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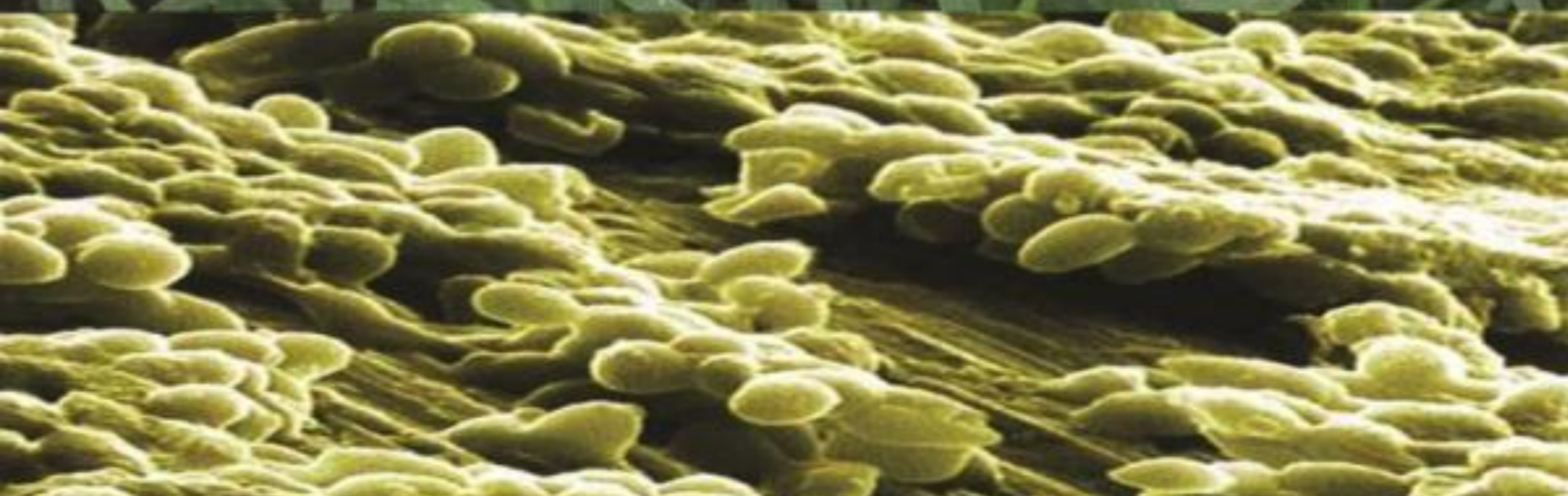

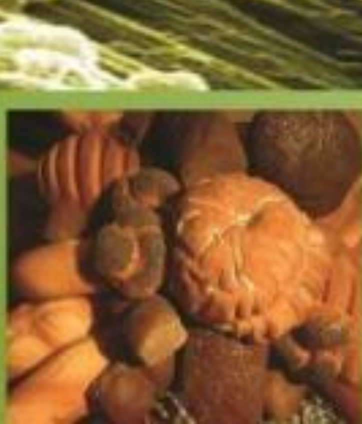

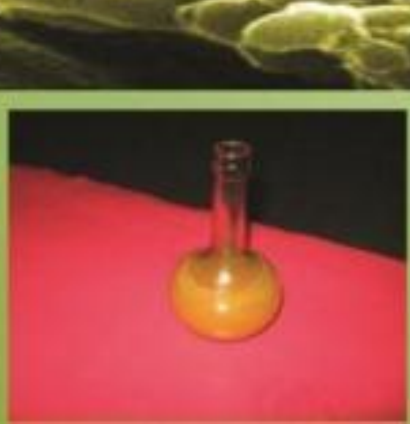

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Addis Ababa, Ethiopia

Message from the Director General

Ethiopia is known for its rich biological diversity. This diversity has been a basis mainly for agriculture, fisheries, social and cultural development. Our daily activities directly or indirectly depend on biological resources.

After ratifying the Convention on Biological Diversity, various efforts have been underway to conserve and sustainably utilize biological resources of the country particularly animals, microbes, plants and their ecosystems as well as the associated indigenous knowledge.

In addition to conservation activities on the ground, awareness creation is crucial tool to enhance the knowledge and appreciation on biological resources. On this basis, Ethiopia celebrated the 11th International Day for Biological Diversity by the theme “Wetland Biodiversity for sustainable development and food security” to raise awareness among all concerned parties and the communities.

Wetland biodiversity has not been given enough attention and many of the resources are under serious threat from siltation, invasive species, and unsustainable utilization. All these challenges coupled with climate change are aggravating the problem. This needs urgent action.

On the other hand, in addition to the previous two Access and Benefit Sharing agreements on Tef and Vernonia, we signed three agreements on three plant genetic resources namely; *Withania somnifera, Osyris* sp., and *Dichrostachys cinerea*. This reminds us that there is no worthless genetic resource and every genetic resource should be conserved and sustainably utilized. This will highly promote our conservation efforts.

Finally, I would like to call upon all concerned institutions to strengthen and synergize our efforts on conservation and sustainable utilization of biological resources; and act responsibly while undertaking different economic and social activities.

Gemedo Dalle (Dr.)

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Understanding Microbes and Microbial Dominance

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1. Understanding microbes

The term "microbe" stands as a generic descriptor for all microscopic organisms, i.e. bacteria, archaea, fungi, microalgae and protozoa together with the viruses. They live in highly organized and interactive communities that versatile, complex and difficult to analyze from many perspectives. However, understanding microbes in far greater detail and in realistic context of whole living systems and taking advantage of their complexities and surmounting the technical challenges of whole-systems biology is a daunting prospect. One of the challenges is that microbes are exceedingly small-only 1/8000th the volume of a human cell and spanning about 1/100th the diameter of a human hair. Investigating processes within this size range is challenging. Likewise, microbial world encompasses millions of genes from thousands of species, with hundreds of thousands of proteins and multimolecular machines operating in a web of hundreds of interacting processes in response to numerous physical and chemical environmental variables. Gene control is complex, with groups or cassettes of genes/operons directing coordinated transcription and translation of genes into interacting proteins. Also, microbes adapt rapidly in response to environmental change, an ability that underlines their survival for billions of years. For instance, various extremophile microbes have adapted to great extremes of pressure, temperature, pH, salinity, and radiation. Their high surface-to-volume ratio enhances interactions and supports adaptation. Unlike animal cells, they have no protective nucleus for their DNA, which leaves it more vulnerable to alteration. Genes move easily among species. Moreover, other microbial communities are awash in genetic material from viruses that confer additional genetic properties and expand their range of adaptability. Moreover, microbial communities can extend in size from cubic millimeter to cubic kilometer. Even relatively simple communities can have millions of genes, giving them a genetic diversity substantially greater than that of higher life forms, even humans. Recent investigations have focused on collecting DNA fragments from environmental samples in the sea and other natural ecosystems. These metagenomic studies have given us a glimpse into the intricacies of these natural ecosystems and their diverse functions.

2. No corner of Earth escapes the influence of microbes

Microbes live nearly everywhere- in soil, water, air, animals, humans, plants, foods. They live under natural conditions and in any extreme habitats- whether hot, cold, salty, arid, acidic, alkaline, high pressure, oxygen-free, or toxic- hot springs, geysers, volcanoes, and ocean vents.

Probably the most important overriding features of microbes are their exceptional diversity and ability to occupy every imaginable habitat for life. Indeed or carrying out processes that we had no idea where microbial in nature. There's hardly a niche on Earth that hasn't been colonized by microbes. Here are some of Earth's toughest microbes with records to debate.

2.1. Swimming in Heat (Heat-lovers)

Steaming hot pools and scalding hydrothermal vents provide a cozy habitat for heat-loving extremists. Such 'supper/hyper thermophiles' produce enzymes that are stable at high temperatures. Some have been isolated and put to work in everything from laundry detergents to food production. The upper limit for life had been widely recognized as 113°C, after a microbe *Pyrolobus fumari* that was discovered in 1997 inside a single hydrothermal vent in the Atlantic Ocean, 3650 metres below the surface. However, a microbe collected from a vent at 2400 metres down in the Pacific Ocean, has upped the chance. It survived and multiplied during a 10-hour blast in a 121°C autoclave, an oven used to sterilize medical equipment. It's been given the preliminary name of "Strain 121" and is in the same family as *Pyrolobus fumari*.

2.2. Relaxing in Cold (cold-lovers)

The frostiest Polar Regions and the darkest depths of the ocean are home for a few microbes that prefer a good chill. Many are bacteria or similar single-celled microbes called archaea, but some lichens called cryptoendoliths go to extremes by colonizing pores in Antarctic rock. There's also an alga that creates reddish watermelon snow. Cold-loving microbes have specialized cell membranes that don't stiffen in frigid temperatures, and many produce a kind of protein antifreeze. Microbes are known to grow at -12°C, and they survive at -20°C. Some studies even hint that a bacterium called *Colwellia psychrerythraea* strain 34H can withstand -196°C, the temperature of liquid nitrogen.

2.3. Enjoying in salt (Salt-lovers)

Despite its name, the Dead Sea does harbor life. It's the saltiest body of water on Earth, but a few microbes thrive there, in water eight times saltier than the ocean. *Haloarcula marismortui* is a microbe that has specialized proteins that protect it from the effects of salt.

2.4. Enjoying in Acid (Acid-lovers)

Acidic hot springs and fountains that would eat away human flesh are no match for some microbes that make themselves at home in the acid. The known are microbes of the genus *Picrophilus.* They thrive at a pH of 0.7, and can grow happily to a pH of 0.

2.5. Enjoying in alkaline (Alkaline-lovers)

The most alkaline environments in the world are soda lakes, which can have a pH as high as 12, similar to ammonia. A number of microbes enjoy those caustic conditions, including *Natronomonas pharaonis*.

