Theme 1. Productivity and Environmental Sustainability for Food Security and Poverty Alleviation

The Ethiopian government has realised that ensuring food security, conserving and sustaining the natural resource-base, and eradicating poverty are the major issues of national priority. The goal is to ensure that the country attains a middle-income status by the year 2025. In these endeavours, it is intended that rural and poor communities should have access to innovations, attain food security, and have accelerated status of development. It is also planned to provide new and more effective solutions to problems than those utilised previously in the overall national development efforts. Given the broad nature of this theme, priority will be given to basic, applied, and development research in the areas of agriculture, environmental and natural resources, climate change, agro-pastoralism, veterinary medicine, land use management, and others.

Sub-theme 1.1. Animal Production and Health

Rationale

Animal production and productivity is very low in Ethiopia. As a result, the country is not benefiting much from the huge animal population and genetic diversity it possesses. The low animal productivity is attributable to a number of constraints which include severe feed shortages (due to diminishing grazing land and plant biodiversity as well as recurrent drought), lack of appropriate breeds, lack of appropriate technologies that enhance animal productivity, unfavourable local and international market conditions, high disease burdens, poor management practices, lack of favourable policies for developing and utilising animal resources, etc.

Undernourishment has particularly become a serious problem posing huge challenges to animal production and productivity in the country. Furthermore, increase in disease incidence, emergence of new diseases, and increasing drug resistance. These problems require innovative

solutions, which call for concerted efforts to discover new therapeutics and diagnostics as well as introducing improved service deliveries. Improvements in animal health rely partly on sustained availability of effective, rapid, accurate, reliable and economical diagnostic techniques and therapeutics as well as effective prevention and control measures.

Aim

The aim of this sub-theme is to enhance livelihoods of farmers/producers as well as increasing the economic benefits from animal production through improved animal health and feeding, etc.

Description

The sub-theme focuses on animal genetics (breed improvement), reproductive physiology and biotechnology, and management improvement, enhancing the quality and availability of existing feed resources and/or seeking alternative economical feed resources, rangeland related potentials and problems, investigating meat and milk and value addition on products, and improvement in the marketing of livestock and livestock products.

The sub-theme also includes research directed towards identifying animal health problems, determining the temporal-spatial magnitude of diseases, disease prioritisation, modelling and risk factors analysis, development of improved methods of disease tracking and monitoring, and clinical/surgical research as a prelude to design appropriate animal disease management packages. The research sub-theme investigates the biopharmaceutical and pharmacological aspects of herbal and ethno-veterinary medicines, development of diagnostics and diagnostic technologies, therapeutics, vaccines and biologicals as well as examining ways to enhance the quality and efficiency of animal health care service delivery.

Potential Collaborators

National and overseas universities that are engaged in livestock research, education, and development, industries, schools and institutions, international, national, and regional agricultural research organisations, disease diagnostic laboratories, regional, zonal, and woreda

bureaus of agriculture of East and West Hararghe, Dire Dawa administrative region, Harari region, pastoral and agro-pastoral development bureau of Somali region, and the livestock owning communities of the respective areas.

Expected Output

- Genetically improved animal breeds
- Conserved animal genetic resources and biodiversity
- Improved and diversified economical quality feed
- Appropriate housing technologies and management practices
- Appropriate technologies for milk, meat, and poultry product preservation and processing
- Better techniques for rangeland improvement, resource utilisation and conservation
- Improved animal health, production and productivity
- Improved animal disease management packages.
- Improved new diagnostics, therapeutics, vaccines & biologicals.
- Improved animal health care service delivery methods and approaches
- Identified, characterized, and evaluated herbal and ethno-veterinary medicines
- Improved meat and dairy products and technologies
- Increased income from animal breeds and products

Research Areas

1.1.1. Development and promotion of animal production and products

The research area includes improvement of breeds and adaptation research, development of feed resources and appropriate production. It shall also include research in animal products such as milk and dairy products, meat and meat by-products, fish products, honey, and animal by-products and waste utilisation. Moreover, the research includes ensuring food security,

quality and safety such as protecting against development of antibiotics resistance, and prevention and control of food-borne diseases and injuries. This research area also focuses on topics meant for enhanced quality of hides and skins of animals such as better ways of flaying, processing, preservation, storage, value addition, manufacturing, marketing, etc and the technologies required for these purposes. The research area also addresses issues related to apiculture and effect of pesticides on bee colonies.

