76 years for Addis Tannery S.C. Sixty-six per cent of these AIs have been in operation for at least ten years and 34 per cent for less than ten years.

Six per cent of the responding AIs are small-scale industries (less than 50 employees), 26 per cent are medium scale industries (50-99 employees) and 68 per cent are large industries (at least 100 employees). The food (particularly sugar) and textile industries employ the majority of workers (nearly 80 per cent). The food industries account for 44 per cent of the large AIs, 46 per cent of the medium-scale AIs and none of the small-scale AIs surveyed. The beverage industries represent 18 and 8 per cent of the large and medium AIs, respectively. The leather industries account for 15, 46 and 100 per cent of the large, medium and small AIs surveyed, respectively. The textile industries account for 23 per cent of the large AIs. Of the responding food industries, none are small-scale AIs. Likewise, none of the responding medium and small industries are textile AIs.

About 84 per cent of the responding AIs operate continuously while the remaining 16 per cent function intermittently. The reasons given for the intermittent processing are associated with seasonal availability of agricultural raw materials, difficult access to market and technical problems.
**Products of the AIs**

The total number of types of semi-finished, intermediate goods produced by the responding AIs is 16. The major producers of these goods are the food industries (50 per cent) and leather industries (31 per cent). The products are animal feeds such as bran, oil cake and molasses for food industries, various types of skins such as pickled sheep and goat skins, wet blue sheep and goat skins, wet blue hides for leather industries, grey fabrics of cotton and polyester, and cotton and acrylic yarn for textile industries.

Sixty-nine types of finished goods are produced by the responding AIs. Of these, 67 per cent are from food and beverage industries, followed by leather (20 per cent) and textile industries (13 per cent).

Goods produced by food AIs include plantation white sugar, ethanol, processed fruits (e.g., orange squash, orange marmalade, guava nectar, etc.), processed vegetables (tomato paste, tomato juice, etc.), various types of flour (mainly wheat), pasta and macaroni, biscuits, bread, edible oil, vegetable ghee, margarine, extracted meal, baby food products and dairy products.

The production of leather AIs includes leather garments (jackets, trousers, etc.), leather shoes uppers, leather lining (from sheep and goat skins, and hides), leather upholstery, hand bags, wallets, small crafts, and other leather articles.

The major AI beverage products include different wines and wine-related brands (such as champagne, vermouth and vinegar), various brands of beer and draft, malt and malt drinks, and washed and sun-dried coffee beans.

Bed sheets/quilt covers, canvas, cotton blankets, shirts (T-shirts and polo shirts), jeans and towels, and woollen products (e.g., carpets, blankets and cloth) are the major finished goods from textile AIs.

**Technology used by the AIs**

**Nature of the technology**

Fifty-four per cent of the responding AIs use capital intensive technologies; the remaining 46 per cent use labour-intensive technology. The majority of food AIs (more than 76 per cent) and leather AIs (more than 64 per cent) use capital-intensive technologies while the bulk of textile AIs (87.5 per cent) and beverage AIs (71 per cent) is for labour-intensive technologies.
That high proportions of responding textile and beverage AIs use labour-intensive technologies can be explained by the fact that a good number of beverage AIs are old and that most textile industries are not only labour-intensive by nature but are also old. Most responding tanneries, on the other hand, were established within the last ten years; they are new, use modern machinery and do not need to employ many workers. Most responding food AIs also use labour-intensive technologies because they are flourmills which do not need to have many employees and because a good number of them are old.

AIs that tend to adopt capital-intensive technologies are those established recently. It is possible that the foreign technology suppliers dictate to them the use of capital-intensive technologies.

**In-house technology development**

Of the responding AIs, only 20 per cent are engaged in in-house R&D. Sixty per cent of the AIs involved in in-house R&D are food industries (mainly sugar, dairy, flour and pasta industries) and 40 per cent are leather industries (mainly tanneries).

The key constraints to in-house technology development as provided by AIs which do not carry out in-house R&D are, in ranking order:

a. Lack of facilities (70 per cent of the AIs);
b. Lack of financial resources (65 per cent of the AIs);
c. Lack of trained technical human resources (62.5 per cent of the AIs); and

d. R&D is not of a priority (30 per cent of the AIs).