2.6. Refreshing in Deep

Microbes from the *Pyrococcus* and *Thermococcus* genera were found in a mud core taken from 1.6 km below the sea floor off the coast. Though they represent the deepest life ever discovered beneath the sea floor, microbes of various kinds have been discovered at even greater depths under the continents. Communities of microbes have been found hunkered down in groundwater as far as 5 km below the surface of the land. Scientists think life exists even further to the point where the subsurface heat becomes unbearable for life. Even the deepest part of the ocean, the Mariana Trench, which plunges 11 km below the surface of the Pacific Ocean, is inhabited. Drops of mud pulled from the trench have yielded a collection of bacteria, fungi and foraminifera, where the pressure would crush a human.

2.7. Walking in dried up

Microbes like the bacterium *Chroococcidiopsis* have been in the most parched place on Earth, the Atacama Desert, which stretches nearly 1,000 km across South America. It rains only a few times a century. It's no coincidence that the desert has been used by filmmakers as a stand-in for Mars. There is also an evidence for the presence of similar microbe on the so-called "the hottest place on earth" Erta Ale, Danakil Depression, Ethiopia, where there is water scarcity and temperature reaches 60-63^{0}C.

2.8. Nestling in a dump

Some microbes like nothing better than to be nestled in a toxic sludge of heavy metals like zinc, arsenic and cadmium. They thrive in hazardous waste dumps and in mine by making a meal out of metal. *Geobacter* bacteria, for example, convert dissolved uranium into a solid form, so it could be put to work cleaning up contaminated land.

2.9. Playing with a blast

Incredibly, the bacterium *Deinococcus radiodurans* can withstand about 2000 times the dose of ionizing radiation that would kill a human, making it the most radiation-resistant microbe known. A blast like that shatters the bacterium's chromosomes, but it can repair itself within hours.

2.10. Flying in the space

Many studies confirm that a variety of bacteria such as *Bacillus* spp., *Streptomyces maritimus*, *Janibacter hoylei*, *Methylobacterium* sp., *Acinetobacter radioresistens*, *Stenotrophomonas rhizophilia*, *Micrococcus* spp., *Staphylococcus pasteuri*, and fungi such as *Penicillium* sp., *Cladosporium cladosporoides*, *Alternaria* sp., *Tilletiopis albescens*, *Engyodontium album* are isolated, using standard isolation media, from the stratosphere at heights of up to 77km.

2.11. Ageing well

Microbes can survive for many, many millennia, though scientists are still debating how long. In 2000, scientists made a very astonishing claim that they had brought to life a 250 million-year-old bacterium dubbed *Bacillus permians*. According to the team, bacterial spores in a drop of water became trapped in a cavity inside salt crystals as they formed 250 million years ago. This and other similar reports remain controversial, but nevertheless, the ever growing list of long-lived microbes gives scientists hope that life may exist elsewhere in the solar system.

3. Collective weight and power of microbes

Whether measured by the number of organisms or by total mass, the vast majority of life on this planet is microscopic. Nowhere is the principle of strength in numbers more apparent than in the collective power of microbes. Each individual microbe is but an almost weightless, one-celled organism, the collective weight of Earth's 5 million-trillion-trillion or five nonillion (1 followed by 30 zeros) microbes accounts for most of the planet's biomass—the total weight of all living things. Even the total number of stars in the universe (7 thousand-billion-billion) pales in comparison to the number of microbes on Earth. Despite around 2000 microorganisms already have their genomes deciphered, a large number remains unexplored. These teaming multitudes profoundly influence the make-up and character of the environment in which we live. With their mighty collective muscle, microbes control every ecological process, from the decay of dead plants and animals to the production of oxygen. It may surprise that we know very little about the microbes that live in the world around us because insignificant number of them can be grown in the laboratory. Understanding which microbes are in each ecological niche and what they are doing there is critical for our understanding of the world.

4. Inhabiting human body

Microbes inhabit the human body. In fact, every person has more than 10 times as many microbes living on and inside his or her body as they have human cells. The human body has 10-100 trillion microbes living on it, making it one giant super-organism. Although most frequently associated with disease, microbes help us much more than they harm us by controlling many of the biological processes that are essential to our survival, including the maintenance of our skin and the digestion of our food. Each person's digestive tract alone harbors about 3 pounds of bacteria. The microbes that normally live in associations with humans on the various surfaces of the body (called the normal flora), such as *Lactobacillus* and *Bifidobacterium*, are known to protect their hosts from infections, and otherwise promote nutrition and health. For the most part, we live peacefully alongside these strangers. Without them, human life would be open to every condition for death.

5. Restive engineers of our planet

Microbes are the major actors in the synthesis and degradation of all sorts of important molecules in environments. Here are some of the facts that they are the best and restive engineers of our planet.

5.1. Primary production

It involves photosynthetic organisms which take up CO_2 in the atmosphere and convert it to organic (cellular) material. Although terrestrial plants are obviously primary producers, planktonic algae and cyanobacteria account for nearly half of the primary production on the planet. These unicellular organisms which float in the ocean are the "grass of the sea", and they are the source of carbon from which marine life is derived.

5.2. Biodegradation

There is no naturally-occurring organic compound that cannot be degraded by some microbe, although some synthetic compounds such as Teflon, Styrofoam, plastics, insecticides and pesticides are broken down slowly or not at all. Here are some facts on natural microbial factories.

5.2.1. Oil -eaters

We are increasingly taking advantage of the versatile appetite of microbes to clean up environments that we have contaminated with crude oil, polychlorinated biphenyls (PCBs) and many other industrial wastes. Some microbes are hard at work cleaning oil spills. *Alcanivorax borkumensis* is one of the most important worldwide due to the fact it produces a wide variety of very efficient oil-degrading enzymes. *Pseudomonas aeruginosa* is playing a significant role in degrading oil (very much likely to be used in remediating oil spill). *Pseudomonas putida* is useful in degrading the organic solvents such as toluene.

5.2.2. Nylon-eaters

Flavobacterium Sp. K172 became popularly known as nylon-eating bacteria, and the enzymes used to digest the man-made molecules became collectively known as nylonase**.** Scientists have also been able to induce another species of bacteria, *Pseudomonas aeruginosa*, to evolve the capability to break down the same nylon byproducts in a laboratory by forcing them to live in an environment with no other source of nutrients.

5.2.3. Plastic-eaters

Microbiologists have found that the Vibrio's group of bacteria appears to be eating away the surfaces of the microplastics. This could be very good news, provided they are actually digesting the polymer molecules and breaking down associated toxins.

5.3. Nitrogen fixation

Nitrogen fixation results in replenishment of soil nitrogen removed by agricultural processes. Some bacteria fix nitrogen in symbiotic associations in plants. Other Nitrogen-fixing bacteria such as *Bradyrhizobium*, *Azospirillum*, *Beijerinckia*, *Azotobacter*, *Frankia*, *Anabaena*, *Nostoc*, *Trichodesmium*, *Calothrix*, *Phormidium*, *Scytonema*, *and Oscillatoria* are free-living in soil and aquatic habitats.

5.4. Fermentation

In the home and in industry, microbes are used in the production of fermented foods. Yeasts are used in the manufacture of beer and wine and for the leavening of breads, while lactic acid bacteria are used to make yogurt, cheese, sour cream, buttermilk and other fermented milk products (*Lactobacillus* spp., *Leuconostoc* spp.). Vinegars are produced by bacterial acetic acid fermentation. Other fermented foods include soy sauce, sauerkraut, dill pickles, olives, salami, cocoa and black teas.

Surprisingly cacao seeds must be fermented, dried, and roasted to produce the chocolate flavor. Fermentation and drying are done at the farm that grows the chocolate trees. These changes are the result of microbial growth such as *Saccharomyces cerevisiae*, *Candida rugosa*, *Kluyveromyces marxianus*, *Lactobacillus* sp., *Streptococcus* sp., *Acetobacter* sp., *Gluconobacter* sp., *Geotrichium* sp., and amylase obtained from *Aspergillus* until the final product of chocolate.

5.5. Medical and pharmaceutical applications

In human and veterinary medicine, for the treatment and prevention of infectious diseases, microbes are a source of antibiotics and vaccines.

5.5.1. *Antibiotics*

These are substances produced by microorganisms that kill or inhibit other microbes which are used in the treatment of infectious disease. Antibiotics are produced in nature by molds such as *Penicillium* and bacteria such as *Streptomyces* and *Bacillus*.

5.5.2. Vaccines

These are substances derived from microorganisms used to immunize against disease. The microbes that are the cause of infectious disease are usually the ultimate source of vaccines. Thus, a version of the diphtheria toxin (called toxoid) is used to immunize against diphtheria, and parts of *Bordetella pertussis* cells are used to vaccinate against pertussis (whooping cough). The use of vaccines such as smallpox, polio, diphtheria, tetanus and whooping cough has led to virtual elimination of these diseases in regions of the world where the vaccines have been deployed.

5.6. Biotechnological applications

The two thermophilic species *Thermus aquaticus* and *Thermococcus litoralis* are used as sources of the enzyme DNA polymerase, for the polymerase chain reaction (PCR) in DNA fingerprinting. As thermophiles have become increasingly important in biotechnological research, the numbers of bio-prospecting groups searching for useful organic compounds in nature have dramatically increased as well.

5.7. Biomining

Thiobacillus ferooxidans gets its energy by metabolizing inorganic materials. As the bacteria eat, they release a waste product of acid and an oxidizing solution of ferric ions. Together these wash the metal right out of the ore. Today *T. ferooxidans* is used to extract more than 25 percent of all the copper mined in the world from what was once considered low-grade ore. Gold ore, once thought to be useless for mining, is also releasing its gold deposits with the help of *T. ferooxidans*. A brew of microbes and fertilizer can be poured directly onto piles of crude ore. This method is much cheaper, more efficient, and more environmentally friendly than other extraction processes.