1.1.2. Animal disease epidemiology and development of animal disease management packages

The research area encompasses research that manipulates factors to maximize health or prevent animal diseases and also evaluates and suggests prevention and mitigation measures against animal disease. This also involves topics concerned with prevention and control of emerging and re-emerging infectious diseases including zoonosis, trans-boundary animal disease, nutrient deficiency diseases of animals, preparedness and response to possible trans-boundary introduction of disease causing agents, and advances in veterinary medical sciences. It also deals with human-livestock-wild animal interface as well as improving animal health care service deliveries.

1.1.3. Improving pastoral and agro-pastoral animal productivity

This research area focuses on breed evaluation and selection for specific products, artificial insemination (AI) application by using semen from selected/superior reproductive males, oestrus synchronization, feed resource improvement, rangeland improvement and management, domestication, herd management, adaptation and evaluation of improved forage species. It also deals with development of animal health packages with special emphasis on camels and goats, and development of technologies and procedures for control of disease dissemination.

1.1.4. Animal genetic resources improvement, conservation, and management

This research area is aimed at the development of innovative methodologies for analysing the whole animal phenotype and basic-biology phenotype association in light of protein network and biological pathways. Research on *sacco*, *in situ* animal genetic resource conservation, developing procedure for wise utilisation of available animal genetic resources for economic growth. This research also deals with introducing, adapting, and the utilising of domestic animals from other countries for the purposes of acquiring traction power, beast of burden, amenity values etc. This research is also concerned with the application of biotechnology to improve productivity, consistency, and quality. This research area focuses on breeding, conservation, and adaptation of indigenous livestock, equines (donkeys, horses, mules, camels), poultry etc.

1.1.5. Development and evaluation of veterinary therapeutics, diagnostics and biologicals

Development and evaluation of vaccine formulations, assessment of protective immune responses, manipulation of relevant animal models for important vaccine-preventable diseases, development and evaluation of biologicals and diagnostic kits, drug development and evaluation ventures, investigation of ethno-botanicals and new treatment systems shall be included under this research area.

1.1.6. Animal feeding and nutrition

This research area includes animal feeds and feeding, evaluation of different feed resources including conventional and non-conventional feeds in terms of nutritional composition, digestibility, and nutrient availability or bioavailability. The research area also encompasses ration formulation for different groups of animals for maximum growth and economic benefits. *In vitro, in sacco* degradability of nutrients, near infrared spectrophotometer and related evaluations, feed poisoning of animals are also the focuses of this research area.

Beneficiary

Farmers, agro-pastorals, industries, scientific community, policy makers, and the wider community

Sub-theme 1.2. Plant Production and Health

Rationale

Ethiopia has diverse agro-ecologies, agro-biodiversity and water resources, and great potential for agricultural production including food security crops, cash crops, industrial crops, tropical and sub-tropical vegetable and fruit crops, indigenous forests, medicinal plants, forage crops, etc. However, the country has been facing recurrent food shortages. This is because production technologies of the crops have not been improved and yields have remained low compared to the increasing population. In this respect, per capita food production and gross domestic product need to be increased through utilisation of improved agricultural technologies and innovations.

The low crop production and productivity in Ethiopia in general and the eastern parts of the country in particular is attributable to a number of complex and inter-dependent production constraints. These include limited access to agricultural inputs, improved crop production technologies, irrigation, and agricultural markets, as well as inefficient market value chains. In addition, soil degradation and nutrient depletion, ravages of pests and diseases as well as weeds are major obstacles to crop productivity and quality. Crop productivity is constrained further by uncoordinated technology transfer, extension, weak partnerships and institutional linkages as well as low rate of adoption of improved technologies. Besides this, the rich plant biodiversity of the country has not been wisely utilized and preserved.