The majority of AIs indicate more than one constraint.

**In-house upgrading of the technology**

The majority (70 per cent) of the respondents do not carry out an in-house upgrading of technologies used. The main reasons provided for the situation by these AIs are, in ranking order:

a. Lack of trained technical human resources (77 per cent of the AIs);
b. Lack of facilities (68.6 per cent of the AIs);
c. Lack of financial resources (60 per cent of the AIs); and

d. Upgrading is not a priority (17 per cent of the AIs).

Of the AIs engaged in in-house technology upgrading (i.e. 30 per cent of responding AIs), 47 per cent are food industries, 33 per cent are leather industries and 20 per cent are beverage industries (all breweries).
Only 16 per cent of the responding AIs are involved in both in-house R&D and technology upgrading. Of the AIs involved in in-house R&D, 80 per cent are also involved in in-house technology upgrading. Similarly, of those AIs engaged in in-house upgrading, 53 per cent are also involved in in-house R&D.

The main reasons for the lack of both in-house R&D in general and in-house upgrading of technology, in particular, are similar. They are associated with lack of facilities, trained technical human resources and financial resources. AIs searching for local funding are beset with high interest rates on bank loans, burdening collateral requirements and lengthy bureaucratic procedures. The lack of government policy actions in support of AIs’ research is most likely the single most important cause of the problem.

**Acquisition of latest technologies**

Seventy two per cent of the respondents do face problems in acquiring the latest technology, while the remaining 28 per cent have no problem in this respect. The key constraints to the acquisition of the latest technologies as provided by the concerned AIs are the lack of financial resources (86 per cent of the AIs) followed by shortage of trained technical human resources (36 per cent of the AIs), lack of facilities (25 per cent of the AIs), lack of information (19 per cent of the AIs), shortage of quality raw materials (8 per cent of the AIs) and inadequate government policy and support (8 per cent of the AIs).

**Linkages between the surveyed AIs and the local ARIs**

**Degree of co-operation**

Only 30 per cent of the responding AIs co-operate with the local ARIs during the period 2000-2001. The vast majority (70 per cent) of the AIs do not entertain any form of co-operation with the AIs. The co-operation was even less prior to 2000 as only 22 per cent of the respondents interacted with the local ARIs during this period.

Of the AIs which co-operate with the local ARIs in 2000-2001, 47 per cent are food AIs, followed by leather AIs (27 per cent), beverage AIs (20 per cent) and textile AIs (6 per cent). The figures for the period preceding 2000 are 46 per cent for food AIs, 27 for beverage AIs, 18 per cent for leather AIs and 9 per cent for textile AIs.

Of the AIs which co-operate with the local ARIs in 2000-2001, 67 per cent are large industries, 20 per cent are medium-size industries and 13 per cent are
small-scale industries. Food industries account for 60 percent of the large AIs and 33 per cent of medium-size AIs which co-operate with local ARIs. Leather industries represent 100 per cent of the small-scale AIs and 67 per cent of medium-size AIs which co-operate with local ARIs. Beverage industries account for 30 per cent and textile industries for 10 per cent.

The above findings point to a poor linkage between AIs and ARIs in Ethiopia. The majority of AIs prefer to co-operate with foreign suppliers of technology in lieu of domestic suppliers. These findings are in agreement with the results of surveys conducted in 1997 and 1998 by the Central Statistical Authority (CSA), which showed that 50 per cent of AIs import their basic inputs, even during good harvest seasons. One of the major reasons for this is that AIs do not always find locally the quality raw material they need.

That the majority of the AIs do not link with local ARIs is a sign of serious disarticulation of the National System of Innovation in Ethiopia. This situation is a serious constraint to the adequate growth of both agriculture and agro-industry in the country.