6. Is conservation of only visible organisms praiseworthy?

No! Microbes may appear endlessly abundant, everywhere and to an extent interchangeable, but some do face real threats to their existence. It could be argued that protecting the ecosystem will suffice to protect its microbes. This is clearly sensible when resources are scarce. However, many ecosystems are neglected in conservation strategies simply because of the absence of larger organisms, for instance desert soil crusts, glaciers, or unusual geological formations.

Regardless of the importance of microbes, scientists have been able to study less than one percent of the estimated millions of microbial species that live on Earth. It is because microbes have strict nutritional requirements and interact with one another in complex ways that currently make it impossible to grow the overwhelming majority of them in the laboratory.

In the past few years, due to advances in molecular methods and techniques, our knowledge of microbial diversity has increased dramatically not only from a phylogenetic and taxonomic perspective but also from an ecological basis. New technologies, particularly in nucleic acid analysis, computer science, analytical chemistry, and habitat sampling and characterization place the study of microbial diversity on the cutting edge of science. Exploration, evaluation and exploitation of microbial diversity is essential for scientific, industrial and social development. The vast microbial diversity of the natural world, combined with ingenious methods to access the diversity, can provide us with a bountiful source of new and valuable products. Therefore, continued research is needed to describe and conserve the unexplored resources for the preservation of natural ecosystems and the future benefit of mankind. Because, if all of Earth's microbes died, so would everything else, including us. But if everything else died, microbes would do just fine. Therefore, we need microbes more than they need us.

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Status of Microbial Culture Collection at Institute of Biodiversity Conservation, Ethiopia

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1. Introduction

Culture collection centers are infrastructures specialized in long-term, *ex situ* conservation of microbes, which include huge numbers of cultures of reference. These cultures are referred to as "type strains" when they constitute the archetype of a species, and as "reference strains" when they are a culture of a lineage with well-identified properties. The "type strains" constitute the primary elements of taxonomy; the "reference strains" are essential parts of a coherent research and development process chain.

Culture collection centers provide support to a wide variety of microbiological work. Their primary function is to collect, maintain, and distribute microbial strains ordered by microbiological laboratories for use in teaching, researching, quality control assays, biotechnology, etc. Culture collection centers are like libraries, but instead of books they store living material, i.e. microorganisms.

2. History of Culture Collection in the World

Culture collection centers were originated when Koch's school introduced pure culture techniques in bacteriology, and the first culture collection center to provide services was established by Prof. Kral, in 1890, at the German University of Prague (Czech Republic). In 1900, Kral published the first catalogue of strains from a culture collection.

After Kral's collection, other culture collection centers were established. There are currently more than 580 culture collection centers in 68 countries which are registered with the World Data Centre for Microorganisms (WDCM) of the World Federation for Culture Collections (WFCC). WDCM database forms an important data hub facilitating communication among WFCC members and providing information about the holdings of the collections.

3. Services of Culture Collection Centers

Most culture collection centers across the world offer the following services to the microbiological community:

- To collect, maintain, and dispatch microbial strains.
- To collect strain data and make accessible to the microbiological research community through printed or on-line catalogues.
- To act as safety deposits of microbial strains with restricted distribution.
- To provide identification services according to the expertise of the culture collection regarding the different kinds of microorganisms.

- To serve as deposits of strains. These can be public strains, and thus published in the culture collection catalogue, strains held for patent purpose under the Budapest treaty; in this case the data are not published in the catalogues. There are also compulsory deposits in bacterial taxonomy every time a new species is described, the type strain being published in the catalogue.
- To organize training courses, mainly related to the identification and maintenance of microorganisms.
- To carryout research, mainly related to taxonomy and microbial preservation.
- To provide general advice in the field of microbiology.

By preserving microbial strains, microbial culture collection centers provide a link to the past; they make it possible to work with the same strains that were described or cited in publications. Moreover, culture collection centers also store newly described microorganisms, which researchers can test for future applications.

4. Current Status of Microbial Culture Collection at Institute of Biodiversity Conservation

The microbial culture collection history of Ethiopia is not well studied. Lack of documentation and scarcity of information is one of the reasons that contribute to the problem. The other major reason might be the absence of practice of preserving microbes for long period of time and lack of facilities to carry out preservation. But, in general terms, it is known that High Learning and Research Institutions isolate and characterize microbes of their own interest. Nevertheless, most of them do not have facilities for long time preservation.

After the former Plant Genetic Resource Centre is reestablished as Institute of Biodiversity Conservation and Research in 1998, it had made tremendous effort in collecting, maintaining and preserving microbes. Currently, IBC has a collection of 233 species of microbes which are identified and preserved from 2004 to 2010. Three of the 233 microbes belong to Archae, 200 of them belong to Bacteria and the rest 30 are fungi. These isolated and characterized microbes have great importance in the area of agriculture, medicine, industry and environmental protection. However, this is very small number when the potential microbial biodiversity of the country is taken into consideration. Thus, expanding major activities such as identifying, characterizing and conserving microbes in collaboration with relevant institutions working on microbes are necessary so that Ethiopia will get more benefit from its microbial diversity.

4.1 Networking

Many Countries over the world developed and implemented their own national policies, laws and regulations for the collecting, maintaining and distribution of biological resources according to the Convention on Biological

Diversity. Ethiopia had developed and started implementing its own national policies, laws and regulations for microbial culture collections so that all collections work under the same framework and play an effective role in the provision of the cultures for research and development. Thus, IBC has a mission to form national network among higher learning and research institutes which work on microbial studies.

4.2 Capacity building

The tasks that face microbial culture collections are enormous. The major challenges are limited funding, lack of personnel and absence of biosystematics. Genomics, post-genomics and other developing areas in bioinformatics are placing enormous demands on researchers and collections, making it imperative that information generation and maintenance of *ex situ* microbial diversity are coordinated and that tasks are shared. Bioinformatics is of increasing importance to the operation of collections, and new ways of collecting, storing, analyzing and presenting data are required to make best use of biodiversity information. Molecular techniques to differentiate between strains and to aid in their identification are increasing in use. Recent work at CABI has shown through PCR fingerprinting of replicates of an isolate of *Metarhizium anisopliae* that polymorphisms were introduced as a result of non-optimized preservation techniques. Therefore, at the very least collections should be adopting molecular techniques to determine whether they are preserving strains without change. Thus, in the absence of well-organized and equipped laboratories and limited funding and personnel; it will not be possible to collect, characterize and utilize the microbial genetic resources of the country. Taking all this into consideration, IBC is striving to build its manpower, technologies and facilities.

4.3 Establishing Ethiopian Microorganisms Collection Center

Many countries and individual institutions have established or are establishing culture collections of microorganisms for the first time, either to provide services to their country or region or in support of their own research programs. They can be either service collections or in-house (research) collections. Service collections offer services outside their own institution, but research collections are established to support their own research programs. Thus, forming Ethiopian Microorganisms Collection Center in IBC is mandatory and will have the following advantages.

- It enables IBC to integrate and coordinate separate activities of research collections that are found throughout the country.
- It will make the task of registering the isolated and identified microorganisms of Ethiopia easy and enables IBC to form Ethiopian database center for microorganisms.

- It will make the accession of microorganisms easy for further research and development.
- It will provide facility for interested researchers and pave a way to provide other services offered by international culture collections.
- It is a primary step to join the World Federation for Culture Collection (WFCC) and collaborating with international institutions.

4.4 Collaboration with other institutions

The World Federation for Culture Collections (WFCC) is a COMCOF (Committees, Commissions and Federations) of the International Union of Microbiological Societies (IUMS) and a scientific member of the International Union of Biological Sciences (IUBS). Its key objective is the promotion and development of collections of cultures of microorganisms and cultured cells. Retention and support of existing collections, as well as assistance and advice to help in establishing new collections is also its key activities. The members of WFCC constitute a unique global network for *ex situ* preservation of microbial diversity which underpins life on earth. There are currently more than 580 culture collections in 68 countries which are registered with the World Data Centre for Micro-organisms (WDCM) of the World Federation for Culture Collections (WFCC). But, Ethiopia is not member of WTCC yet. And, this makes Ethiopia be unable to find many of the advantages acquired by membership.

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Mushroom Cultivation for Sustainable Food Security

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1. Background

Ethiopia has a tropical monsoon climate characterized by wide topographic-induced variations. With rainfall highly erratic, Ethiopia is usually at a high risk for droughts as well as intra seasonal dry spells. The majority of the population depends on agriculture as the primary source of livelihood and the sector is dominated by smallholder agriculture.

An ever increasing human population and diminishing farm sizes have resulted in declining soil fertility and associated land degradation, culminating in decreased land productivity and increasing poverty levels. There-fore, cultivation of edible mushroom offers a unique opportunity to bio-convert agricultural and forestry waste materials into valuable foods and medicines.

Mushroom is a fungus with a distinctive fruiting body, which can be either epigeous or hypogenous and large enough to be seen with naked eye and to be picked by hand and which have a texture appearance and manner of growth all their own. It belongs to a fungi in basdiomycota division. They include edible, non-edible, medicinal and poisonous species. There are over 1,500,000 species of fungi on earth. Among this, the number of mushroom species is estimated at 140,000. For millennia, mushrooms have been valued by human kind as edible and medicinal resources. Currently about 35 mushroom species have been cultivated commercially and of these around 20 are cultivated on an industrial scale. The mushroom most produced worldwide is *Agaricus bisporus* followed by *Pleurotus ostreatus, Lentinula edodedes*, *Auricula auricular*, *Flammulina velutipes*, *Volverila volvovocea*, *Grifola frondosa*, *Pholiota nameko and Ganoderma lucidum*.