Little efforts have been made to improve productivity and quality of crops through introducing, enhancing, and breeding of crops and improving agronomic practices as well as through transfer of appropriate knowledge and technologies.

Aim

The aim of this sub-theme is to undertake research related to improving plant productivity,

quality, and health.

Description

Conducting research on priority crops through exploring and utilisation of genetic potentials and manipulating environmental conditions through appropriate agronomic and cultural practices including technologies that help to optimize the profitability and sustainability of cropping systems are among the major activities under this sub-theme. These include variety selection, plant breeding, weed management, tillage, crop rotation and selection, and management of plant nutrients in the soil.

Molecular (marker assisted selection) and tissue culture techniques in variety development, and producing disease free propagating materials are also the targets of this sub-theme. Likewise, enhancing availability of improved seed and other propagating material through integrated seed sector supply systems, also falls under this sub-theme, as do landscaping and floriculture.

Particular focus will be given to food security crops, fruit corps, vegetable crops, cash crops (coffee, oil crops, etc), fibre crops (cotton), sugar crops (sugarcane), industrial crops (sisal, kenaf) and beverage crops under this sub-theme.

Potential Collaborators

National organisations such as the Ethiopian Institute of Agricultural Research (EIAR), Ministry of Agricultures (MOA), Institute of Biodiversity Conservation (IBC), Oromia Agricultural Research Institute (OARI), Somali Regional Pastoral and Agro-pastoral Research Institute (SoRPARI), regional agricultural bureaus, Ethiopian public universities, Swedish International Development Agancy (SIDA), overseas universities such as Wageningen University, Swedish University of Agricultural Sciences, Langston University, Oklahoma State University, and other international research organisations such as Consultative Group on International Agricultural Research (CGIAR) centres (CIP, ICARDA, ICRAF, IFPRI, CIAT, CIMMYT, IITA), smallholder farmers, private farmers, and private enterprises.

Expected Output

- Newly improved crop varieties
- Quality food
- Efficient and sustainable agronomic management practices
- Improved post-harvest handling technologies, value adding crop varieties and products.
- Collected, characterized, evaluated and conserved germplasm for use in hybridization and genetic diversity.
- Available options for a diversified cropping system
- Improved production, processing, and management knowledge and technologies for export crops.
- Appropriate technologies for improving soil fertility, problematic soils, disease, insect pests and weeds that enhance crop production
- Quality seeds and other propagation material of food and cash crops for enhanced productivity and incomes
- Improved crop pest and disease management practices

Research Areas

1.2.1. Field crops

Research shall be directed towards increasing the productivity of high priority crops in ways that enhance environmental services and build social resilience for transforming production systems. This research area focuses on development and promotion of improved field crop varieties, management practices, soil fertility/problematic soil management practices, pest and disease management, and post-harvest handling. It also focuses on ensuring the nutritional, processing and export qualities of the crops. Research will be done to mitigate mycotoxin contaminations and post-harvest management of sorghum, groundnut, maize, and other

crops. In general, research on each crop will focus on variety development, pest and disease management, production management/agronomy, processing, and alternative uses of the crops.

Research shall also be undertaken to address the following issues: dissemination, and better utilisation of higher yielding varieties of priority food, fibre, oil, fibre crops (cotton), sugar crops (sugarcane), industrial crops, and beverage crops; enhancing productivity and efficiency of locally adapted crop systems; developing tools of system-wide, value-chain analysis; undertaking classification of climatic, soil, water, and other physical characteristics of specific geographies; enhancing nutritional, processing and export qualities of the crops; and examining the potentials and specific challenges of urban agriculture.

1.2.2. Horticultural crops

The priority crops in this research area are vegetable crops, root and tuber crops, fruit crops, mushrooms, and cash crops. The improvement of horticultural crops deals with developing varieties and technologies for rain-fed and/or irrigation agriculture, for problematic soils, and for export and local consumption. This research area also deals with the nutritional, processing, and export quality of produces, post-harvest handling, landscape and floriculture.