The slight improvement in the co-operation between AIs and ARIs after 1999 may be ascribed mainly to the awareness created through a workshop organized by EARO in November 1999. The workshop brought together agro-industries, exporters, research institutions and commercial farmers and facilitated their interaction and discussions of their respective problems. Prior to the workshop which concentrated on crops, experts from research institutions, owners and managers of agro-industries, export companies and farmers were invited to visit crop research stations so as to have hands-on information on the technologies that exist at the stations. Each of the guests presented a paper reflecting and discussing issues at stake. All participants at the workshop came to the same conclusion after visiting the stations: most technologies (e.g., improved seeds, and raw materials) they need are available at the research stations but not in sufficient amounts at the farm level where they can be duplicated to satisfy their demand. The participants also agreed that ARIs had the potential to solve most problems faced by AIs. The workshop recommended, among others, that commercial farms be established and given incentives needed to duplicate, for the AIs, the technologies available at the research stations. The workshop also recommended that a mutually fruitful co-operation be promoted and effected between the AIs and the ARIs. The workshop can be considered as a positive step towards enhancing AI-ARI relations.

Areas of co-operation

The main areas of co-operation listed, in decreasing order of importance, by the co-operating AIs in 2000-2001 (i.e., AIs which co-operate with local ARIs)
are “information exchange” according to 93 per cent of these co-operating AIs, “development of new and improved varieties” (47 per cent of the co-operating AIs), “choice of appropriate technology” (27 per cent of the co-operating AIs), and “provision of facilities in support of local agricultural research” (19 per cent of the co-operating AIs). This order was the same during the period preceding 2000.

Food industries represent 50 per cent of the AIs co-operating with ARIs in 2000-2001 information sharing followed by leather industries (29 per cent), beverage industries (14 per cent) and textile industries (7 per cent). The corresponding figures for the period preceding 2000 were 50, 25 and 25 per cent for food, leather, and beverages, respectively. Textile AIs did not co-operate in information sharing with local ARIs in this period.

Food and beverage industries each account for 43 per cent of AIs co-operating with AIs in 2000-2001 in the “development of new and improved varieties”, followed by leather industries (14 per cent). Textile industries do not co-operate with local ARIs in this area. Prior to 2000, the proportion of industries co-operating with ARIs in the area was 50 per cent for each the food and beverage AIs, while leather and textile industries do not co-operate with ARIs in this particular area.

In the area of choice of appropriate technology, food industries represent 50 per cent of AIs co-operation in 2000-2001 with the local ARIs, followed by leather and beverage industries (25 per cent each). Textile AIs do not co-operate with ARIs in this area. Prior to 2000, beverage industries accounted for 100 per cent of the AIs co-operating with ARIs in the area.

**Types of linkages**

Of the AIs which interacted with local ARIs prior to 2000, 73 per cent reported “exchange of information” as the major area of co-operation, followed by “joint project for development of new technologies” (45 per cent), “improvement of farming practices” (18 per cent), “providing facilities for research to support ARIs” (9 per cent), “choice of appropriate technology” (9 per cent). In 2000-2001, “exchange of information” is recognised by 87 per cent of AIs that interact with ARIs as the major area of co-operation, followed by “joint project development of new technologies” (33 per cent of AIs), “choice of appropriate technology” (27 per cent of AIs), ”providing research facilities to support ARIs” (13 per cent), and “development of cultural practices through research” (13 per cent of AIs).
Effects of types of processing on the co-operation

Of the AIs which co-operated with ARIs in 2000-2001, 80 per cent operate continuously and 20 per cent intermittently. Food industries represent 50 per cent of co-operating AIs which operate continuously, followed by leather industries (25 per cent), beverage industries (17 per cent) and textile (8 per cent).

Within the food industry, 86 per cent of co-operating AIs operate continuously and only 14 per cent intermittently. A higher proportion (75 per cent) of the co-operating leather industries function continuously as compared to 67 per cent of the co-operating beverage industries.

Effects of product characteristics on the co-operation

Of the AIs which co-operated with local ARIs in 2000-2001, 73 per cent produce finished goods, 20 percent produce semi-finished (or intermediate) goods and 7 per cent produce both finished and semi-finished goods. Seventy five per cent of the co-operating leather AIs (all tanneries) are engaged in the production of semi-finished leather destined to further processing in the leather products industries. Of all the co-operating industries that produce semi-finished goods, 60 per cent are leather AIs and 40 per cent are food AIs.