Mushroom cultivation can directly improve livelihoods through economic, nutritional and medicinal contributions. Besides to their edibility and health benefits, their mycelia can produce a group of complex extra cellular enzymes which can degrade and utilize the lignocelluloses wastes in order to reduce pollution. It has been revealed recently that their mycelia can play a significant role in the restoration of damaged environments. Saprotrophic, endophytic, mycorrhizal, or even parasitic mushrooms can be used in mycorestoration, which can be performed in four different ways. Microfiltration (using mycelia to filter water), mycoforestry (using mycelia to restore forests), mycoremediation (using mycelia to eliminate toxic waste, and mycopesticides (using mycelia to control insect pests); these methods represent the potential to create the clean ecosystem.

2. Nutritional value

Mushrooms are health foods that are relatively low in calories and fat but rich in vegetable proteins, chitin, vitamins, and minerals. Furthermore, it is advocated that mushrooms constitute an increasing share in the world diet.

Mushrooms both add flavor to bland staple foods and are a valuable food in their own right, they are often considered to provide a fair substitute for meat, with at least a comparable nutritional value to many vegetables. The consumption of mushrooms can make a valuable addition to the often unbalanced diets of people in developing countries.

Fresh mushrooms have high water content, around 90 %, so drying them is an effective way to both prolong their shelf-life and preserve their flavor and nutrients. Mushrooms are a good source of vitamin B, C and D, including niacin, riboflavin, thiamine, and folate, and various minerals including potassium, phosphorus, calcium, magnesium, iron and copper. They provide carbohydrates, but are low in fat and fiber, and contain no starch. Furthermore, edible mushrooms are an excellent source of high quality protein (reportedly between 19-35%) and white button mushrooms contain more protein than kidney beans. In addition to all the essential amino acids, some mushrooms have medicinal benefits of certain polysaccharides, which are known to boost the immune system.

3. Medicinal value

The second major attribute of mushrooms are their medicinal properties. Today, an estimated 6% of edible mushrooms are known to have medicinal properties and can be found in health tonics, tinctures, teas, soups and herbal formulas. *Lentinula edodes* (shiitake) and *Volvariella volvacea* (Chinese or straw mushroom) are edible fungi with medicinal properties widely diffused and cultivated.

The medicinal properties of mushrooms depend on several bioactive compounds and their bioactivity depends on how mushrooms are prepared and eaten. Shiitake are said to have antitumor and antiviral properties and remove serum cholesterol from the blood stream. Other species, such as *Pleurotus ostreatus* (oyster), *Auricularia auricular* (mu-er), *Flammulina velutipes* (enokitake), *Termella mesentrica* (yin-er), *Grifola frondosa* (maitake) *and Ganoderma lucidum*(Reshi*)* have varying degrees of immune system boosting, lipid lowering, anti-tumor, anti-microbial and viral properties, blood pressure regulating, hypercholesterolemia and other therapeutic effects. Mushrooms represent a vast source of yet undiscovered potent pharmaceutical products and their biochemistry would merit further investigation.

4. Source of Income

Mushroom cultivation activities can play an important role in supporting the local economy by contributing to subsistence food security, nutrition, and medicine; generating additional employment and income through local, regional and national trade and offering opportunities for processing enterprises.

Trade in cultivated mushrooms can provide a readily available and important source of cash income for men and women as well as for the old and disabled a like.

The role played by women in rural mushroom production can be very significant. Certain parts of the mushroom cultivation process, such as filling substrates in containers and harvesting are ideally suited for women's participation. Several programs have enhanced women's empowerment through mushroom production by giving them the opportunity to gain farming skills, financial independence and self-respect.

5. Mushroom cultivation in Ethiopia

In many parts of Africa, mushroom eating is a well-developed habit. In Ethiopia also, is a common practice particularly in rural area in traditional ways. However, there is no exhaustive collection, experimentation, documentation and modern cultivation technology. With regard to Ethiopian wild edible mushrooms, very little was written and few edible mushroom are identified like *Agaricus campestries*, *Agaricus bingensis*, *Agaricus augustus*,*Chlorophyllum molybdites* and *Termitomyces* species. There is great opportunity to expand the mushroom cultivation technology in Ethiopia for the following reasons.

- Mushrooms require short production period;
- A bulk of agricultural and industrial waste raw materials are available;
- Mushroom production is throughout the year;
- Mushrooms require little land;
- Mushrooms do not require light;
- Mushrooms convert inedible plant biomass to nutritious food;
- Mushrooms are high value international crops with growing global market;
- Mushrooms require simple cultivation techniques.

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Metagenomics: Core of Paradigm Shift in Microbial Diversity Analysis

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1. Introduction

Microbes are dominating the ecosystem and have much practical significance in agriculture, pharmaceutical and food industries, genetic engineering, chemical industries and environmental protection. They provide various valuable products such as metabolic products (carbohydrates, proteins, lipids) and novel genes that use to produce in central metabolic products. Despite these obvious importance of microbes, very little is known of their diversity (number of species present in environment) and its ecological function. This is because, conventional (culture based) methods are dependent on microbial study that limits analysis to those grown under laboratory conditions which are only about 1% of microbial communities and also lack information about interaction of microbial species with other species and its environment.

2. Concept and Principle of Metagenomics

Since the advent of molecular techniques, scientists have developed various molecular methods which are culture independent and superior to culture dependent methods in providing ample information on interaction of microbial species with other species and its environment. Because these techniques involve analysis of variability at DNA level it is the most successful approach to explore microbial diversity and to determine the species composition of mixed microbial communities. These techniques have wide applications in microbial ecology to enumerate microbes in their natural habitat and to determine the structure, function, and dynamics of microbial community.

Broadly, the molecular techniques can be grouped into two major categories; (i) DNA fingerprint based and (ii) sequence base techniques. The former class comprises denaturing gradient gel electrophoresis, temperature gradient gel electrophoresis, single strand conformation polymorphism and terminal restriction fragment length polymorphism. Genomic and partial DNA segment sequencing are part of the latter category and these techniques are superior in metagenomics compared to DNA finger printing techniques sequencing. Early sequencing methods involve PCR amplification of small DNA segments and cloning of these segments into appropriate vector which is time consuming and laborious activity

Metagenomics is a new field of study and techniques that allow the study of genomes directly obtained from environmental samples. It is defined as "the application of modern genomic techniques to the study of communities of microorganisms directly in their natural environments, bypassing the need for isolation and laboratory cultivation of individual species. It is also described as culture independent analysis of a mixture of microbial genomes and as an effective tool for the discovery of new natural products and microbial functions. Thus, metagenomics allows the assessment and exploitation of the taxonomic and metabolic diversity of microbial community at an ecosystem level.

Early techniques of metagenomics comprise some processes that involve isolating of DNA from environmental sources and cloning it into vectors that allow cloning and expression of large and complex DNA segments or gens. The three major steps of metagenomics include; (i) sampling and nucleic acid extraction, (ii) clone library construction and (iii) analysis of clone libraries/sequencing.

Two different sequencing methods are commonly used in metagenomics study using sequencing base techniques. These are (i) Sanger sequencing method and (ii) Pyrosequencing methods. The former method was developed in 1975 by Sanger that based on plus and minus of nucleotide and it was a critical transition technique leading to the modern generation of latest sequencing methods. The later sequencing method (Pyrosequencing) is a method of DNA sequencing (determining the order of nucleotides in DNA) based on the "sequencing by synthesis" principle. It differs from Sanger sequencing, in that it relies on the detection of pyrophosphate release on nucleotide incorporation, rather than chain termination with dideoxynucleotides. The technique was developed by Pål Nyrén and Mostafa Ronaghi at the Royal Institute of Technology in Stockholm in 1996. The desired DNA sequence is able to be determined by light emitted upon incorporation of the next complementary nucleotide by the fact that only one out of four of the possible A/T/C/G nucleotides are added and available at a time so that only one letter can be incorporated on the single stranded template (which is the sequence to be determined). The intensity of the light determines if there are more than one of these "letters" in a row. The previous nucleotide letter (one out of four possible dNTP) is degraded before the next nucleotide letter is added for synthesis: allowing for the possible revealing of the next nucleotide(s) via the resulting intensity of light (if the nucleotide added was the next complementary letter in the sequence). This process is repeated with each of the four letters until the DNA sequence of the single stranded template is determined.

3. Application of metagenomics

Some challenges that human being has been faced today include break out of new disease and resistant pathogens, large-scale climatic and atmospheric changes, gaps for need of stronger and more nutritious crops, environmental contamination, and scarcity of energy are some of the driving forces for interpreting the enormous array of processes and interactions that characterize microbial communities on Earth. Potential /applications/ opportunities that can be addressed through metagenomics include:

- **Agriculture:** The development of more effective and comprehensive methods for early detection of threats to food production and food safety and growing more nutritious crops using microbial biofertilizers.
- **Earth sciences:** describe and predict global environmental processes, change and sustainability through development of genome-based microbial ecosystem models.
- **Life sciences:** The improvement of new theory and predictive abilities in community-based microbial biology, ecology and evolution.
- **Biomedical sciences:** The definition, on a global scale, of the effects of the human microbiome to health and disease in individuals and populations and the advance in novel treatments based on this knowledge.
- **Energy:** The advance of microbial systems and processes for new bioenergy resources that will be more economical, environmentally sustainable, and resilient in the face of disruption by world events.
- **Environmental remediation:** Design advanced tools for monitoring environmental damage at all levels.
- **Biotechnology:** Generation of beneficial industrial, food, and health products through identification and exploitation of the biosynthetic and biocatalytic capacities of microbial communities.
- **Biodefense and microbial forensics:** The development of vaccines and therapeutics against potential bioterror agents, the deployment of genomic biosensors to monitor microbial ecosystems, and the ability to identify and characterize microbes that have played a role in war, terrorism and crime.