Research shall be conducted on root and tuber crops (potato, sweet potato, carrot, etc.), mushrooms, leafy vegetables (cabbages, tomato, pepper, onion etc), tropical fruit crops (mango, banana, citrus, cherimoya, papaya, etc), and sub-tropical and temperate fruit crops (peach, plum, apple etc). The research shall generally focus on variety development, pest and disease management, production management/agronomy, value addition, processing, and alternative uses of the crops.

1.2.3. Harar coffee

This research area focuses on improvement of coffee genetics, agronomy, processing, and postharvest management for sustainable production and quality enhancement. The research area also deals with coffee nutrition as well as pest and disease management for enhanced

organic coffee production. It also deals with developing a database on the extent of contamination of coffee with pesticide residues, heavy metals, and mycotoxins. Developing methods for effective management of these contaminants and educating the growers and processors on these vital issues through research and extension are also among the focus areas of this research. The research area also deals with quality standards and value addition of coffee.

1.2.4. Spices

Ethiopia in general and eastern Ethiopia in particular, has agro-ecologies suitable for production of annual and perennial spices: *Capsicum* (hot pepper), cumin, fenugreek, coriander, black mustard, rosemary, koseret (*Lippia* spp.), rue, basil, and others.

This research area focuses on developing high yielding and high quality spice varieties, conserving genetic resources of spices, and protection systems using traditional and non-traditional techniques. It is also important to develop post-harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes. The research area also deals with monitoring and adoption of new and existing technologies to make sure that research is targeted to the needs of the farming community.

1.2.5. Bio-energy plants

The research area focuses on bio-energy plants which are essential as an alternative energy source in terms of replacing petroleum-based energy and reducing long-term carbon dioxide emissions. Some plant species have high potential in producing bio-fuel; among these plants, castor bean (*Ricinus communis*), Ethiopian mustard (*Brassica carinata*), Vernonia (*Vernonia galamensis*), and Jatropha (*Jatropha curcas*) are the promising plants in eastern Ethiopia. Thus, this research area addresses problems related to the development of improved varieties and production packages, identification of potential areas and productivity of bio-fuel plants and their utilisation.

1.2.6. Industrial crops

This research area deals with aspects of improving production and productivity of crops such as sugarcane (*Saccharum officinarum*), cotton (*Gossypum hirstum*), tobacco (*Nocotiana tabaccum),* sisal (*Agave sisalina*), etc.

1.2.7. Forage crops

This research area deals with improvement of forage crops. It also deals with the nutritional, processing, post-harvest handling, and feeding technologies of the crops. Furthermore, the research area focuses on improving indigenous and exotic grass and legume forage species for sustainable forage seed production, preservation, and utilization.

1.2.8. Indigenous trees/shrubs and medicinal/aromatic plants

This research area deals with domestication, improvement, and utilisation of indigenous forest, fruit, aromatic, and medicinal plants. It also deals with the nutritional, processing, post-harvest handling, value addition, and marketing of the products.

1.2.9. Soil fertility, quality, and productivity

This research area focuses on ensuring long-term productivity of soil, through finding ground breaking fertiliser technologies that increase production while preserving soil integrity. Research is also done to improve knowledge about the specific soil protection, remediation, health and fertilizer needs of the country. This research area also includes optimizing mineral nutrition of plants, thus striving for optimum, environmentally sound, sustainable, and efficient fertilisation technologies and practices (including integrated nutrient management, carbon sequestration, use of crop rotations, bio-fertilisers etc). It also focuses on identifying soil amendments and practices that facilitate fertilizer uptake and minimise nutrient losses; studying nutrient use and nutrient cycling in cropping systems; investigating genotypic differences in nutrient uptake and use efficiencies; developing rapid appraisal methodologies to identify the physical, social, political, economic, and other constraints to improved soil

fertility. It also deals with cataloguing and developing paths to utilize effective and appropriate soil nutrient management to increase soil health and provide resilience from weather shocks.