Food industries accounted for 58 per cent of co-operating AIs which produce finished goods, followed by beverage industries (25 per cent), textile and leather industries (8.5 per cent each). The majority (67 per cent) of the co-operating AIs process agricultural raw materials of plant origin; the remaining 33 per cent process raw materials of animal origin.

Effects of the nature of technology used on the co-operation

About 41 per cent of the responding AIs that use capital-intensive technologies in their factories co-operate with local ARIs and constitute 73 per cent of all the co-operating AIs. Food industries represent 63 per cent of the co-operating AIs using capital intensive technologies in their factories, followed by leather industries (27 per cent) and beverage and textile industries (about 10 per cent). Beverage industries represent 50 per cent of the co-operating AIs using labour-intensive technologies in their factories, followed by leather and textile (25 per cent each). However, it should be noted that four of the co-operating food industries use labour intensive technologies in their plantations.
**Effects of in-house R&D and technology upgrading**

Forty per cent of the responding AIs that are engaged in in-house R&D co-operate with local ARIs; the remaining 60 per cent do not. This may be ascribed to the fact that the primary beneficiaries of the ARIs’ improved seed are the food AIs which not only cannot afford to establish their own R&D facilities and do not have the critical mass of qualified human resources to do the job.

Only 33 per cent of the responding AIs that carry out in-house technology upgrading co-operate with local ARIs; the remaining 67 per cent of co-operating AIs are not involved in in-house technology upgrading.

It would appear from the above that only a few AIs involved in in-house R&D or technology upgrading find it necessary to co-operate with the local ARIs. As reported later in this document, some of the reasons for this are that

a. The ARIs do not publicise their activities and achievements;

b. The service of the ARIs is not based on information collected from the AIs; and

c. The service is not demand-driven.

**Effects of proximity of the Agricultural Research Institutions**

The three large sugar factories in Ethiopia (Metehara, Wonji and Fincha) maintain good co-operation with the nearby research stations (i.e., Melkassa, Melka Worer and Bako), while Addis-Modjo Edible Oil Complex S.C. has a close co-operation with their nearby Debre-Zeit agricultural research station and with Holeta agricultural research station. Kaliti Food S.C. cooperates with the nearby Debre-Zeit agricultural research centre. Three leather industries (Hora Tannery Plc, Modern Zege Leather Products Industry and Blue Nile Tannery) have cooperation with the National Animal Health Research Centre, the Animal Health Division of the Ministry of Agriculture, the Veterinary Service, and the Animal and Animal Products Enterprise. Awash Wine S.C., also closely works with Melkassa and Debre Zeit Agricultural research stations. A few other AIs tend to entertain some type of cooperation with agricultural research stations if they happen to be located near these stations.

The distance that separates the AIs from the ARIs may, therefore, be a significant factor affecting AI-ARI relations.
Quality of the co-operation

Eighteen per cent of the AIs that cooperated with ARIs prior to 2000 evaluated their relationships with local ARIs as very good, 27 per cent as good, 46 per cent as fair and 9 per cent as poor. The corresponding proportions for 2000-2001 are 43, 21.5, 21.5 and 14 per cent in favor of very good, good, fair and poor, respectively. The quality of the co-operation appears, therefore, to be improved a bit in 2000-2001 as compared to the period prior to 2000. EARO’s workshop held in November 1999 might be the cause of this improvement.

In general, where there is a good cooperation between local AIs and ARIs, requests to cooperate emanate from both sides, suggesting a good flow of information and know-how between the two establishments. For example, in 2000-2001, 60 per cent of the co-operating AIs made various requests to or sought assistance from the local ARIs (mainly EARO), and nearly 67 per cent of them received requests from the local ARIs. Similarly, prior to 2000, almost 64 per cent of the co-operating AIs made requests to or sought assistance from the local ARIs while almost 73 per cent of them received requests from the local ARIs. With very few exceptions, the requests made by the co-operating AIs to local ARIs have been granted.