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Never Underestimate the Role of Algae to our Ecosystem

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1. Introduction

Algae are diverse group of simple, plantlike photosynthetic eukaryotic organisms that range in size from minute phytoplankton (single celled) to giant marine kelps that may grow to 60 meters long. Most algae use the energy of sunlight to make their own food through a process called photosynthesis. Algae have some features which make them unlike normal land plants; they lack vascular tissues and other adaptations to live on land like true roots, leaves, and other structures typical of true plants. Algae also reproduce quite differently to the flowering plants. They have spores like the ferns, mosses, lichens and liverworts.

Algae can grow almost anywhere where there is water, no matter how transient. They are most abundant and diverse in oceans, lakes, ponds, streams and other wetlands, but they also colonize bark, leaves, rocks, soil, snow and even animals. Algae are divided into three main groups green, brown and red algae based on having different photosynthetic pigments. The study of algae is termed as phycology, and one who studies algae is known as a phycologist.

2. Microalgae

Microalgae are the most important photosynthetic groups of algae which are mostly single celled especially Dinoflagellates, Bacillariophyta and Chlorophyta are the main ones. Microalgae have many special features, which make them an interesting class of microorganisms. Many freshwater algae are microscopic in nature. Microalgae are very colorful. They exhibit different colors such as green, brown, red and have mixtures of these colors. They can also be found on land attached to various surfaces like steps, roofs, etc. All major bodies of water have these organisms in abundance. Most of these organisms can tolerate different degrees of salinity.

2.1 Importance of microalgae

Algae can play important role in the wellbeing to humans and most other forms of life. The following are some importance of microalgae.

2.1.1 Base for aquatic food chain

Ecologically microalgae are very important as a foundation of most aquatic food webs and food chains which can support the abundance of animals because in all habitats they are important primary producers. Phytoplankton mostly single-celled types of algae are eaten by small animals called zooplanktons (mostly crustaceans such as tiny shrimp) that reside near the surface of the sea. The zooplanktons are in turn fed upon by larger zooplankton, small fish, and some whales. Larger fish eat the smaller ones. At the top of the open-water food web may be fish-eating birds, seals, whales, very large fish such as sharks.

2.1.2 Main Oxygen producers

Algae provide much of the Earth's oxygen and are the primary source of global oxygen (30-50% is produced by algae). They capture more of the sun's energy and produce more oxygen (a byproduct of photosynthesis which is vital gas for animals) than all plants combined. They are known by their absorbance of CO_2 from atmosphere as main sinkers of CO_2 to minimize global shock.

2.1.3 Nutrient recycling

Phytoplanktons have crucial significance in the recycling of very important nutrients like carbon, nitrogen and oxygen in biosphere. They are principal in Carbon-fixing and oxygenating agent. In soil crusts, algae are major N-fixing components and, with lichens and bryophytes, important in colonizing and binding the substrate.

2.1.4 Source of alternative energy

Studies show that some species of algae can produce up to 60% of their dry weight in the form of oil. Microalgae are capable of producing large amounts of biomass and usable oil in either high rate algal ponds or photo bioreactors. This oil can then be turned into biodiesel which could be sold for use in automobiles. The production of microalgae and processing into biofuels will provide economic benefits especially to rural communities. Predictions from small-scale production experiments bear out that using algae to produce biodiesel may be the only viable method by which to produce enough automotive fuel to replace current world diesel usage.

2.1.5 Source of food

Some algae species have been used in animal and human diets since very early times. Filamentous algae are usually considered as 'macrophytes' since they often form floating masses that can be easily harvested, although many consist of microscopic, individual filaments of algal cells. Algae also form a component of periphyton, which provides natural food for fish and other aquatic animals

Laboratory investigations have also been carried out to evaluate both microalgae and macro algae as possible alternative protein sources for farmed fish because of their high protein content and productivity. Algae are used as a source of food because they contain high amounts of protein carbohydrates and fats.

2.1.6 Industrial products

Some microalgae and macroalgae provide a natural source for the manufacture of chemicals called alginates that are used as thickening pharmaceutical drugs and stabilizers in the industrial preparation of foods. Algae are also used for cosmetics, to make different kinds of agars which are used for the growth of microorganisms in the laboratory and in producing different chemicals. Industrially some food items such as creams and chocolates are made from some species of algae.

2.2 Algae conservation

Both *in situ* and *ex situ* methods have been adapted for algae conservation. In-situ conservation is the best way to conserve algae which may include protecting and cleaning the water body from unnecessary weeds; protecting water bodies from chemical fertilizers and industrial wastes; and preventing from runoff; applying area closure etc. Whereas ex-situ conservation is disadvantageous because of the difficulty to maintain their natural environment and it is more expensive.

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Microbes: Handy Tools of Biotechnology

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1. Roles of Microbes in Biotechnology

Biotechnology existed long before there was a special word for it. Many of the principles and some of the techniques involved in biotechnology are ancient. It begun in Egypt when bread was accidentally left out in rain, triggering fermentation in which microbes were part of it or used in the process and has been practiced for thousands of years to produce beer, wine, chees, bread and yoghurts. Now Biotechnology is the application of biological systems and processes for the enhancements of production to human necessities.

Microbes play a central role in biotechnology, not only as convenient platforms and tools but also as organisms that can be improved to serve a particular purpose. They not only provide the foundation for much of the basic research involved in biotechnology, they help to create many of the processes which are integral to this science. The early scientific study of microbes concentrated on their effects, such as causing disease. Eventually, scientists discovered microbes could be used for the study of processes which are common to all living organisms.

2. Some of Microbes used in Biotechnology

Microbes are a fundamental element of biotechnology. Without microbes, biotechnology would not be as advanced as it is, nor would it include such a broad range of applications. Biotechnology would be an extremely limited science without microbes. *Escherichia coli (E. coli)* are the best-known and most useful microbe in the field of biotechnology. While many people connect the name *E. coli* with food poisoning, it is important to remember that *E. coli* is a normal inhabitant of the human intestine. Although certain strains of *E. coli* are pathogenic and cause illness, most strains do not. Moreover, the strains generally used in laboratories have already been altered or selected for desirable characteristics. Another famous bacterium that is often used in biotechnology is *Agrobacterium tumefaciens* a bacterium that in nature causes a disease called crown gall. The same attribute that makes this bacterium a disease of plants and its ability to insert its genetic material into the cells of its host plant makes it useful to biotechnology researchers. DNA technology has also been used to increase plant resistance to disease. The genes for an insecticide have been obtained from the bacterium *Bacillus thuringiensis* and inserted into plants to allow them to resist caterpillars and other pests.

Biotechnology seeks to develop new drugs to treat diseases. Some of these drugs are proteins that are produced by bacteria. There are extensive variety and types of vaccines. Vaccines have treated and prevented the spread of millions of dangerous and contagious microbes across the world. Microbes in vaccines have helped save millions of lives.

Biotechnology also focuses on improving industrial processes and seeks new sources for industrial materials. This could mean bioremediation of industry-generated pollution or using microorganisms to make a process more efficient. For example, specially tailored microbes are used to help produce valuable chemicals.

Many different strains of algae, *Chlamydomonas reinhardtii* is perhaps the most popular algae in biotech and biology labs today. Popular viruses in biotechnology and biomedical research include retroviruses like HIV, which incorporate their genetic material into their host cells' genomes; adenoviruses, which cause respiratory tract infections but may also be useful as gene therapy vectors; and phages (viruses that infect bacteria), which are useful in a variety of molecular biology techniques.

Microbes also have valuable use in genetic engineering as "vector", such as *E. coli*. Munching bacteria is the genetically engineered bacteria that are used for cleaning oil spills, with modifying the DNA structure of the bacterium called *Bacillus thuringiensis*. The genes to be inserted are cloned into a binary vector, which contains T-DNA and can be grown in both *E. coli* and *Agrobacterium* bacteria. Once the binary vector is constructed the plasmid is transformed into empty *Agrobacterium* (containing no plasmids) and plant cells are infected. The *Agrobacterium* will then naturally insert the genetic material into the plant cells.

The first genetically engineered medicine was synthetic human insulin, approved by the United States Food and Drug Administration in 1982. Genetic engineering' or genetic manipulation as it should properly be called, relies essentially on the ability to manipulate molecules *in-vitro*. Most biomolecules exist in low concentrations and as complex, mixed populations which is not possible to work with effectively. This problem was solved in 1970 using the molecular biologist's favorite bug, *E. coli*, normally innocuous commensal occupant of the human gut.

Recently, thermostable polymerases (Taq DNA polymerase) have become important, which is extracted from *Thermus aquaticus*. This bacterium has evolved to grow in hot springs at temperature which kills most other species. Taq DNA polymerase allows the amplification of as little as one molecule of DNA into a large amount by means of repeated cycles of denaturation, annealing and extension. This is known as the polymerase chain reaction:

The domestic and industrial effluents often contain harmful heavy metals. These heavy metals cause soil contamination when these effluents are used for irrigation purposes. The biotechnological methods and procedures are being developed to prevent the contamination by these heavy metals and also restore the contaminated soils. This involves the selective use of engineered microbes. *Ganoderma lucidum*, which is a wood rotting fungus, is a highly potential biosorbent material for heavy metals and thus can be used to control contamination by heavy metals.

Plasmids have been also constructed which can enhance the recovery of gold from arsenopyrite ores, by *Thiobacillus ferroxidans*.

The role of microbes in biotechnology is much broader than has been discussed here, and new uses are continually being discovered. Without microbes, biotechnology would not be as advanced as it is, nor would it include such a broad range of applications. Microbes are a fundamental element of biotechnology.