1.2.10. Plant diseases, pests, and weeds

This research area deals with the study of the biology, ecology, epidemiology, diagnostics, and management of major diseases (late blight, rusts, smuts, root rot, etc.), pests (insect pests such as army worms, locusts, birds, storage pests, etc) and weeds (including invasive weeds such as *Parthenium spp., Prosopis juliflora, Lantana camara, etc* and parasitic weeds such as *Striga spp., Oroanche spp.*, etc. and grass weeds) of crops, forests, rangelands and water bodies in different agro-ecologies as well as development of crops resistant to pathogens.

The research area also includes disease pathology which involves mechanisms of resistance and susceptibility of crops to diseases caused by fungi, bacteria, viruses and nematodes; epidemiology/microbial ecology: biology of pathogens (life cycles, interactions with other microorganisms, effect of environment) in the laboratory, greenhouse, and field; modelling/statistics involving development and delivery of plant disease prediction models (disease forecasting); application of decision theory to the management of diseases of crops; molecular genetics/genomics; disease resistance; transfer of agronomically important genes from wild relatives of crops to cultivated crops; development, molecular cytogenetic characterisation, and maintenance of germplasm stocks.

It also focuses on assessing the distribution and impact of invasive weeds, management of invasive weeds through utilisation of compost, bio-fertilizers, and insect bio-agent (e.g. *Zygogramma bicolorata*).

1.2.11. Germplasm enhancement and maintenance

The focus of this area is germplasm enhancement through collection, characterisation, evaluation, hybridization and maintenance. It also deals with improving plant genetic resources through conventional plant as well or molecular marker techniques. Emphasis will be given to

sorghum, coffee, groundnut, maize, wheat, pulses, potatoes, barley, fenugreek, cassava, teff, finger and pearl millets, rice, sesame, etc.

Beneficiary

Farmers, scientific community, government, policy makers, industry, research institutions, and the wider public.

Sub-theme 1.3. Environment, Natural Resources, and Climate Change

Rationale

Over the coming decades, Ethiopia needs to respond to the impact of a changing climate and other environmental changes. Research in this sub-theme is intended to focus on developing capabilities that can support the development of innovations in social systems and sectors of society enabling socio-ecological resilience to global change impacts.

Environment is an essential component of human wellbeing and contributes positively to human security, provides basic materials for good life, health and social relations. Nevertheless, today the world is confronted, more than ever before, with unprecedented environmental pressures that are posing extraordinary scientific, social, and economic challenges to the society. Most of the challenges are triggered by anthropogenic activities.

Climate change has become a global issue due to natural and anthropogenic processes being manifested in environmental incidents including floods, drought, increasing desertification, global warming, water scarcity, unexpected precipitation, and others. The major causes for these calamities are different processes of land degradation such as soil erosion, deforestation, overstocking and overgrazing, mismanagement of agricultural lands, improper industrial and municipal waste management, and lack of awareness in natural resources management.

The consequences of the above processes can be evidenced by declining environmental viability, dwindling natural resources (especially soil and its organisms, water, vegetation,

wildlife) and unsustainable agriculture that weaken social resilience. To tackle the problems, there is a need for intervention through participatory research on natural resources and climate change.

Ethiopia is vulnerable to hazards caused by one of the major environmental problems, climate change. Climate change presents an immediate and unprecedented threat to the food security and incomes of millions of Ethiopians who depend on small-scale agriculture for their livelihoods. Most areas in Ethiopia are vulnerable to severe environmental problems related mainly to natural resources degradation. The problems are multifaceted and are the results of intricate nexus of factors. Therefore, the environment, natural resources and climate change related issues need to be treated as an integrated whole to address challenges.

Aim

The aim of this sub-theme is to sustainably improve livelihoods, reduce poverty, and ensure food security using research-based solutions to environmental problems, land degradation, and ecosystem services.

Description

The sub-theme focuses on researching and developing sound management practices and technologies for high priority environmental challenges such as pollution (water, soil, air), climate change, disasters (drought, flood, landslide), and trade-offs between environmental laws and investment and seeking solutions for problems related to major natural resource use and management (soil, forest, land, biodiversity, ecosystems).