Causes of lack of co-operation between AIs and ARIs

Of the AIs which did not co-operate with local ARIs in both the periods before and after the EARO’s workshop of November 1999, 71 per cent consider the failure of the AIs to request assistance from ARIs as the most important reason for the lack of co-operation. The second reason, which is provided by 51 per cent of the non-collaborating AIs, is the failure of ARIs to seek assistance from AIs. The third reason, which is given by 20 per cent of the non-collaborating AIs, is that technologies developed by local ARIs are not available in adequate quantities needed by AIs. The fourth reason is provided by 17 per cent of the non-collaborating AIs and is the lack of awareness on how local ARIs can assist AIs.

Causes of poor adoption by AIs of technologies generated by ARIs

Factors preventing the AIs from forging links with local ARIs are varied. Lack of information is the most overwhelming constraints as indicated by 74 per cent of AIs that do not have any kind of collaboration with the AIs. According to 51 per cent of the non-collaborating AIs, the second most important constraint is the poor relations between the AIs and local ARIs. Only 11.4 per cent of the non-collaborating AIs indicate that the technologies
developed by local ARIs either fail to respond to their needs or are irrelevant to the AIs.

It would appear that, indeed, ARIs lack effective mechanisms of transferring their technologies to the end users. They are not successful in communicating efficiently with AIs and most likely with farmers and, therefore, do not take appropriate actions that are conducive to the adoption of their technologies. It is very likely that their reliance on public extension services known to be inadequate is at the heart of their problem.
IV. Conclusions

A study of linkages between AIs and ARIs considered respectively as users and producers was conducted by SDD/ECA in 1999-2001. The methodology used involved a survey of 50 responding AIs out of 66 contacted and an interview held with the Ethiopian Agricultural Research Organization (EARO). The degree and other particulars of the co-operation between AIs and the ARIs were studied along with the constraints to mutually beneficial relations between the two establishments.

Only 22 and 30 per cent of the responding AIs (i.e. 15 and 11 out of the surveyed 50 AIs) co-operated with ARIs in 2000-2001 and prior to 2000, respectively. The slight increase in co-operation reported after 1999 may be ascribed to the sensitisation efforts of EARO which organized in November 1999 a workshop that brought together AIs and ARIs. There was also an improvement in the quality of the relations between AIs and ARIs following the workshop. In general, the poor co-operation between the AIs and ARIs is believed to be a possible sign of serious disarticulation of the National System of Innovation in Ethiopia.

The few AIs which co-operate with ARIs do so in the areas of “information exchange, development of new or improved varieties/genotypes”, “choice of appropriate technology” and “provision of facilities in support research of ARIs”. Information exchange is ranked first and is followed in decreasing order by other areas listed.

Causes of little or no co-operation are, in decreasing order:

a. Failure of AIs to seek assistance from ARIs;
b. Failure of ARIs to seek assistance from AIs;
c. Unavailability of technologies developed by ARIs in adequate quantities needed by AIs; and
d. Lack of awareness of how ARIs can assist AIs.

Other factors that are likely to affect the underlying co-operation are product characteristics, types of processing, in-house R&D and/or upgrading, and proximity of AIs to ARIs.
V. Recommendations

1. Because of the positive effects of the workshop convened by EARO in November 1999, it is highly recommended that this research organization continue to conduct similar workshops at regular intervals in order to bridge the information gap between AIs and ARIs. Since only 30 out of a total of 1963 AIs participated in the workshop, more needs to be done in order to cover the remaining 1933 AIs.

2. To further bridge the information gap between AIs and ARIs, EARO needs to popularize its activities and results using various media, such as television (TV), radio, press, and talk shows. It should hold regular weekly panel discussions of short duration on radio and TV. It should also advertise its research findings and give interviews for the most popular local newspapers and magazines.

3. EARO also need to develop appropriate mechanisms for the diffusion of its research result, not only at the level of AIs but also at that of the farmers. This calls for the need to incorporate extension activities in the work programme of EARO which must make sure that its technologies are adopted by the potential users.