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Impact of Indigenous Invasive Species on Forage & Pasture Genetic Resource Diversity in Pastoral Areas of Borena Zone

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1. Introduction

The pastoral rangelands of Ethiopia are located around the peripheral or the outer edge of the country, almost surrounding the central highland mass. Among the pastoral rangelands, the Borena Rangeland is the drier areas assumed to be the best cattle rangeland in the country. However, it is one of the worst affected region by recurrently occurring drought accompanied by mismanagement that lead to dramatic threats of the natural vegetation, deterioration of pasture both in quality and quantity and hence unable to sustain livestock production, which is the major occupation of the inhabitants.

The more recent serious phenomenon is the encroachment of native ranges and ecosystems in dry lands of Borena areas by indigenous invasive species. According to Gufu Oba (1998), encroachment of these species was aggravated in Borena rangeland after the 1960s and worsened following a ban on the use of fire. Coppock (1994) reported that about 15 woody plant species are considered encroachers in the Borena rangelands.

These indigenous invasive species are significantly impacting the socio-economic development of the region and threatening the native biodiversity. Despite the ecological, economic and socio-cultural significance, quantitative and site specific information on various aspects of these species were either scanty or lacking.

Thus, there is a need to gather and compile the available information and more importantly there is urgency for the collection of the threatened forage and pasture biodiversity for future utilization in research and development before it is wiped out by invasive species.

2. Methodology

The study and collection was conducted from June 23/10/2001 – 18/11/2001 E.C. in Borena Zone of 3 districts, Dirre, Moyale and Yabello that were selected based on infestation of invasive species and threat level on the forage and pasture genetic resource with particular interest on indigenous invasive plant species in the areas. The collection was undertaken in collaboration with the Ministry of Agriculture and Rural Development offices of the area.

The collection mission was undertaken on available threatened grasses and legumes species in Dirre, Moyale and Yabello of Borena Zone and ripe seeds were collected. At each collection site; the detailed passport data was recorded on each collected accession using standard collection sheet. An attempt was made to gather local knowledge about the plants, when local farmers were present at the site.

In addition, to capture the information on the invasive species and the threat to the forage and pasture genetic material a semi structured questionnaires and informal interviews with locally known elder pastoralists were conducted. Three kebeles were selected from Dirre, Moyale and Yabello Weredas each and five locally known elder pastoralists were selected from each kebele.

3. Results and Discussion

3.1 Impacts of indigenous invasive plant species on forage and pasture genetic resource diversity

Unwanted plant species have invaded the rangeland of Borena areas. According to Zonal Pastoral and Agricultural Development Office, out of 13 weredas of the Zone, 8 weredas found in the lowlands are invaded by plant species and the invaded area of the weredas ranging from 30 - 75% of the total area of the weredas. High invasion was observed in Arero, Moyale, Dirre and Yabello weredas but other 5 weredas of the Borena Zone are not affected by the invasion due to the Mid and high land climatic condition of the area.

According to the pastoralists of Dirre, Moyale and Yabello weredas, *Acacia drepanolobium, A. mellifera, Euphorbia spp., A. bussei, A. reficiens, Commiphora spp., A. oerfota and Sensevieria ehrenbergii* are invading the area and are expanding at alarming rate.

Figure 1. Invasion of *Acacia drepanolobium* in Moyale wereda

Natural grazing lands (grasses, bushes and herbaceous plants) are the major source of feed for livestock and livestock production is almost totally dependent on native pasture in Borena lowland areas in general. According to pastoralists interviewed in Dirre, Moyale and yabello weredas, grasses, browse trees and legume species were found abundantly before the invasion but currently they have decreased in abundance and some of the grasses are at the stage of local extinction from these areas. This is due to the invasion of indigenous plant species and majority of the plains of grazing lands found in the Borena lowlands are invaded. According to report obtained from Pastoralist Agriculture and Rural Development office of the area, 18, 9 and 19 kebeles of Dirre, Moyale and yabello weredas, respectively are invaded by *A. drepanolobium, A. mellifera, Euphorbia nubica,* *A. bussei, A. reficiens, Commiphora spp., A. oerfota and Sensevieria ehrenbergii*.

There are different species of grasses, browse trees and legumes grown in the area. The major species of grasses used for livestock feed are *Pennisetum mezianum, Cenchrus cilliaris, Chrysopogon aucheri, Digitaria milanjiana, Dactyloctenium aegyptium, Heteropogon contortus, Sorghum sp., Cynodon dactylon, Eleusine intermedia* and *Bothriochloa insculpta*. Some of the grasses such as *Cenchrus cilliaris, C. aucheri, Andropogon canaliculatus, Sorghum sp. and P. mezianum* are also having other uses like roofing the traditional thatch houses.

The major browse tree species used in the area especially during the dry season are Amarressa (Local name), *Phyllanthus sepialis, Rhus natalensis, R. vulgaris, Euclea divinorum Harmsia sidoides Grewia tembensis Grewia spp*. and *Acacia tortilis*. In addition, the fruits of *Grewia spp*. and *Balanites aegyptica* are eaten by human. According to the information obtained from interviewed pastoralists of weredas, the invasion of indigenous plants started before 15 years. The invasion increased from time to time at alarming rate and invaded the natural grazing lands by destroying under growing grasses and changing the area to unusable land. The invaders form dense and impenetrable thickets that can overtake developed landscapes and out-compete other native plant species. Clearing the areas of grazing lands invaded by invasive indigenous plant species are very tedious and costly (in terms of time, money and logistic resources).

Therefore, the invasion reduced the diversity of forage and pasture species of the Borena areas especially Dirre, Moyale and Yabello weredas reducing their abundance, distribution and by changing grazing land ecosystem to deep thickets of invasive plant species. As the result of this invasion:

- decrease in number of livestock assets per head of the pastoralists due to shortage of feed occurred.
- productivity of the livestock decreased in terms of the product obtained from livestock (milk, meat and other products)
- pastoralists and their livestock migrated to another place to search feed source. The pastoralists of Dirre, Moyale and Yabello weredas migrated to the border of Southern People Nations and Nationalities Regional Sates and Kenya.

3.2 Minimizing the impacts

Manual clearance of the invasive species either in groups or individually is practiced by the pastoralists. According to Zonal Pastoralist and Agricultural Development office and the interviewed pastoralists of Dirre, Moyale and Yabello weredas, the Government and different NGOs gave support for the pastoralists in order to control the invasion.

The Government gave attention in order to control the invasion by giving training and mobilizing the communities, supplying different cutting tools. Moreover, various NGOs are participating in supporting clearing activities. Local communities have been trained how to control and manage invasions such as thinning, debarking, ring barking and uprooting of the invasive plant species. Incentive measures have also been introduced in to the areas.

Generally, different efforts have been done to control the bushes by applying different clearing practices; but it needs more coordinated effort of the communities, the government and stakeholders. Owing to their fast regeneration and regrowth ability from the remnant roots and stem stocks, advanced measures have to be introduced and efforts coordinated to control and eradicate them.

Figure 2. Rehabilitated area by clearing *A. drepanolobium*

4. Conclusion and Recommendation

The range lands of Borena areas contain huge diversity of grasses, herbaceous plants and browse plants. These resources serve as a source of feed for Borena livestock population especially for Borena cattle breed which are peculiar in the country. But, since recent years, invasion and expansion of indigenous plant species become a threat for range lands of Borena areas and grass species which are at the stage of local extinction. Different efforts have been done by communities, government and NGOs to clear invading bushes and recover forage and pasture species. But the attention and control measures given to the invading bushes during the previous years are not enough when compared to the area invaded by bushes.

Generally, the impact of invasive indigenous plants should be analyzed both from biodiversity point of view which depends on the ecosystem to which they spread and from livelihoods point of view that includes the socioeconomic aspect of the invaded areas. The pastoral communities of the area revealed that the negative effects posed by invasive species outweighed the merits they gave for the communities and the ecosystem of the area.

Therefore, the following points are recommended for conservation of threatened species as well as prevention and control of the invasive plants.

- Collect and conserve the remaining representative samples of grasses and browse tress of the area.

- Create strong relationship between research centers and different regional institutions in order to control invasion of indigenous plants and for restoration of lost biodiversity of the area.
- Create awareness and mobilize the pastoral communities on prevention to new areas and mechanical control of invading plant population and encourage and increase the participation of communities in exploitation of invading plants products (charcoal, fuel wood).

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Coordinate Data Complementation for Previous Field Crop Landrace Collections of North Shewa

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1. Introduction

Spatial analysis can provide critical information on the diversity present in specific geographic areas and can be used to identify hot spots of diversity (Scheldeman *et.al*, 2010). To study the spatial distribution of crop landraces the information on latitude and longitude is crucial. Having collected these data one can easily identify what is found where. Even though these coordinate data are fulfilled for considerable numbers of the crop landraces in the national genebank (Institute of Biodiversity Conservation) there are so many accessions which are devoid of it.

A total of 2549 accessions of landraces of 21 different field crop plants (Barley, Triticum, Sorghum, Faba bean, field pea, teff, check pea, linseed, lathyrus, lentil, noug, brassica, maize, fenugreek, phaseolus, sesamum, avena, carthamus, vigna, ricinus, pennisetum in the order of their size in the gene bank), were collected at different times from 20 weredas of the zone and are conserved at the national gene bank. From these holdings cereals constitute 1789 accessions (70%) followed by pulses 609 accessions (23.8%) and oil crops 128 accessions (5%). Out of the total 2549 accessions 1193 have their coordinate data (latitude and longitude) collected but the remaining 1356 do not have these data. This makes more than half of the collections from the zone lacking their coordinate data with them. It is this gap that has initiated the coordinate data collection mission in this zone with the following objectives: complementing the coordinate data of landraces so that their passport data is fulfilled; to sketch the map that shows the distribution of field crops collected from the zone.