Potential Collaborators

Local government and private colleges and universities, environmental protection authorities, overseas universities and research institutes, federal and regional research institutes, federal and regional ministries (such as Ministry of Water Resources, Ministry of Agriculture, Ministry of Environment and Forest Resources, Ministry of Mines and Energy), National Meteorological Agency, Municipalities.

Expected Output

- Database on environmental problems and natural resources
- Biophysical knowledge that leads to new approaches to enhance productivity and profitability of the environment in general and the soil, water, forest, biodiversity and other resources in particular
- Improved technologies/knowledge dissemination and understanding of barriers to increasing rural incomes from the environment and natural resources
- Knowledge for ensuring gender equity and involvement in environmental protection and natural resources management
- Improved technologies that enable the building of climate change resilient natural resources and societies

Research Areas

1.3.1. Environmental research, development, and management

This research area addresses major and high priority environmental problems such as water, air, soil pollution, persistent organic pollutants (POPs), solid and liquid wastes (particularly of urban), and agricultural chemicals (fertilizers, pesticides, herbicides etc), landslide, earth quake, drought, flood; their assessment, mapping and developing integrated management scenarios. Possible research projects include: assessing environmental disaster risks and developing management scenarios; assessment of impacts of major environmental pollution (water, air, and soil pollution) and developing management options; assessing and developing management scenarios for persistent organic pollutants and non-biodegradable plastic wastes mainly used as bags; assessing the impacts of agricultural chemicals on the environment; developing technologies for productive use of solid and liquid urban wastes; handling and disposal of used and expired chemicals; developing early warning systems and public information and means of disaster risk reduction; reducing environmental health risks and

ensuring safety; promoting gender-sensitive work on environmental protection; developing environmental laws and policies and studying their effects on the environment.

1.3.2. Natural resources analysis, use, and management

This research area addresses problems related to conservation and characterisation of major natural resources such as soils, forests, biodiversity and others. It also deals with use and management of natural resources. Research topics may include soil resources protection and analysis (soil characterisation, classification and mapping, problematic soil management, soil erosion control, soil conservation); forest resources analysis, use, and management for environmental protection and soil and water conservation as well as carbon sequestration; wildlife management and conservation; biodiversity conservation and management (including microbial resources) and ecosystems conservation and utilisation for sustainable development; integrated watershed development and management for improving ecosystem functioning; land administration for sustainable land use and management; gender and natural resources management.

1.3.3. Water resources assessment, development, utilisation, and management

This research area addresses issues related to water resources, mainly those related to their spatial and temporal distribution, their development for economic and sustainable exploitation for different purposes, and their integrated management to ensure sustainable use. Possible projects include: water resources assessment, mapping and development; water resources utilisation and management (irrigation and drainage, water harvesting, household consumption, industrial use, and the like); water resources engineering; water use policies.

1.3.4. Climate change and its management

This research area addresses issues related to impacts of climate change hazards on livelihood assets and society; assessment of vulnerability of communities and their assets to climate change hazards and adaptation, mitigation, and coping strategies to hazards. Possible projects include characterisation, classification and mapping of climate; assessing climate change

impacts on livelihood assets, resources and society; development and implementation of diagnosis and vulnerability assessments as a basis for deciding on adaptation and mitigation strategies; development of adaptation technologies, practices, and policies for confronting near-term and progressive climate variability; developing mitigation technologies, practices and policies for reducing greenhouse gas (GHG) emissions and enhancing carbon sequestration; managing weather and climate risks in agriculture. Focusing on natural resources management and conservation especially soil, forest, other vegetation, and water in adapting to and mitigating climate change.

1.3.5. Non-renewable resources

This research area focuses on analysis, exploration, mapping and developing technologies for economic and sustainable utilisation of natural resources that do not renew themselves at a sufficient rate for sustainable economic extraction in meaningful human time frames. These resources include, but are not limited to fossil fuels (such as coal, petroleum, and natural gas), metal ores (such as iron, copper, aluminium ores etc), noble metals (gold, silver, diamond etc), radioactive fuels (e.g. uranium ore), certain aquifers, rocks and minerals that have high economic value.

Beneficiaries

The scientific community, industries, policy makers, and the wider public