4. Associations of AIs engaged in similar activities should be formed after the manner of tanneries. For example, different associations may be established for edible oil industries, flour/bread/biscuits and pasta producers, tanneries, breweries and textiles. Research/technology centres could be established under each association to help to forge linkages between the concerned AIs and ARIs, and to carry out full-fledged in-house R&D and technology upgrading in support of member AIs.

5. A further study of the linkages between Ethiopia’s AIs and ARIs is needed. This study requires that a larger sample which is more representative of the country’s 1963 AIs be surveyed to allow an in-depth statistical testing of the effects of various variables affecting the co-operation between the AIs and ARIs.

6. EARO is hereby urged to participate fully in the study mentioned above by filling in and returning the questionnaires it has already received from the ECA on the linkages between Ethiopia’s AIs and ARIs.
7. The recommendation to EARO that commercial farms be established and given incentives to duplicate in sufficient quantities for the AIs, agricultural raw materials needed by these AIs should be implemented. The Government of Ethiopia should take policy actions in this regard, particularly in connection with a land tenure system that is conducive to easy acquisition of agricultural land by farmers for the purpose, without much entanglement in the process of acquisition.

8. The EARO workshop, which brought together Ethiopia’s AIs and ARIs for the first time, should be selected as a best practice and popularized in ECA member countries.

9. Studies must be undertaken to identify and remove the bottlenecks in the National System of Innovation in Ethiopia. A particular emphasis must be given to AI-ARI relations in these studies. The sub-regional studies must also identify and compile best practices in forging linkages between local ARIs and AIs in Africa. These best practices should be disseminated for use in ECA member countries.

10. The Government should also take actions to encourage and/or improve the competitiveness of AIs. Among other measures, it should allocate a revolving fund free of interest charge for AIs, to assist them to establish and function R&D facilities.
## Annexes

### Table 1. Ethiopian agro-industries involved in the survey

<table>
<thead>
<tr>
<th>Type of Industries</th>
<th>Address</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. FOOD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Addis Modjo Edible Oil Complex S.C.</td>
<td>Addis Ababa (A.A)</td>
<td>01-651270/01-167074</td>
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<tr>
<td>2. Anbessa Flour &amp; Macaroni Factory (East Afica Group ETH Ltd)</td>
<td>A.A.</td>
<td>01-201242/01-711400</td>
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<tr>
<td>3. Fafa Foods S.C.</td>
<td>A.A.</td>
<td>01-651755/01-165805</td>
</tr>
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<td>4. Diredawa Food Complex S.C.</td>
<td>Diredawa</td>
<td>05-114020/05-113038</td>
</tr>
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<td>5. Wonji/Shewa Sugar Factory</td>
<td>Wonji (Oromia)</td>
<td>01-513488/02-110977</td>
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<tr>
<td>6. Metehara Sugar Factory</td>
<td>Metehara (Oromia)</td>
<td>02-110600/02-510934</td>
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<td>7. Fincha Sugar Factory</td>
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<td>01-512557</td>
</tr>
<tr>
<td>8. Bahirdar Edible Oil Company</td>
<td>Bahirdar (Amhara)</td>
<td>08-200920/08-200755</td>
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<td>9. Abuare Edible Oil Factory</td>
<td>A.A.</td>
<td>01-112743</td>
</tr>
<tr>
<td>10. Birale Edible Oil Factory</td>
<td>A.A.</td>
<td>01-654914/01-654500</td>
</tr>
<tr>
<td>11. ELFORA Agro-Industries Plc</td>
<td>A.A</td>
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</tr>
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<td>12. Nazareth Edible Oil Factory</td>
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<td>02-112476</td>
</tr>
<tr>
<td>13. Teramaj Edible Oil &amp; Macaroni Factory*</td>
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<td>01-163406/01-651800</td>
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<td>14. Misrak Flour and Bread Factory</td>
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<td>01-653255/01-160468</td>
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<tr>
<td>15. Kokeb Flour Mills Factory</td>
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<td>01-650777</td>
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<tr>
<td>16. Kaliti Food Processing Factory*</td>
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<td>01-340144/01-340157</td>
</tr>
<tr>
<td>17. Nazareth Flour Factory*</td>
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<td>Type of Industries</td>
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</tr>
<tr>
<td>18. Yerer Flour Factory</td>
<td>Nazareth (Oromia)</td>
<td>02-112901/02-111543</td>
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<td>19. Debrezeit Flood Industry</td>
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<td>20. Kaliti Food S.C.</td>
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<td>21. Ethiopia Amalgamated Ltd.</td>
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<td>22. Dairy Development Enterprise</td>
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<td>23. Addis Ababa Flour Mill</td>
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<td>24. Enat Agro-Industry Plc (Flour Mill)*</td>
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<td>25. Upper-Awash Agro-Industry Enterprise</td>
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<td>26. Gonder Edible Oil Factory*</td>
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<tr>
<td>27. Awassa Flour Factory*</td>
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<tr>
<td>28. Getachew Beffa Edible Oil Factory*</td>
<td>Dilla</td>
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<tr>
<td>29. St. George Flour Factory*</td>
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2. BEVERAGE