Site Description

North Shewa Zone is one of the ten zones in the Amhara National Regional State. It lies between 8^0 42' 40"N to 10^0 46' 40" N latitude and $38^{\ 0}$ 36' 54"E to 40^0 6' 13"E longitude. The zone covers a total area of 15,936.13 km^2 (CSA, 2007).

Coordinate data collection mission was carried out at 18 weredas of North Shewa zone of Amhara National Regional State on 18 crop species. Though the mission targeted the North Shewa zone of Amhara it has covered two additional zones namely North Shewa zone of Oromiya National Regional State and Oromiya zone of Amhara National Regional State. This is because wereda, zonal and regional structure and territory now a days is quite different from earlier days when those previous collection missions were made. A case in point is the then Laybetna Tachebet wereda which is now divided into two independent weredas one of which

(Merhabete) belonging to Amhara's North Shewa and the other (Dera) to North Shewa Oromiya. There are also additional cases though they are in the same zone. For instance, Gerakeya going to two weredas Menzegera whose center is Mehalmeda and Menzekeya whose center is Zemero. By the same token Lalomama becomes two Mama Midir and Lalo Midir. Despite these changes in territory the mission based itself for this data collection on specific locality from where the crops were previously collected.

2. Methodology

The data was collected using eTrex/ GARMIN personal navigator. The specific locality stated on the passport data of each accession was used to locate the specific site from which that particular accession was taken. The assistance from the local guides was used in identifying the specific locality. The map was created by using Arc sin 9 GIS software. The coordinate data were collected in degree and minute. To convert it to degree decimal so that it will become suitable to Arc sine 9 to sketch the map, the following formula was used:

$$degree + \frac{minute}{60}$$

3. Results and Discussion

The mission covered 18 out of 20 weredas of the zone from which field crops were collected. This coordinate data collection ranged from 09^0 13.492'N (Hageremariam kesem wereda Koremash kebele) to 11^0 11.613'N (Weremo wajetuna mida wereda Embibelo kebele) latitude and 038^0 29.319'E (the then Laybetna tachbet wereda currently Dera wereda of North Shewa Oromiya zone Keru sekebeke kebele) to 039^0 59.318'E (the then Efratanagidm wereda, Senbete wereda currently at a specific site 42 km from shewa robit to karakore) longitude.

As a result of the data collection mission 530 accessions of landraces were complemented for their coordinate data which constitutes 39.15% of the accessions that are found in the genebank without coordinate data from this zone. This is either due to no locality is specified or the locality doesn't indicate the specific site instead it is read as broad category. More precisely, a total of 231accessions, of which 135cereals, 89 pulses, five oil crops and two spices were found to have no locality. Besides 385 sorghum accessions do have their locality being either Teguletna bulga or Yfatna timuga, names which represent the former Awrajas. These awrajas may have many weredas under them so making the data collection impossible. Furthermore, two accessions were found to have a locality from South Wello like Degolo and shilafaf. This also created a big challenge in the process of collection of the data. Despite all these difficulties, it was possible to collect the coordinate data for 530 collections. In addition to the coordinate data, 59 accessions without their altitudinal data were also complemented.

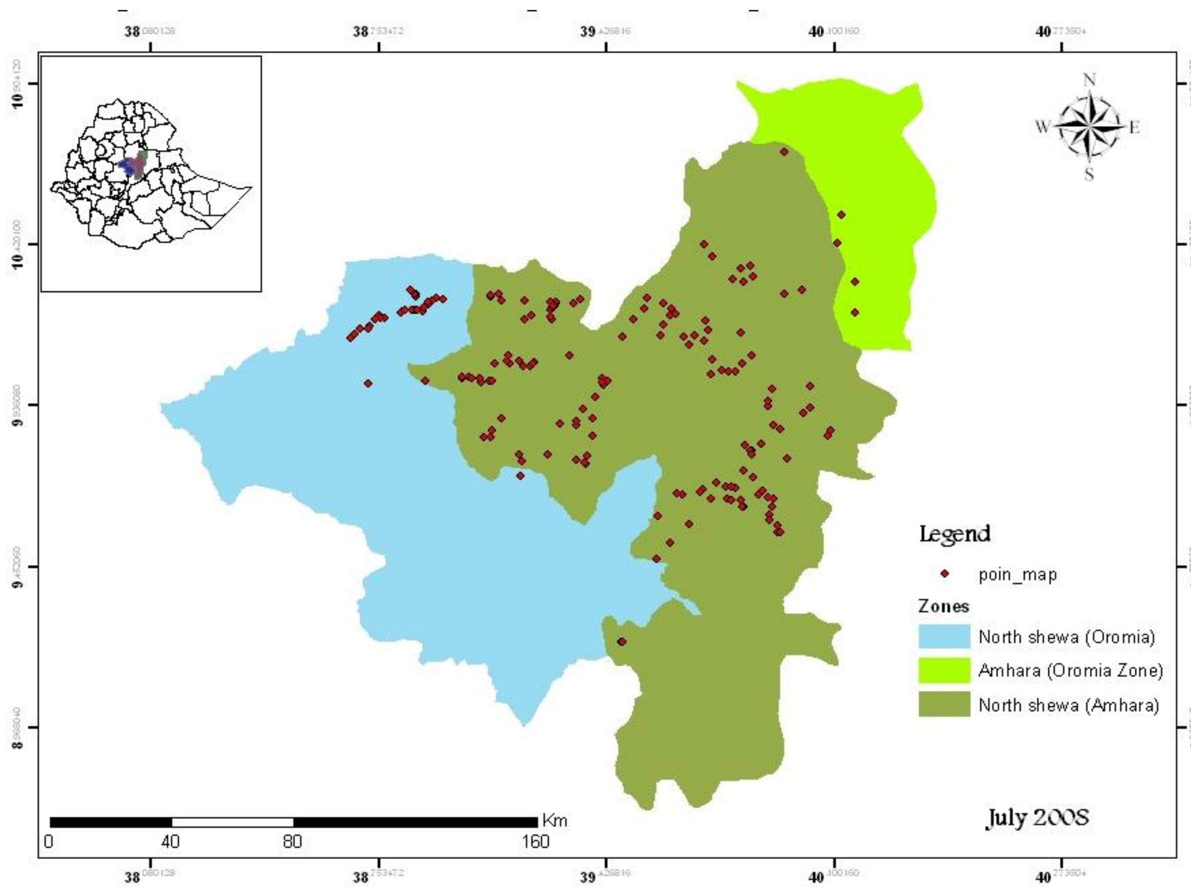

Figure 1. Distribution map of accessions of field crop landraces of North Shewa complemented for their coordinate data.

Out of these accessions for which the coordinate data were complemented, 167 (31%) were found be characterized. Cereals constituted the largest share that is 80 accessions, and then comes pulses 55 accessions and oil crops 31 accessions. As a result of this it is now possible to produce the distribution map of the genebank crop collections of North Shewa zone (Fig. 1).

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Illegal Transfer of Genetic Resources from Ethiopia: a Preliminary Survey of Knowledge of Stakeholders

Genetic Resources Transfer & Regulation Directorate; Institute of Biodiversity Conservation

1. Introduction

Bio-piracy means the smuggling of diverse forms of flora and fauna including the appropriation and monopolization of traditional knowledge and derivatives of biological resources. Bio-piracy causes the loss of control of local community over their resources. Concerns about bio-piracy derived from concern for biodiversity itself and concern for the rights of those who own or steward biodiversity and the traditional knowledge related to it. In the last few years, through the advance of biotechnology, the facilitating of registering international trademarks and patents as well as international agreements on intellectual property, the possibilities of exploitation of genetic resources and associated indigenous knowledge have increased.

In 1992, in Rio de Janeiro, the Convention on Biological Diversity was signed. The Convention aims, among others, at the regulation of access to biological resources and sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial utilization of genetic resources with the communities. Despite CBD provision, implementation of the objectives has so many hurdles. Genetic materials are smuggled by different mechanisms and routes. Protection of genetic materials and associated indigenous knowledge from bio-piracy needs basic information on the route of illegal movement of biological resources, and the extent that these movements are known by public and stakeholders. This paper presents results of a survey conducted to find out means and routes of illegal movement of genetic materials from Ethiopia. The study also attempted to assess the awareness level of participants on bio-piracy and legal frame works on Access and Benefit Sharing.

Specific objectives

- To know the level of public awareness on bio-piracy
- To document basic information on illegal movement of various genetic materials and the associated indigenous knowledge from the country
- To know the awareness level of participants on legal frame works on Access and Benefit Sharing.
- To recommend appropriate actions to be taken to halt or minimize illegal transfer of genetic materials

2. Material and Methods

The survey was carried out by using structured questionnaires developed for the purpose of collecting information on illegal movement of genetic resources, and awareness level of legal frameworks. The questionnaires were filled mostly by different professionals working in agricultural and natural resource management sectors, research and teaching institutions.

3. Results

Awareness of stakeholders on access and benefit sharing principles, domestic and international legal frame works on access and benefit sharing and illegal movements of genetic resources were investigated. A total of 54 individuals working in different institutions participated in the study. Questions on age, sex and educational level of participants were also filled up. Ages of the Participants ranged from 20-59; most (59%) fall within the range of 30-49 years. The majority (85%) of the participants were male and the rest were female. The educational levels of these participants were also recorded. Sixty eight percent of the participants have M.Sc. degree and above. Eleven percent of the participants have B.Sc degree, 4% were diploma graduates and the remaining did not indicate their educational background.

Fifty percent of the respondents said they know adequately and 44.4% said they know very little of the subject matter. With regard to awareness of the participants about the existence of the legal frame work on access to genetic resources and traditional knowledge, 30 % responded that they know adequately, whereas the remaining majority (66.5%) said either knows very little or nothing. The participant's awareness on illegal movements of different genetic resources was also assessed. The Majority of the participants (76%) indicated that they are aware of illegal movements of different genetic resources. Over 35% of the participants indicated that they knew export of specific plant types. The remaining majority did not know any specific crop. Among the respondents who indicated specific plants, 18.5% and 14.8% indicated that they knew about illegal movements of medicinal plants and cereals respectively. The respondents awareness of illegal movements of animal genetic resources showed that 38.8% of respondents knew that all types of animals were illegally transferred to other countries. Similarly, the survey results showed illegal movements of microbial genetic resources. The study participants also indicated route of illegal movements of genetic materials. Most participants (40.7%) said that different routes were used and 25% said that land was the route of illegal movement of animals. The survey also assessed about who were involved in illegal transfer of genetic resources. The results indicated different groups; including researchers.

4. Discussion

The survey has shown that genetic resources of the country are illegally transferred to different countries through different routes. As indicated by 18.5 % of respondents, medicinal plants are among genetic resources illegal transferred. Most of medicinal plants on which over 70% of the rural population of Ethiopia relies on for the treatment of various ailments are illegally transferred and possibly used as pharmaceuticals or other products elsewhere.

Today, a substantial number of drugs are developed from plants exported from developing countries. Most medicinal preparations were derived from plants, whether in the simple form of plant parts or in the more complex form of crude extracts, mixtures, etc. The majority of these involved isolation of the active ingredient (chemical compound) found in a particular medicinal plant and its subsequent modification. Similarly, the present preliminary survey results indicated that animal genetic resources and microbial genetic resources of this country are also transferred by combination of routes to different countries. In spite of being owner of diverse genetic resources that can be used for social and economic development of the country, Ethiopia is not making any benefit out of these genetic materials transferred to other countries. Companies in developed countries make use of these illegally accessed genetic resources and apply for patents and if granted, the patents give the companies the right to prevent anyone else including the country of origin from manufacturing or selling the product. Among Ethiopian plant genetic resources that were misappropriated and yielding high economic benefits in other countries include Endod (*Phytolacca dodecandra*), Yellow dwarf virus resistant barley, caffeine free coffee (*Coffee arabica*) and Teff (*Eragrostis tef*).

Although the present study has limitations of sample size and absence of participants from the local communities, it provided a baseline data which may help for further comprehensive study. The study indicated that at least professionals working in different institutions are aware of illegal transfer of genetic materials to various countries. The study participants have indicated individuals involved in the illegal access to genetic resources are diverse and include tourists, development agents, traders, and even researchers. On the other hand, the majority of these participants said that they were not aware of the existence of national or international legal frame work on access to genetic resources and associated traditional knowledge. Similarly, these professionals did not have knowledge of the established rules and regulations on benefit sharing from the use of genetic resources. Therefore, lack of adequate involvement of the various relevant stakeholders in the regulation of bio-piracy may be due to lack of awareness of the legislative system in place or due to weakness of the implementation mechanisms of the legislative frame work on the ground.

The systematic search for biologically active compounds in nature has gained a new significance as a component of biodiversity conservation strategies. Furthermore, the increasing availability of new scientific and technological tools have enabled new levels of precision and effectiveness in the identification, collection, processing and utilization of novel substances in medical, agricultural or industrial applications. The knowledge and implementation of the legal frame works, particularly regarding access to and benefit sharing from the use of genetic resources and associated indigenous knowledge, prior informed consent, intellectual property protection and others are important to conservation and sustainable use of our genetic resources and to our socio-economic development.

Illegal movements of the valuable genetic resources of the country underpin that conservation and sustainable utilization of biological resources cannot be achieved if the practice is not halted. Therefore, it is time to mobilize all stakeholders in an effort of conservation and sustainable use of our genetic resources and benefit sharing from the use of the same. Working on awareness creation is very crucial to make this effort fruitful and obtain fair and equitable share of benefits from the use of our genetic resources which generate incentives for conservation and sustainable use of our biological resources.

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Biodiversity News

Ethiopia marked the 11th International Day for Biodiversity at Bahirdar

By Bethelhem Ketema

27 May 2012, Bahir Dar - The Institute of Biodiversity Conservation organized educational and outreach activities on wetland biodiversity to mark the celebration of International Day for Biodiversity (IDB) on May 26th2004 in Bahirdar. The international theme of IDB for this year is "Marine Biodiversity". Ethiopia celebrated the day using the theme "Wetland Biodiversity: for sustainable development and food security", which is more relevant and timely.

IBC has organized a stakeholders' forum, educational trip to Lake Tana and Tis-Abay Fall to centralize the role of people in the management, conservation and sustainable utilization of wetland biodiversity. Dr. Gemedo Dalle, the Director General of IBC, in his welcoming speech said that biodiversity is a sustainable base for development. Each region has rich biodiversity which needs to be conserved and sustainably utilized. Recognizing their value also facilitates their conservation and sustainable utilization.

Ato Awlachew Masere, Amhara National Regional State President Office Diaspora Affairs and Public Relations Directorate Director, at his opening speech on behalf of the Amhara Regional State President, addressed that wetlands have enormous values for the community in particular. He said "…In addition to tourism, Lake Tana and Abay have rich biological diversity which is not explored and used properly. Yet it needs social awareness to conserve and utilize them for sustainable development".

Three research papers namely; Fisheries Resources Base of Ethiopia and its Contribution to Food Security, Biodiversity of the Lake Tana basin: Challenges, Threats and Opportunities, and Fish diversity of the Amhara Region were presented by IBC, AAU and Bahir Dar Fishery and Aquatic Life Research Center, respectively and were discussed by participants.

Dr. Seyoum Mengistou, a Professor from Addis Ababa University, enlightened that although some wetlands are degraded beyond restoration point, there is room to rehabilitate them through conservation measures. According to Dr. Seyoum, restoration programs for the Lake Tana Water shade have shown promising results and should be continued.

Dr. Seyoum raised the issue of Lake Tana invasion by Water hyacinth as serious potential threat to the Lake, Abay River and the Great Renaissance Dam.

Dr. Seyoum said "… Lake Tana is being invaded *by Eichornia crassipes*, a water hyacinth which floats on water by forming a huge mass that blocks light and damages the fish breeding and feeding sites. The species reproduces very fast and enhances evapotranspiration eventually reducing the water volume. In the long run, it is a huge challenge that the invader may reach the Great Renaissance Dam and pose a serious threat. We have alerted policy makers and local authorities about the issue repeatedly. This needs urgent action!"

Dr. Misikire Tessema, Researcher at the Institute of Biodiversity Conservation, said that Ethiopia has 200 fish species which occur in different water bodies out of which 40 species are endemic and 10 species are introduced. It is therefore not surprising that the fish genetic resources in the lakes and rivers of Ethiopia are of actual and potential interest for commercial uses.

Ato Alayu Yalew, Director and Researcher at Bahir Dar Fishery and Aquatic Life Research Center, pointed out that fish has many values such as ecological value, nutritional value, recreational value, economic value and social value. By reducing the pressures on wetlands and using them sustainably could ensure sustainable development and food security.

The half-day conference on IDB provided an opportunity for stakeholders to discuss existing and emerging issues and possible solutions related to the conservation and sustainable utilization of wetland biodiversity.

IBC signed ABS agreement on three plant species with private company

By Bethelhem Ketema

14 June 2012 Addis Ababa – The Institute of Biodiversity Conservation (IBC) and Docomo P.L.C signed an agreement on Access to and benefit sharing from the use of three different plants species for the purpose of manufacturing essential oils, cosmetics and herbal medicine in Ethiopia.

The company, which mainly has an investment in U.S.A and a subsidiary in different African countries, signed 10 year agreement with IBC to use three Ethiopia's plant genetic resource as a raw material for its products and to share the monetary and non-monetary benefits with Ethiopia based on the rules and regulations of the Access and Benefit Sharing (ABS) laws of Ethiopia and the Convention on Biological Diversity (CBD). The monetary benefits include lump sum, royalty, upfront and license fees whereas the non-monetary benefits are knowledge and technology transfer and capacity building.

Previously IBC has entered into two ABS agreements on Tef and Vernonia. This third agreement is signed for three different plant species; namely *Dichrostachys cinerea, Osyris* sp. and *Withania somnifera*.

Dr. Gemedo Dale, Director General of IBC, on the Agreement signing ceremony explained that these three species are wild plants and have never been considered as valuable resources. But now, they have got a chance to become an enormous asset for Ethiopia's economy.

Dr. Gemedo said "Ethiopia earned more than 2 million birr just by signing this Agreement. This shows that there is no worthless genetic resource, every single genetic resource should be conserved and considered valuable as they have potential value in one way or the other."

Dr. zeleke W/Tensay, Director of Genetic Resources Transfer & Regulation Directorate, noted that this ABS agreement exercise differs from the previous two agreements for various reasons. "IBC has learned a lot from the past experiences, and the factory which uses these genetic resources is going to be built in Ethiopia and the pre-negotiation processes went according to the proclamation and regulation of the country and involved detailed processes to come to this final stage."

The benefits will be shared between the company and the community/the government of Ethiopia. The benefits obtained from the use of these genetic resources are incentives to the community/government to conserve and sustainable utilize Ethiopia's biodiversity.

Cover Photos

a. Front Cover

Top Photo: *Edible Mushrooms*

Middle Photo: *Yeast Cells*

Bottom Photos: *Injera, Wine, Bread, Tej* (left to right)

b. Back Cover

Top Photo: *Acacia drepanolobium* (indigenous invasive plant)

Bottom Photos: *Osyris* sp., *Dichrostachys cinerea, Witania somnifera* (left to right)

Photo Credits: Microbial Case Team, Delessa Angassa, Wikipedia

Institute of Biodiversity Conservation

22 June 2012

Globally, cost of damage caused by invasive species is estimated to be £1.5 trillion per year.

"There is no worthless genetic resource;
Every single genetic resource has to be conserved!"