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<th>Type of Industries</th>
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</thead>
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<td>1. Meat Abo Brewery S.C.</td>
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<td>2. Harar Brewery S.C.</td>
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<td>3. Bedele Brewery S.C.*</td>
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<td>4. B.G.I Brewery – Bati Beer and Draft Beer</td>
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<td>01-515196/03-510396</td>
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<tr>
<td>5. Assela Malt Factory</td>
<td>Assela (Oromia)</td>
<td>02-311444/02-311644</td>
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<td>6. Awash Winer S.C.</td>
<td>A.A</td>
<td>01-712328/01-204790</td>
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<tr>
<td>7. Nejat International Plc</td>
<td>A.A</td>
<td>01-753089/01-342398</td>
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<td>8. Wondo Trading Plc</td>
<td>Awassa</td>
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<tr>
<td>3. TEXTILE</td>
<td></td>
<td></td>
</tr>
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<td>1. Akaki Textile</td>
<td>A.A (Akaki)</td>
<td>Arbaminch</td>
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<td>Awassa</td>
<td>Adwa (Tigray)</td>
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<td>Ethio Leather Industry (ELICO)</td>
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<td>8. Diredawa Textile Factory (Addis Izmir)</td>
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<td>Shewa Tannery</td>
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<td>9. Adey Abeba Yarn Factory*</td>
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<td>11. DES Ginning Factory S.C.*</td>
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<td>4. LEATHER</td>
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<td>5. Ethio Leather Industry (ELICO)</td>
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<td>Sebeta (Oromia)</td>
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<td>9. Mersa Tannery*</td>
<td>Mersa Tannery*</td>
<td>Wollo Mersa (Amhara)</td>
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<td>10. HAFDE Tannery Plc</td>
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<td>Type of Industries</td>
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<td>11. Horra Tannery Plc</td>
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<td>12. Dire Tannery*</td>
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<td>13. Walia Tannery</td>
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<td>14. Bale Tannery*</td>
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<td>15. Genuine Leather Craft Plc</td>
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<td>16. Ethio San Bin Leather Garment Factory</td>
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<td>18. Modern Zege Leather Products Industry</td>
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<td>01-157279</td>
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* Agro-Industries that did not respond; i.e. 16 AIs failed to respond out of a total of 66 AIs.
Table 2. Distribution of agro-industries surveyed by type of industry

<table>
<thead>
<tr>
<th>Type of agro-industries</th>
<th>Number and percentage of agro-industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>21 (42 %)</td>
</tr>
<tr>
<td>Leather</td>
<td>14 (28 %)</td>
</tr>
<tr>
<td>Textile</td>
<td>8 (16 %)</td>
</tr>
<tr>
<td>Beverage</td>
<td>7 (14 %)</td>
</tr>
<tr>
<td>Total</td>
<td>50 (100 %)</td>
</tr>
</tbody>
</table>
References


